**Determinants of Price Discovery in Three Indian Markets**

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**Abstract:** National Stock Exchange (NSE) and Bombay Stock Exchange (BSE) are the two largest stock exchanges in India by turnover. Single stock futures also trade on the NSE and this segment has been recognized time and again as a world leader. Linkage between turnover and information share (Hasbrouck IS, Gonzalo Granger CS and Putniņš ILS) has been explored for 50 component stocks of benchmark NIFTY50 Index of NSE, trading on NSE (Spot and Future) and BSE (Spot). Results indicate the higher turnover on both segments in NSE contributes to improvement in price discovery share for stocks trading on both NSE Spot and Futures market, but BSE turnover does not contribute to improvement in information sharing by stocks trading on BSE.

**1. INTRODUCTION**

Indian capital market has undergone a major transformation and structural change post liberalization reforms. The degree of integration of capital market with the economy is essentially related to the efficiency of that market. Market efficiency explains the relationship between the information and share prices in the capital market. The market that is efficient in processing information and in turn reflecting in its prices is an efficient market. The process through which asset markets reach equilibrium price levels is known as Price Discovery. The increased efficiency in information processing allows for faster price discovery. The presence of various markets allows information to flow through various channels. Higher liquidity implies greater participation by various groups of investors and traders and hence faster information absorption. Most of the stocks are traded in both the markets and presence of derivatives markets support the spot markets in discovering the equilibrium prices.

The stocks that are traded in both the markets differ in their prices, but for no arbitrage condition, there should not be any difference in their prices. Also, the Futures market and its underlying spot market are linked to the cost of carry model, which is based on the principle of no arbitrage. It implies that futures price serves as market’s expectations of subsequent spot price. Understanding the influence of one market on the other and the role of each market segment in price discovery is the central question in market microstructure design and is very important to academia and regulators. Theoretically, in the absence of taxes, costs, and other market frictions, Futures price is an unbiased estimator of the spot price for the stocks traded in both the markets at a fixed future date but in reality, institutional factors such as liquidity, transaction costs, and other market restrictions may produce an empirical lead-lag relationship between price changes in the three markets. Moreover, all the markets do not trade simultaneously for many assets.

Financial market pricing theory states that market efficiency is a function of how fast and how much information is reflected in prices. The rate at which prices exhibit market information is the rate at which this information is disseminated to market participants.

Research in the area of price discovery and information sharing amongst futures and spot markets is important from two main standpoints. Firstly, it has implications for market efficiency. Second, besides being of academic interest, understanding information flow across markets is important for hedge funds, portfolio managers, and hedgers for hedging and devising cross-market investment strategies.

Till date, researchers are trying to determine the factors which impact the contribution of a particular market in price discovery. This research is a step in that direction. The paper explores the linkages between turnover in the three markets and their contributions to price discovery.

Section 2 presents a short review of literature; Data and Methodology are discussed in Section 3. Section 4 presents the results and discussions and Section 5 concludes.

**2. LITERATURE REVIEW**

There have been a number of studies examining the intraday causal relationship between the futures markets and its underlying spot markets and but a few that examine the two prominent spot markets (NSE and BSE) of India. There have been contrary views on impact lead-lag relationship or price discovery process. Examining the Major Market Index (MMI), Stoll and Whaley (1990) found that the futures lead the spot by 5 minutes. Ghosh (1993) used cointegration to assess the price discovery process in the S&P500 spot and futures market and found evidence to support the superiority of futures in price discovery. Bi-directional causality was found between S&P500 spot and futures returns by Wahab and Lashgari (1993). Tse (1995) used a VECM method to examine the Nikkei 225 spot and futures market for a period of 5 years and found that the futures market leads the spot market, but not vice versa. FTSE 100 futures were found to lead the FTSE 100 index by Brooks, Rew, and Ritson (2001). So and Tse (2004) used Hang Seng index, futures and tracker data for three years and measured the individual contributions to price discovery. They found that almost three-fourth of the price discovery was due to the futures market and rest by the spot market. Chan (1992), Hasbrouck (1995), Jong and Donders (1998), Booth (1999), Turkington and Walsh (1999), Menkveld (2003), Chuang (2003), Barclay and Hendershott (2004), Sharma and Gupta (2005), Gupta and Singh (2006) assessed the prices discovery efficiency of equity futures in different countries namely: America, the Netherlands, Germany, Australia, Taiwan, Hong Kong, respectively. Except for Barclay and Hendershott (2004), in almost all the research studies significant evidence of efficient price discovery through equity futures market is observed which indicates the utilization of the lower cost structure of the futures markets.

