# An Investigation of Spot and Futures Market Spread in Indian Stock Market

ISBN: 978-81-924713-8-9

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**Executive Summary**
Spread is an important component of the trading process in a capital market. Spread illustrates the market characteristics of transaction cost, liquidity, volatility, market efficiency etc. Therefore, estimation of spread is very important in the capital market theory. In India, we found a few studies on spot market bid-ask spread and could not find the studies on derivative market bid-ask spread. Therefore, there is a need to investigate the bid-ask spread of both Indian spot and derivative market. In addition, we examine the applicability of High-Low Spread Estimator (HLSE) in Indian market by comparing results with well-known Roll spread estimator. Further, we investigate the informational efficiency of the bid-ask spread of both spot and futures market by using CNX Nifty index and Nifty futures index respectively. We analyse the characteristics of spot and futures market by observing cross sectional results. We adopt correlation technique to know the relationship between two markets and also between two models. We examine the informational efficiency of the spread series of the both the markets.
The empirical results show that there is a high correlation between the spot and futures market spread. The result shows the presence of calendar 'year-end' effect or high 'basis' effect (difference between spot and futures). We found high correlation between results of HLSE and RSE. The less difference in the results of both models supports the applicability of the HLSE in the Indian spot and futures market. The Anova results demonstrate time varying spread across study period. This leads to informational inefficiency of the spread component. This informational inefficiency could adversely affect the spread estimator results. However, the ADF test proves the stationarity of the return series. The results also show that spread component is smaller than price and return. Therefore, the impact of informational inefficiency of the spread is less on the investors. Finally, we conclude that HLSE model is applicable to Indian spot and future market. The analysis of market depth, transaction cost and liquidity is an interesting area in the Indian capital market. This is left for the future research.

*In the theory of market microstructure, bid-ask spread is one of the important components, which signifies the transaction cost, liquidity, volatility, inventory costs, asymmetric information cost etc. In India, the study on the spread is very less. Therefore, we investigate the nature of the bid-ask spread of both stock and futures market by using CNX Nifty index and Nifty futures index respectively. We use six months high frequency data and adopt Roll (1984) spread estimator and high-low spread estimator (HLSE) to estimate the spread. We found high correlation between both spot and futures market and in the in the results. The results prove that the spot and futures market spread has high positive relationship and informationally inefficient.*

**Key words*:*** Bid-Ask Spread, Roll Spread Estimator, High Low Spread Estimator, CNX Nifty Index, Nifty Futures Index.

## 1. Introduction

The study on market microstructure is of great importance to stakeholders of exchanges. The microstructure design helps to understand the liquidity, price formation process and efficiency of the markets (O'Hara, 1997). The bid-ask spread in one of the component of the market microstructure which helps to analyse the order processing costs, inventory costs and asymmetric information costs. Demsetz (1968) linked the spread behaviour to cost of transaction of a security. The other empirical studies showed that nature of bid-ask spread reflects the tick size effect, volume, depth, price formation, and information flow, risk, volatility, liquidity and presence of market makers in the market. The bid-ask spread is important component of the trading process. This is used as diagnostic component in the microstructure theory to explore the market quality.

The research on bid-ask spread is very less and we do not find the studies on behaviour of spread in the Indian derivatives s market. Both equity and derivatives s markets are order driven markets. However, the nature of trading is different in equity and derivatives markets. The trading of securities in equity segment is full value based and derivatives s market is margin based. This influences the trading volume and risk of investors in the derivatives s market. Therefore, the study on the spared of both the equity market and derivatives s market is significant. To study the spread behaviour several models are used in the literature. Most of the spread estimators have postulated that no adverse selection cost is present in the market. This is true according to the finding of Tse (1999). He stated that futures market is free from the insider trading and asymmetric information effects. Therefore, the adverse selection is less in the futures market. These factors favour the assumptions of several spread estimators. This shows that applicability of the spread estimator in the derivatives s market produces valid

results and helps to understand pricing model of derivatives s market. The derivatives trading started in India in the year 2000 with index futures. This market is rising with increased volumes and new products in the trading basket. The derivatives turnover reached to Rs. 382, 11,408.05 cores for the year 2013-2014 in the Indian market.