The area of emerging market research, Bohl, Salm and Schuppli (2011) show that in markets with presumably uninformed private investors, the superiority of the futures market for price discovery might break down. In fact, in such cases, the spot market will lead the futures market in price discovery. Yang, Yang, and Zhou (2012) found evidence to support the Bohl, Salm and Schuppli (2011) results. They studied China’s future market and found the contrarian result of the spot market leading the futures market.

The studies related to cointegration of Indian stock market by Jha and Nagrajan (1999) report that the stock prices in the BSE and NSE are cointegrated in the long run but show a considerable difference in the short run. Narayan et al. (2004) examined the cointegration of the stock markets of Bangladesh, India, and Sri Lanka. The study reports that in the long run, the stock prices in Bangladesh, India, and Sri Lanka Granger cause stock price in Pakistan. Wong and Guorui (2005) investigate the long run relationship and short run dynamic linkage between the India stock market and the stock markets of the US, the UK, and Japan. The study indicates that the Indian stock market is integrated and sensitive to the dynamics of these markets in the long run. The study conducted by Chaula et al. (2006) examined the random walk hypothesis and the market integration among the Indian stock market vis-à-vis the developed economies such as the US, the UK, Australia and Canada. The results exhibit the existence of random walk hypothesis and no cointegration is established among these markets confirming the weak efficiency. Further, the study suggests that there exists a unidirectional causality from developed market to the Indian market. A study by Madhusoodanan and Kumar (2008) reveal the existence of market integration between the BSE and NSE. The study further confirms the role of NSE as a dominating factor over BSE.

In view of the policy innovations in the capital market during the liberalization era, it is desirable to test the price discovery and information sharing functions in the Indian stock market between the NSE and the BSE, BSE and NSE Futures and NSE and NSE Futures. We use the Johansen and Juselius(1990) multivariate cointegration test to test for cointegration. A Vector Error Correction Model (VECM) is then fitted to the pairs, Hasbrouck (1995) Information Share(IS) and Gonzalo and Granger (1995) Component Share(CS) and then combining the IS and CS such that their dependence on noise cancels out which is known as the Information Leadership Share (ILS), developed in Yan and Zivot (2010) and Putniņš (2013). Then by forming panel data, we test whether the turnover of stocks is significant in determining the price discovery metrics.

**3. DATA AND METHODODOLOGY**

**3.1 DATA**

There are 22 stock exchanges in India, National Stock Exchange (NSE) and Bombay Stock Exchange (BSE) being the most prominent ones. BSE which began formal trading in 1875 is one of the oldest in Asia. Since 1991, the Indian capital market has undergone a major transformation and structural change. The first exchange to be based on an open electronic limit order book in India was the NSE, which started trading debt instruments in June 1994 and equity in November 1994. Although the market capitalization in similar for both indices, NSE and BSE vary from each other in terms of volume of trading, for a given stock the NSE usually trades about 10 times the volume as the BSE.

NIFTY 50 is considered as a barometer for the Indian capital markets and is composed of 50 blue chip stocks across 23 sectors of the Indian Economy. These stocks are chosen based on a methodology that prioritizes several factors. Therefore, these 50 stocks are among the most liquid and widely traded stocks on the NSE.

This study utilizes intraday prices, observed at 5-minute intervals, for the 50 stocks of the NIFTY 50 index traded on the NSE and the BSE along with their corresponding futures from November 23rd, 2015 to May 18th, 2016. Data period was chosen based on availability of data from the Bloomberg terminal. Because futures expire on the expire on the last Thursday of every month, the Futures prices were rolled over to the next month future price series on the Monday preceding the expiry. The data spans a period of six months with 9,044 observations of price for 50 stocks of Nifty50 trading in NSE spot market, NSE Futures and BSE spot market.

These pairs of series were converted into new price series by taking logarithms of the existing series to minimize the heteroscedasticity in the data and allows for a better fitting model. There are no significant differences among the descriptive statistics between the two spot market prices and between the spot and Futures prices for stocks, which indicates similar price movements in all three pairs, which is to be expected if no arbitrage condition holds. In addition, observing prices at five-minute intervals allow us to closely examine the minutest of movements in the prices and any deviations between the markets. The descriptive statistics indicate that prices in all markets seem to share a similar distribution.

**3.2 EMPIRICAL METHODOLOGIES**

The price series for each of 50 stocks trading in NSE Spot (NSE\_S), BSE Spot (BSE\_S) and NSE futures (NSE\_F) were tested for the presence of a unit root using the Augmented-Dickey-Fuller (1979) and Phillips-Perron (1988) test. All the series observed indicated the presence of a unit root. The difference series indicated an absence of a unit root. Therefore, all of the series under consideration were found to be integrated of order 1 (I(1)). Because the variables are integrated of the same order, the Johansen-Juselius (1990) test was applied to test for cointegration and to estimate the long-term relationship within the three pairs. The Johansen-Juselius test provides more efficient estimates of the cointegrating relationship than the Engle and Granger (1987) estimator (Gonzalo, 1994). It is also robust to non-normality (Cheung and Lai, 1993) and heteroscedasticity (Lee and Tse, 1996). The lag length of the model was estimated using the Schwarz Information Criteria (SIC). Every pair exhibited cointegration. These results were as expected due to the underlying nature of the price series and the pair-wise relationship.

Following these tests, a Vector Error Correction Model (VECM) was estimated for each pair of the NSE\_S-NSE\_F, BSE\_S-NSE\_F and NSE\_S-BSE\_S pairs to model the short run effect of the error correction term (ECT), which was isolated from the cointegrating vector as estimated in equation (1, 2 and 3). The following equations were estimated for each pair:

ECT1t=α1t + NSE\_St+ϒ1NSE\_Ft (1)

ECT2t=α2t+ BSE\_St+ϒ2NSE\_Ft (2)

ECT3t=α3t+ NSE\_St+ϒ3BSE\_St (3)

-1+1t (4)

-1 +2t (5)

-1 +3t (6)

-1 +4t (7)

-1 +5t (8)

-1 +6t (9)

Where NSE\_S, BSE\_S, and NSE\_F are log-prices for each stock pair of the NSE and BSE spot markets and NSE futures market, ECTt-1 is the lagged ECT estimated from the cointegration, and the μ series are white noise residuals.

This VECM model forms the basis of computing the price discovery contribution of each market in each pair using the methodologies described Hasbrouck (1995) and Gonzalo Granger (1995). These two are the most widely used methodologies for estimating the information share contribution of markets in the literature.

**3.2.1Hasbrouck information share (IS)**

Hasbrouck (1995) defines price discovery in terms of the variance in terms of the innovations to the common factor. The model measures each market’s relative contribution to this variance, and this is termed as market’s Information Share (IS).

This methodology is very sensitive to the correlation among the variance of the error terms in the VECM but at an ultra-high frequency of observation (one second) this variance is almost 0; therefore, the upper bounds and lower bounds are close together. Because this study utilizes prices observed at five-minute intervals, there is a larger gap in the upper and lower bounds. This has also been documented in the literature by Tse (1995).

**3.2.2 Gonzalo-Granger Information Share (CS)**

The Gonzalo-Granger information share is only concerned with the error correction process and the movement of markets to correct disequilibria among prices. Because markets absorb news at different rates, disequilibria occur among markets with cointegrating prices. Their prices then adjust so as to return to equilibrium. The model measures the contribution of the price movements to the common factor, as estimated by the coefficient of the ECT.

The effect of correlation among the residuals of the VECM model is not taken into account in the Gonzalo-Granger information share. Hence in the absence of significant correlation, both the Gonzalo-Granger and Hasbrouck information shares yield similar results; however, if the correlation is high, the results differ. In this study, because, the prices are being observed at five-minute intervals, the correlation among the residuals of the VECM model is not very high, and both information shares are expected to give similar results.

**3.2.3 Information Leadership Share (ILS)**

Recent studies show that IS and CS both are sensitive to the relative level of noise between two markets – they measure a combination of leadership in impounding new information (what price discovery metrics aim to measure), and the relative level of noise in the price series (Yan & Zivot, 2010; Putniņš, 2013). Consequently, IS and CS tend to overstate the price discovery contribution of the less noisy market. Of the two, IS places greater weight on the speed at which a price series impounds new information, compared to the CS metric which is largely a measure of the relative levels of noise. It is likely that the levels of noise in the prices of the two markets examined in this paper are vastly different considering their differences in liquidity levels, market structure, and instrument types. Therefore, it is important to keep in mind the sensitivity of IS and CS to differences in microstructure noise when interpreting the results.

An important insight of the recent price discovery literature is that a combination of IS and CS is able to correctly attribute contributions to price discovery without being influenced by differences in noise levels. Intuitively, IS and CS can be combined such that their dependence on noise cancels out. This measure, known as the Information Leadership Share (ILS), developed in Yan and Zivot (2010) and Putniņš (2013).

We estimate all three price discovery metrics, noting that they measure different aspects of price discovery.