In this study, we adopt latest spread estimator HLSE and one of the prominent estimator developed by Roll (1984) to estimate the spread in the Indian spot and futures market. The HLSE is based on the assumptions of high prices are buyer initiated and low prices are seller initiated trades. The HLSE assume that high-low price ratio reflects volatility and bid-ask spread. Further, HLSE claims that the volatility increases with the time and bid-ask spread is constant over time. These two aspects permit to estimate the spread based on the HLSE model. The Roll (1984) spread estimator (RSE) is built based on the assumption that observed prices reflect fundamental value of the security and follow random walk. Based on these beliefs, Roll (1984) developed spread estimator on negative autocorrelation. Schultz (2000) empirically showed that the intraday trade prices are more suitable to RSE to generate accurate spread. We use high frequency (minute by minute) data consisting of 6 months from September 2013 to February 2014. We assess the correlation of bid-ask spread of the both the models and measure the market efficiency by using bid-ask spread.

The paper is organised as follows. The next section reviews the existing literature on bid-ask spread. Section 3 describes the data and methodology and section 4 presents the empirical results. Finally, section 5 concludes the paper.

## 2. Review of Literature

In the theory of market microstructure two forms of bid-ask spread estimators are developed. One type of estimators is based on serial covariance and other types of estimators based on order flow of the market. The RSE is the first spread estimator developed on the basis of daily returns serial covariance. Choi, et al (1988) transformed the RSE and integrated the assumption of serial correlation with relevance of transaction type. Stoll (1989) developed new spread estimator in relation to covariance. This estimator is developed based on transaction price changes as a probability function of price reversal and magnitude of price reversal. George et al. (1991) formulated the bid-ask spread model with the covariance difference of actual returns and bid price returns. They empirically proved that new estimator is efficient, unbiased and produces good results. Lesmond et al. (1999) developed the new spread estimator to measure the transaction cost by using daily data sets. He found that his new spread estimator results were highly correlated (85%) to the other generalised spread estimators.

The results of spread models developed by the researchers showed that spread is an important component of the market. The studies have focused the nature of spread and analysed the impacts in a scientific way on the working efficiency of financial market. Ferri and Jani (2005) studied the relationship between bid-ask spread and currency options trading activity on Philadelphia Stock Exchange. They pointed out that the bid-ask spread is one of the components in the market microstructure which reflects the order processing cost, inventory cost and asymmetric information cost. He also shows that presence of market specialists in the market have impact the highest bid and the lowest ask price. Hasbrouck (2004) developed a new model to estimate the spread based on the Markov chain Monte Carlo estimation and applied to futures contracts. He concluded that S&P Index has highest liquidity, Euro and UK Pound has moderate liquidity and pork belly contract has very low liquidity.

The Laux and Senchack (1992) and Ma et al (1992) studied the futures market liquidity by using momentum based estimates in the context of RSE. They found that futures bid-ask spread changes against the hypothesis of constant spread. Easly et al (1987) concluded that the informed traders prefer to trade in higher quantities and the higher quantity of trades offer less favourable price to other traders. They also showed that trading volume influences the price and spread of the security at a particular time. Therefore, Zhang and Hodges (2012) extended the RSE by incorporating size and their probabilities in the spread measure and constructed multiple spreads. Goyenko et al (2009) developed the bid-ask spread estimator with the assumption that higher size in the effective tick stimulates wider bid-ask spread. They pointed out that the relationship between effective tick size and spread helps to analyse the price clustering in the market. Holden (2009) observed that low-frequency spread estimators help to study the nature of liquidity and market microstructure of the markets. Therefore, he developed three low-frequency spread estimators based on three facts of the daily data; price clustering, serial covariance and high, ask price and low, bid price. His models have two approaches, integrated model and multi-factor model. The integrated model has two branches that are Holden and Holden2. The Holden is combined approach of price clustering and serial correlation. Holden2 is extended version of Holden with high, ask price and low, bid price. Based on the performance tests, he found that multi factor and Holden2 models perform well compared to other models used in the study.