**3.2.4 Panel Regression**

After calculating the price discovery metrics, to determine the factors affecting the information share, we regress the respective information share of each pair of the respective series on turnover of the stock trading in the two markets being tested for price discovery. Test for poolability suggest that the data cannot be pooled and needs to be analysed in a panel structure. Estimating the model using pooled data would have ignored the heterogeneity present in the data, which will be captured using panel analysis. Null under Hausman test was rejected and a fixed effects model was used for estimation.

**4. Empirical Results**

All 50 pairs of NSE\_S and NSE\_F, BSE\_S and NSE\_F and NSE\_S and BSE\_S series exhibit the presence of a unit root, were cointegrated with each other and were then modeled using VECM so as to allow estimation of Hasbrouck (IS) and Gonzalo-Granger (CS) information shares. ILS is calculated using the IS and CS. Table 1, 2 and 3 lists the IS, CS and ILS for each stock trading in three above-mentioned pairs of markets.

---Insert Table1---

---Insert Table2---

---Insert Table3---

From Table 1, it can be observed that for every stock, the IS for NSE spot market has a higher information share content than that of the NSE futures market. If we look at the Gonzalo-Granger Component Share (CS), for 21 stocks, NSE futures have higher information share as compared to NSE spot market. The remaining 29 stocks have the spot market indicating higher information content than that of the futures market. ILS also indicates that for 29 stocks spot market has a higher information content and for the rest 21 stocks, future market has higher information content but the 29 stocks for which the CS indicates that spot market has higher information content are not same 29 stocks which are being indicated by ILS that have a higher information content.

From Table 2, it can be observed that for every stock, the BSE spot market has a higher IS than that of the NSE futures market. For 16 stocks, CS indicates that the NSE Futures market has higher information content than the BSE spot market and ILS indicates that for 19 stocks NSE future market has higher information content.

From Table 3, it can be observed that for almost every stock, NSE spot market has higher information content that the BSE spot market.

If one market reacts faster to information, and the other market is slow to react, due to market frictions such as transactions costs or market microstructure effects, a lead-lag relation in returns is observed. The market that provides greater liquidity, lower transaction costs, and less restriction, is likely to play a more important role in price discovery. Looking at the three tables, we can see that there is not too much variation in the information share. There’s almost equal information sharing between any two pairs of stock except for the NSE spot market and BSE spot market. New information is reflected in the spot and its corresponding futures markets simultaneously in the short run. The price discovery metrics indicate that the spot markets and their corresponding futures market are efficient in the short run and NSE spot market lead in price discovery over the BSE spot market at five-minute intervals.

Information share metrics were regressed, using panel regression, on the corresponding turnover of the stocks being traded in both the markets for which we calculated the information share. The striking result is that for the dependent variable which included the BSE spot market in its price discovery metric, the coefficient of the log of values of BSE spot market i.e. DTIBVAL turns out to be insignificant in each of the cases. Tables 4 – 6 present the result of the panel regression.

---Insert Table 4---

---Insert Table 5---

---Insert Table 6---

This indicates that the turnover on BSE does not contribute to information sharing. Turnover on both NSE Spot as well as NSE Futures markets shows significant coefficient in the models, indicating that they have an impact in improving information share of their corresponding market. Analysis of the coefficient signs indicate that increased turnover is related to higher information share of NSE Spot / Futures markets.

Panel regression indicates that for each price discovery metric, the value of contracts traded on the BSE has no significant impact in determining the information share for the BSE spot market and NSE Futures market and for the NSE spot market and BSE spot market.

**5. CONCLUSIONS**

In a perfectly running world, every bit of information should be reflected simultaneously in the underlying spot market and its futures markets. However, in reality, information can be disseminated in one market first and then transmitted to other markets due to market imperfections. This paper investigates the relationship between the NSE spot market, NSE futures markets and BSE spot market for the individual stocks that comprise the NIFTY 50 index. The purpose was to analyze the price discovery mechanism and direction of information flow along with the relative importance of different markets in determining the equilibrium prices in single stocks. Cointegration was found between the stocks trading in the three pairs of markets, indicating a long term relationship and co-movement in a specified range, supporting the no arbitrage condition.

Our results of the price discovery metrics indicate that Hasbrouck Information Share on average is higher for NSE spot market than its corresponding future market, BSE spot market has higher information content than NSE futures market and NSE spot market has higher information share content than BSE spot market. On average, Gonzalo-Granger CS and ILS give the same result as given by Hasbrouck IS. When we run the regression for the panel data with respective information share metrics as the dependent variable and the corresponding turnover of the stocks being traded, according to panel least squared method, BSE spot market’s turnover has no impact on the price discovery metrics. This indicates that trading in BSE does not contribute towards it price discovery share. Increased trading in both NSE Spot and NSE futures, leads to increase in their respective price discovery shares.

The dominance of NSE futures market or NSE cash market over BSE cash market may be due to the fact that NSE has set up one of the best online trading systems in the world and liquidity is very high in NSE. This is evident from the fact that less than half the number of companies are listed in BSE are listed in NSE but the market capitalization is almost similar for the two.

While higher support for the spot market than the futures market indicates that the futures market is not fulfilling its role of assisting the underlying spot market in price discovery. This could be because the Indian Futures market is still young and many financial institutions- such as mutual funds, banks and insurance companies are restricted to trading only in the cash market by the Securities and Exchange Board of India (SEBI).

These results have significance for both policy makers and investors. Trading on BSE does not lead to contribution in information share, indicating either an illiquid market or high impact costs. In such a situation, investors should avoid trading on the BSE and should prefer NSE. This has been witnessed since long in the significantly higher turnover of trading happening on the NSE as compared to the BSE.

In order to improve the price discovery participation of the futures market, the restrictions on institutional investors must be relaxed. Institutional investors should be allowed to take directional risks in the futures markets as they do in the cash markets, with restrictions to curb speculative activities. For investors, the superiority of the cash market indicates its importance to the construction of quantitative trading systems. Because it has a higher contribution to price discovery than the futures market, the cash market contains more information about the direction of the individual stocks.

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Table 1

Information share content for NSE spot market and BSE spot market

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Stock Symbol* | ***Hasbrouck information share*** | | *High IS market* | ***Gonzalo-Granger Information share*** | | *High CS market* | ***Information Leadership Share*** | | *High CS market* |
| *NSE\_S* | *BSE\_S* | *NSE\_S* | *BSE\_S* | *NSE\_S* | *BSE\_S* |
| ACC | 60.2% | 39.8% | Spot | 52.5% | 47.5% | Spot | 50.1% | 49.9% | Spot |
| ACEM | 55.4% | 44.6% | Spot | 53.2% | 46.8% | Spot | 45.9% | 54.1% | Future |
| ADSEZ | 58.1% | 41.9% | Spot | 52.6% | 47.4% | Spot | 52.2% | 47.8% | Spot |
| APNT | 60.5% | 39.5% | Spot | 51.2% | 48.8% | Spot | 56.2% | 43.8% | Spot |
| ARBP | 65.7% | 34.3% | Spot | 55.3% | 44.7% | Spot | 60.8% | 39.2% | Spot |
| AXSB | 66.7% | 33.3% | Spot | 49.0% | 51.0% | Future | 67.6% | 32.4% | Spot |
| BHARTI | 61.4% | 38.6% | Spot | 54.9% | 45.1% | Spot | 53.1% | 46.9% | Spot |
| BHEL | 62.7% | 37.3% | Spot | 53.6% | 46.4% | Spot | 57.5% | 42.5% | Spot |
| BHIN | 60.9% | 39.1% | Spot | 54.0% | 46.0% | Spot | 50.5% | 49.5% | Spot |
| BJAUT | 58.9% | 41.1% | Spot | 50.3% | 49.7% | Spot | 52.0% | 48.0% | Spot |