The several studies focused on the relationship between spread and other variables like, return, liquidity, volatility, hedge ratio, market maker etc. Amihud and Mendelson (1986a) found that higher spread motivate investors to hold the securities for longer period in a clientele effect. They also found the functional relationship between asset value and spread. Amihud and Mendelson (1986b) examined the relationship of spread, liquidity and stock returns. They found that the investors expect higher returns from higher bid-ask spread securities. They concluded that investors' holding period influences the functions of spread and returns. They explored the positive effect of spread on returns. Finally, they concluded that high spread leads to high returns with lower sensitivity compared to less spread securities.

McInish and Wood (1992) and Aitken and Frino (1996) studied determinants of equity market spread. Kofman and Moser (1997) studied futures market bid-ask spread. Ding (1999) studied determinates forex market bid-ask spread. They have found that price volatility is positively related to bid-ask spread and negatively related to trading activity of the market. Chalmers and Kadlec (1998) showed that amortized spread positively affects the required rate of return of the security. Handa, et al (1998) studied liquidity of order driven market and quote driven market. They found less liquidity in order driven

market compared to quote driven market. Brockman and Chung (1999) noted that systematic changes in the depth can mitigate the high instability of the spread. They also observed that larger spread stimulus to decrease the depth in the market. Brockman and Chung (2008) found the larger spread and weak depth during the period of market stress. They also found the increased commonality feature in liquidity (measured by absolute spread) during the period of market stress.

Corwin (1999) studied the trading behaviour of NYSE firms (which are having specialist participation in the market) by using spread, depth and transitory volatility. They observed that the spread and depth differ across the firms and this is because of specialists' functions in the market. Crown and Schultz (2012) tested the efficiency of the HLSE, RSE and Lesmond, Ogden and Trzcinka (1999) (LOT measure) in simulated condition. They pointed out that HLSE spread series is highly correlated with actual spread compared to other spread estimators. They found high correlation between spreads of HLSE, RSE and LOT measure. Pinder (2003) investigated the factors influencing bid-ask spread of Australian Options Market (AOM). He demonstrated that the options (put and call) bid–ask spreads are positively influenced by value of options, maturity timings, absolute hedge ratio and volatility of underlying securities' return. He found negative relation between option spread and level of trading activity in the option series. He observed that market makers active presence in the market decreases the bid-ask spread in the market. Krishnan and Mishra (2013) studied the factors influencing liquidity on the NSE by using Nifty index. They found that volume and spread influence the liquidity. They also found the presence of U-shaped pattern in the liquidity and spread.

The bid-ask spread is extensively studied in the theory of market microstructure on foreign financial markets. The empirical studies have used the bid-ask spread to analyse many components of the market. These are level of liquidity, factors affecting liquidity, seasonality in liquidity, inventory effect, volume-volatility relationship, return, impact of structural changes, efficiency of the market etc. The majority of the studies have concentrated on the spot market and studies on derivatives market are less. In India, we found a few studies on spot market bid-ask spread and could not find the studies on Indian derivatives' market bid-ask spread. Therefore, we investigate the bid-ask spread of both Indian spot and derivatives market. We also examine the applicability of HLSE in Indian market by comparing results with the well-known estimator-RSE. We also investigate the informational efficiency of the bid-ask spread of both spot and futures market.

The literature shows that in many models, the bid-ask spread plays a significant role in the theory of market microstructure. Therefore, this study focuses on the issues related to bid-ask spread.

## 3. Data and Methodology

We use high frequency data of Nifty Index and Nifty futures index of six months from 1st August 2013 to 28th February 2014. We use minute by minute spread of Nifty Index and Nifty futures to estimate the spread. This helps to obtain the spread of both market indices and to analyse the spread nature of both market. We adopt two estimators to estimate the spread for both spot and futures market viz. the RSE and HLSE.