| BOB | 64.5% | 35.5% | Spot | 49.2% | 50.8% | Future | 60.2% | 39.8% | Spot |
| BOS | 62.7% | 37.3% | Spot | 61.1% | 38.9% | Spot | 45.8% | 54.2% | Future |
| BPCL | 61.4% | 38.6% | Spot | 50.4% | 49.6% | Spot | 58.5% | 41.5% | Spot |
| CIPLA | 61.4% | 38.6% | Spot | 51.7% | 48.3% | Spot | 58.3% | 41.7% | Spot |
| COAL | 66.7% | 33.3% | Spot | 51.4% | 48.6% | Spot | 62.5% | 37.5% | Spot |
| DRRD | 60.7% | 39.3% | Spot | 53.1% | 46.9% | Spot | 55.2% | 44.8% | Spot |
| EIM | 66.7% | 33.3% | Spot | 55.6% | 44.4% | Spot | 56.6% | 43.4% | Spot |
| GAIL | 61.5% | 38.5% | Spot | 49.1% | 50.9% | Future | 59.5% | 40.5% | Spot |
| GRASIM | 60.2% | 39.8% | Spot | 57.0% | 43.0% | Spot | 45.3% | 54.7% | Future |
| HCLT | 63.4% | 36.6% | Spot | 52.1% | 47.9% | Spot | 56.4% | 43.6% | Spot |
| HDFC | 63.7% | 36.3% | Spot | 52.4% | 47.6% | Spot | 57.0% | 43.0% | Spot |
| HDFCB | 66.7% | 33.3% | Spot | 54.8% | 45.2% | Spot | 54.6% | 45.4% | Spot |
| HMCL | 65.4% | 34.6% | Spot | 53.7% | 46.3% | Spot | 58.2% | 41.8% | Spot |
| HNDL | 65.9% | 34.1% | Spot | 48.5% | 51.5% | Future | 60.0% | 40.0% | Spot |
| HUVR | 65.4% | 34.6% | Spot | 51.7% | 48.3% | Spot | 60.5% | 39.5% | Spot |
| ICICIBC | 61.6% | 38.4% | Spot | 51.2% | 48.8% | Spot | 62.4% | 37.6% | Spot |
| IDEA | 56.0% | 44.0% | Spot | 52.9% | 47.1% | Spot | 48.9% | 51.1% | Future |
| IIB | 68.7% | 31.3% | Spot | 54.1% | 45.9% | Spot | 59.2% | 40.8% | Spot |
| INFO | 63.7% | 36.3% | Spot | 53.5% | 46.5% | Spot | 56.8% | 43.2% | Spot |
| ITC | 64.4% | 35.6% | Spot | 53.5% | 46.5% | Spot | 55.7% | 44.3% | Spot |
| KMB | 64.2% | 35.8% | Spot | 55.6% | 44.4% | Spot | 53.3% | 46.7% | Spot |
| LPC | 64.5% | 35.5% | Spot | 52.0% | 48.0% | Spot | 60.0% | 40.0% | Spot |
| LT | 62.9% | 37.1% | Spot | 51.3% | 48.7% | Spot | 61.2% | 38.8% | Spot |
| MM | 67.2% | 32.8% | Spot | 50.9% | 49.1% | Spot | 64.6% | 35.4% | Spot |
| MSIL | 63.2% | 36.8% | Spot | 51.4% | 48.6% | Spot | 61.2% | 38.8% | Spot |
| NTPC | 64.8% | 35.2% | Spot | 53.0% | 47.0% | Spot | 55.4% | 44.6% | Spot |
| ONGC | 62.6% | 37.4% | Spot | 51.0% | 49.0% | Spot | 56.8% | 43.2% | Spot |
| PWGR | 61.7% | 38.3% | Spot | 55.0% | 45.0% | Spot | 50.8% | 49.2% | Spot |
| RIL | 59.0% | 41.0% | Spot | 51.1% | 48.9% | Spot | 58.8% | 41.2% | Spot |
| SBIN | 66.8% | 33.2% | Spot | 48.0% | 52.0% | Future | 68.4% | 31.6% | Spot |
| SUNP | 59.9% | 40.1% | Spot | 53.0% | 47.0% | Spot | 55.3% | 44.7% | Spot |
| TATA | 63.3% | 36.7% | Spot | 50.4% | 49.6% | Spot | 62.8% | 37.2% | Spot |
| TCS | 59.0% | 41.0% | Spot | 50.2% | 49.8% | Spot | 51.7% | 48.3% | Spot |
| TECHM | 56.2% | 43.8% | Spot | 54.3% | 45.7% | Spot | 46.9% | 53.1% | Future |
| TPWR | 66.9% | 33.1% | Spot | 54.3% | 45.7% | Spot | 55.3% | 44.7% | Spot |
| TTMT | 62.4% | 37.6% | Spot | 54.9% | 45.1% | Spot | 58.9% | 41.1% | Spot |
| UTCEM | 62.1% | 37.9% | Spot | 52.4% | 47.6% | Spot | 54.5% | 45.5% | Spot |
| WPRO | 64.3% | 35.7% | Spot | 55.6% | 44.4% | Spot | 53.1% | 46.9% | Spot |
| YES | 64.6% | 35.4% | Spot | 46.9% | 53.1% | Future | 65.4% | 34.6% | Spot |
| Z | 60.1% | 39.9% | Spot | 54.5% | 45.5% | Spot | 49.7% | 50.3% | Future |

Table 2

Information share content for NSE spot market and BSE spot market

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Stock Symbol* | ***Hasbrouck information share*** | | *High IS market* | ***Gonzalo-Granger Information share*** | | *High CS market* | ***Information Leadership Share*** | | *High CS market* |
| *BSE\_S* | *NSE\_F* | *BSE\_S* | *NSE\_F* | *BSE\_S* | *NSE\_F* |
| ACC | 57.0% | 43.0% | Spot | 48.6% | 51.4% | Future | 56.4% | 43.6% | Spot |
| ACEM | 55.7% | 44.3% | Spot | 49.5% | 50.5% | Future | 55.0% | 45.0% | Spot |
| ADSEZ | 57.7% | 42.3% | Spot | 52.4% | 47.6% | Spot | 52.1% | 47.9% | Spot |
| APNT | 56.3% | 43.7% | Spot | 51.0% | 49.0% | Spot | 53.9% | 46.1% | Spot |
| ARBP | 58.8% | 41.2% | Spot | 59.2% | 40.8% | Spot | 44.3% | 55.7% | Future |
| AXSB | 54.3% | 45.7% | Spot | 51.7% | 48.3% | Spot | 48.6% | 51.4% | Future |
| BHARTI | 53.5% | 46.5% | Spot | 52.0% | 48.0% | Spot | 48.1% | 51.9% | Future |
| BHEL | 55.7% | 44.3% | Spot | 52.5% | 47.5% | Spot | 48.3% | 51.7% | Future |
| BHIN | 52.9% | 47.1% | Spot | 55.3% | 44.7% | Spot | 44.8% | 55.2% | Future |
| BJAUT | 54.7% | 45.3% | Spot | 50.4% | 49.6% | Spot | 52.1% | 47.9% | Spot |
| BOB | 57.2% | 42.8% | Spot | 50.9% | 49.1% | Spot | 53.1% | 46.9% | Spot |
| BOS | 57.6% | 42.4% | Spot | 53.3% | 46.7% | Spot | 52.0% | 48.0% | Spot |
| BPCL | 54.0% | 46.0% | Spot | 55.7% | 44.3% | Spot | 45.3% | 54.7% | Future |
| CIPLA | 54.5% | 45.5% | Spot | 53.5% | 46.5% | Spot | 49.3% | 50.7% | Future |
| COAL | 54.9% | 45.1% | Spot | 49.7% | 50.3% | Future | 53.4% | 46.6% | Spot |
| DRRD | 54.5% | 45.5% | Spot | 53.0% | 47.0% | Spot | 48.6% | 51.4% | Future |
| EIM | 57.3% | 42.7% | Spot | 57.1% | 42.9% | Spot | 46.5% | 53.5% | Future |
| GAIL | 53.5% | 46.5% | Spot | 54.5% | 45.5% | Spot | 45.5% | 54.5% | Future |
| GRASIM | 57.6% | 42.4% | Spot | 48.3% | 51.7% | Future | 58.6% | 41.4% | Spot |
| HCLT | 55.7% | 44.3% | Spot | 49.6% | 50.4% | Future | 53.7% | 46.3% | Spot |
| HDFC | 54.7% | 45.3% | Spot | 51.5% | 48.5% | Spot | 50.8% | 49.2% | Spot |
| HDFCB | 58.9% | 41.1% | Spot | 50.7% | 49.3% | Spot | 58.0% | 42.0% | Spot |
| HMCL | 55.1% | 44.9% | Spot | 53.9% | 46.1% | Spot | 47.2% | 52.8% | Future |
| HNDL | 57.1% | 42.9% | Spot | 54.5% | 45.5% | Spot | 48.4% | 51.6% | Future |
| HUVR | 54.2% | 45.8% | Spot | 47.5% | 52.5% | Future | 55.6% | 44.4% | Spot |
| ICICIBC | 56.0% | 44.0% | Spot | 48.7% | 51.3% | Future | 56.3% | 43.7% | Spot |
| IDEA | 53.5% | 46.5% | Spot | 43.6% | 56.4% | Future | 60.3% | 39.7% | Spot |
| IIB | 55.4% | 44.6% | Spot | 51.6% | 48.4% | Spot | 51.5% | 48.5% | Spot |
| INFO | 56.2% | 43.8% | Spot | 48.1% | 51.9% | Future | 56.7% | 43.3% | Spot |
| ITC | 54.8% | 45.2% | Spot | 49.9% | 50.1% | Future | 51.5% | 48.5% | Spot |
| KMB | 56.9% | 43.1% | Spot | 46.1% | 53.9% | Future | 60.0% | 40.0% | Spot |
| LPC | 54.8% | 45.2% | Spot | 56.0% | 44.0% | Spot | 44.5% | 55.5% | Future |
| LT | 53.7% | 46.3% | Spot | 51.2% | 48.8% | Spot | 49.3% | 50.7% | Future |
| MM | 56.8% | 43.2% | Spot | 53.9% | 46.1% | Spot | 50.8% | 49.2% | Spot |
| MSIL | 54.8% | 45.2% | Spot | 51.4% | 48.6% | Spot | 49.1% | 50.9% | Future |
| NTPC | 54.0% | 46.0% | Spot | 49.7% | 50.3% | Future | 50.4% | 49.6% | Spot |
| ONGC | 53.2% | 46.8% | Spot | 50.8% | 49.2% | Spot | 48.5% | 51.5% | Future |
| PWGR | 55.0% | 45.0% | Spot | 50.6% | 49.4% | Spot | 52.8% | 47.2% | Spot |
| RIL | 53.2% | 46.8% | Spot | 52.7% | 47.3% | Spot | 46.2% | 53.8% | Future |
| SBIN | 54.3% | 45.7% | Spot | 51.3% | 48.7% | Spot | 49.2% | 50.8% | Future |
| SUNP | 54.7% | 45.3% | Spot | 50.6% | 49.4% | Spot | 52.0% | 48.0% | Spot |
| TATA | 54.3% | 45.7% | Spot | 50.1% | 49.9% | Spot | 50.8% | 49.2% | Spot |
| TCS | 54.5% | 45.5% | Spot | 47.8% | 52.2% | Future | 55.1% | 44.9% | Spot |
| TECHM | 55.6% | 44.4% | Spot | 49.7% | 50.3% | Future | 54.8% | 45.2% | Spot |
| TPWR | 56.0% | 44.0% | Spot | 60.8% | 39.2% | Spot | 38.8% | 61.2% | Future |
| TTMT | 56.4% | 43.6% | Spot | 52.7% | 47.3% | Spot | 50.7% | 49.3% | Spot |
| UTCEM | 52.7% | 47.3% | Spot | 44.1% | 55.9% | Future | 60.4% | 39.6% | Spot |
| WPRO | 56.1% | 43.9% | Spot | 51.5% | 48.5% | Spot | 51.3% | 48.7% | Spot |
| YES | 54.5% | 45.5% | Spot | 48.1% | 51.9% | Future | 53.1% | 46.9% | Spot |
| Z | 53.6% | 46.4% | Spot | 50.2% | 49.8% | Spot | 50.4% | 49.6% | Spot |