First, the RSE is one of the prominent estimators used in the financial market literature to estimate the spread. This estimator was developed based on the co-variance. The Roll showed that the transformation of the serial co-variance of price changes produce the spreads. The Roll model as follows.

$$S - 2\sqrt{-Cov(\Delta P_t, \Delta P_{t-1})} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Second, the HLSE was developed by Crowin and Schultz (2012) which is based on the high low prices. The HLSE model postulates that time positively influences to increase the variance; however, time does not influence to increase spread. The HLSE is formulated based on the assumption that the ratios of high-low price series reflect the variance of stock price and bid-ask spread. The HLSE implies that trade prices follow diffusion process and observed prices are more than actual prices by spread 50% high (low) for buy (sell) prices. The model also implies that the daily high (low) values are buyer (seller) initiated trades. Based on above specifications, Crowin and Schultz (2012) modelled the HLSE as-

$$\left[\ln\left(\frac{H_t^O}{L_t^O}\right)\right]^2 = \left[\ln\left(\frac{H_t^A(1+S/2)}{L_t^A(1-S/2)}\right)\right]^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where, $H_t^O$ and $L_t^O$ represents observed high and low prices, respectively. $H_t^A$ and $L_t^A$ represents actual high, low prices respectively; and $S$ represents spread component.

The model specification to estimate the spread is

$$S = \frac{2(e^{\alpha}-1)}{1+e^{\alpha}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where, $\alpha = \frac{\sqrt{2\beta}-\sqrt{\beta}}{3-2\sqrt{2}} - \sqrt{\frac{\gamma}{3-2\sqrt{2}}}$ ..... (4)

Where, $\beta = E\left\{\sum_{j=0}^{1}\left[ln\left(\frac{H_{t+j}^O}{L_{t+j}^O}\right)\right]^2\right\}$ and $\gamma = \left[\ln\left(\frac{H_{t,t+1}^O}{L_{t,t+1}^O}\right)\right]^2$ ..... (5)

Where, $H^{o}_{t+j}$ is the observed price at time $t+j$. The $H^{o}_{t,t+1}$ and $L^{o}_{t,t+1}$ is high (Low) prices of two consecutive days.

Crowin and Schultz (2012) applied HLSE to intraday data and proved that HLSE is valid for the intraday data and spread reflects the intraday patterns. We estimate spread by using both RSE and HLSE on high frequency data. In addition, we compute the minute by minute cross sectional spread (Roll spread and HLSE) to analyse the results by considering time varying factor.

**Augmented Dickey-Fuller Test (ADF test)**

We adopt parametric augmented Dickey-Fuller test to know the stationarity of the return series. If the series are stationary, then there is no unit root in the series. Notably, ADF does not follow t-distribution principle thus, ADF statistic is skewed to left side. Therefore, we form the hypothesis as -

The null hypothesis is: The series contains unit root ($\Omega$ =0, denotes contains unit root)

The alternative hypothesis is: The series does not contain unit root ($\Omega$ < 0, denotes series doesn't contain unit root)

The ADF test equation is-

$$\Delta Z_t = \alpha_1 + \beta_1 t + \Omega z_{t-1} + \sum_{i=2}^{m} \varpi_i \Delta Z_{t-1} + e_t \quad \text{..... (6)}$$

Where $e_t$ is an error term and $\Delta Z_{t-1} = (Z_{t-1} - Z_{t-2})$ ..... (7)

Finally, we use F-statistic values of analysis of variance test to measure the cross sectional spread differences within and between months. This helps to test the hypothesis of constant spread across time periods.

## 4. Empirical Results

We use HLSE and RSE spread estimators to investigate characteristics of futures and spot market by using Nifty futures and Nifty spot market indices, respectively. The HLSE and RSE are developed based on different assumptions. Thus, the nature of capturing the components of liquidity and volatility is different from model to model. We test both the models' fitness and the spread correlations in both the markets. Hussain and Hussain (2011) argued that HLSE and RSE results have very low correlations. This evidence contradicts the findings of the study conducted by Crowin and Schultz (2012). Therefore, we investigate correlations of the results produced by both HLSE and RSE in Indian market. While computing the Roll spread, we consider negative co-variance and omit the positive co-variance (32%), which does not support to transform the co-variance to estimate the Roll spread. Likewise, we omit negative alpha values (38%) and corresponding spread values in HLSE model, which are not capable of explaining the spread. Crown and Schultz (2012) proved that omission of negative alpha values in HLSE model helps to estimate good results and the negative alpha values produce negative spread in the model. Practically, there is not possible in the financial market. Therefore, we omit these negative spread as suggested by Chordia, Roll, and Subrahmanyam (2001, 2002).

The table 1 reports the result of HLSE and Roll spread estimator for six months period. The month wise cross sectional spread mean values of the HLSE model are low compared to RSE for all the six months for both the markets. The statistically significant t-statistics of spread produced by HLSE and Roll model show that both the models produce significantly dissimilar results. This shows that the two models have different assumptions. The assumptions of the model play a significant role in characteristics of the spread and represents different variables like transaction cost, liquidity etc.

Crown and Schultz (2012) investigated the efficiency of the three spread estimators namely, the RSE, Holden estimator and HLSE. They found high correlation between Holden estimator and HLSE In this study, the month wise cross sectional correlation results prove the positive relationship between the HLSE and RSE spread for all the months. The December month experiences low mean difference and high correlation between the spread of both estimators. The possible reason for this might be calendar 'year-end' effect or high 'basis' effect (difference between spot and futures). This reveals seasonal effects in the HLSE estimator and RSE. The correlation of futures market spread is low for all months compared to spot market. This shows that the futures market is highly liquid compared to the spot market in all the months. Further, the time varying cross sectional mean differences indicate time varying liquidity of both spot and futures markets.

**Table 1** *The Cross Sectional Results of High-Low Spread Estimator, Roll (1984) Spread Estimator, T Test and Correlation*

| Months | Cross Sectional Spreads | | | | | | |
|---|---|---|---|---|---|---|---|
| | Market | Estimators | Observations | Mean | t statistic | p value | Correlation |
| Sept | Futures | High-Low Spread | 7499 | 0.04444 | -16.6552 | 0.0000 | 0.7462 |
| | | Roll Spread | 7499 | 0.05859 | | | |
| | Spot | High-Low Spread | 7499 | 0.04055 | -15.7646 | 0.0000 | 0.7542 |
| | | Roll Spread | 7499 | 0.05351 | | | |
| Oct | Futures | High-Low Spread | 7800 | 0.032208 | -21.2131 | 0.0000 | 0.5304 |
| | | Roll Spread | 7800 | 0.04277 | | | |
| | Spot | High-Low Spread | 7800 | 0.028581 | -18.5348 | 0.0000 | 0.5817 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Roll Spread | 7800 | 0.03809 | | | |
| Nov | Futures | High-Low Spread | 7213 | 0.029162 | -17.9998 | 0.0000 | 0.5304 |
| | | Roll Spread | 7213 | 0.038214 | | | |
| | Spot | High-Low Spread | 7213 | 0.025656 | -18.9553 | 0.0000 | 0.5817 |
| | | Roll Spread | 7213 | 0.033931 | | | |
| Dec | Futures | High-Low Spread | 7887 | 0.022473 | -13.2640 | 0.0000 | 0.7799 |
| | | Roll Spread | 7887 | 0.029278 | | | |
| | Spot | High-Low Spread | 7887 | 0.02065 | -9.8090 | 0.0000 | 0.8011 |
| | | Roll Spread | 7887 | 0.025897 | | | |
| Jan | Futures | High-Low Spread | 8625 | 0.022982 | -20.6529 | 0.0000 | 0.6569 |
| | | Roll Spread | 8625 | 0.031496 | | | |
| | Spot | High-Low Spread | 8625 | 0.021434 | -12.5612 | 0.0000 | 0.7117 |
| | | Roll Spread | 8625 | 0.026854 | | | |
| Feb | Futures | High-Low Spread | 7124 | 0.021557 | -19.3228 | 0.0000 | 0.6264 |
| | | Roll Spread | 7124 | 0.029276 | | | |
| | Spot | High-Low Spread | 7124 | 0.018461 | -14.7656 | 0.0000 | 0.6263 |
| | | Roll Spread | 7124 | 0.024544 | | | |
| 6 Months | Futures | High-Low Spread | 46148 | 0.028687 | -50.342 | 0.0000 | 0.7008 |
| | | Roll Spread | 46148 | 0.038132 | | | |
| | Spot | High-Low Spread | 46148 | 0.025816 | -35.458 | 0.0000 | 0.7202 |
| | | Roll Spread | 46148 | 0.03367 | | | |

**Table 2** *The Results of Correlation Between Futures and Spot Market*

| **Correlation Results (Futures and Spot)** | | |
|---|---|---|
| | **High-Low spread** | **Roll Spread** |
| Sept | 0.9261 | 0.8523 |
| Oct | 0.8404 | 0.7482 |
| Nov | 0.7273 | 0.7289 |
| Dec | 0.9137 | 0.8510 |
| Jan | 0.8611 | 0.8177 |
| Feb | 0.8465 | 0.7938 |
| 6 Months | 0.8820 | 0.8245 |

We use correlation technique to investigate the nature of relationship between future and spot market and also between two models. We examine the time varying relationship of spread series by cross sectional correlation technique. The cross sectional correlations of both the models show that highly positive relationship between future and spot market for all the months. Therefore, we infer that the future and spot market spread have high positive relationship. However, we have found the time varying fluctuations between the months and the changing relationship with the time. The HLSE estimator spread signals more positive relationship between the markets compared to results of RSE for overall study period. The differences in the correlations between the spread of HLSE and RSE is very less for all the months in both spot and futures market. This shows that the HLSE and RSE produce similar results and HLSE model is applicable to both Indian spot and futures market. These results are similar to the results of Crown and Schultz (2012) and contradict the results of Hussain and Hassan (2011).

**Table 3** *The Results of Analysis of Variance*

| **Estimators** | **Market** | **Months** | ***F-statistics*** | ***P-value*** |
|---|---|---|---|---|
| **High-Low Spread** | Futures | 6 | 130.408 | 0.0000 |
| | Spot | 6 | 105.547 | 0.0000 |
| **Roll Spread** | Futures | 6 | 431.249 | 0.0000 |
| | Spot | 6 | 430.848 | 0.0000 |

The spread needs to be equal for all the period in ideal market conditions. The spot and futures markets' tick size does not change in the study period. Thus, we expect constant spread in the all six months. We adopt Analysis of variance (Anova) technique to test the cross sectional spread difference in different months. Table 3 presents the Anova results of both the spot and futures market. The Anova test statistics are statistically significant for both future and spot market spreads series obtained from the both the models. These indicate that both markets have informationally inefficient spread series. This violates many spread estimators' assumption that market is informationally efficient. The informational inefficiency of the spread could lead to problems in estimating spread. However, the spread component is very small compared to the returns series and return series stationarity is more important. Therefore, we investigate the stationarity of the spot and futures markets return series by using Augmented Dickey-Fuller test (ADF test). The ADF test results show the presence of stationarity characteristic in the two market returns series. Hence, the effect of the informational inefficiency of the spread may not significantly impact the market participants.

## 5. Conclusions

The spread is very important component of the trading process in a capital market. Spread illustrates the market characteristics of transaction cost, liquidity, volatility, market efficiency etc. Therefore, estimation of spread is very important in the capital market theory. In this study, we estimate the Indian spot and futures market spread by using HLSE and RSE. We also test the validity of HLSE and compare the results of HLSE with the results of RSE. We analyse the characteristics of spot and futures market by observing cross sectional results. We adopt correlation technique to know the relationship between the two markets and also between the two models. We examine the informational efficiency of the spread series of both the markets.

Based on the results, we found the high correlation between the spot and futures market spread. The result shows the presence of calendar 'year-end' effect or high 'basis' effect (difference between spot and futures). We found high correlation between results of HLSE and RSE. The less difference in the results of both models support the applicability of the HLSE in the Indian spot and futures market. The Anova results demonstrate time varying spread across study period. This leads to informational inefficiency of the spread component. This informational inefficiency could adversely affect the spread estimator results. However, the ADF test proves the stationarity of the return series. The results also show that spread component is smaller than price and return. Therefore, informational inefficiency of the spread impact is less on the investors. Finally, we conclude that HLSE model is applicable to Indian spot and future market. The analysis of market depth, transaction cost and liquidity is an interesting area in the Indian capital market. This is left for the future research.

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