Table 3

Information share content for NSE spot market and NSE futures market

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *Stock Symbol* | ***Hasbrouck information share*** | | *High IS market* | ***Gonzalo-Granger Information share*** | | *High CS market* | ***Information Leadership Share*** | | *High CS market* |
| *NSE\_S* | *NSE\_F* | *NSE\_S* | *NSE\_F* | *NSE\_S* | *NSE\_F* |
| ACC | 56.8% | 43.2% | Spot | 49.4% | 50.6% | Future | 56.0% | 44.0% | Spot |
| ACEM | 54.9% | 45.1% | Spot | 46.6% | 53.4% | Future | 57.9% | 42.1% | Spot |
| ADSEZ | 56.1% | 43.9% | Spot | 56.7% | 43.3% | Spot | 45.2% | 54.8% | Future |
| APNT | 54.6% | 45.4% | Spot | 47.3% | 52.7% | Future | 56.0% | 44.0% | Spot |
| ARBP | 56.8% | 43.2% | Spot | 62.8% | 37.2% | Spot | 37.7% | 62.3% | Future |
| AXSB | 54.3% | 45.7% | Spot | 52.6% | 47.4% | Spot | 47.2% | 52.8% | Future |
| BHARTI | 52.5% | 47.5% | Spot | 53.6% | 46.4% | Spot | 45.0% | 55.0% | Future |
| BHEL | 52.8% | 47.2% | Spot | 50.2% | 49.8% | Spot | 48.0% | 52.0% | Future |
| BHIN | 51.4% | 48.6% | Spot | 55.1% | 44.9% | Spot | 43.1% | 56.9% | Future |
| BJAUT | 53.5% | 46.5% | Spot | 49.6% | 50.4% | Future | 52.5% | 47.5% | Spot |
| BOB | 55.4% | 44.6% | Spot | 50.8% | 49.2% | Spot | 53.2% | 46.8% | Spot |
| BOS | 53.4% | 46.6% | Spot | 54.3% | 45.7% | Spot | 46.5% | 53.5% | Future |
| BPCL | 54.6% | 45.4% | Spot | 55.6% | 44.4% | Spot | 46.0% | 54.0% | Future |
| CIPLA | 52.2% | 47.8% | Spot | 50.1% | 49.9% | Spot | 48.5% | 51.5% | Future |
| COAL | 53.7% | 46.3% | Spot | 50.5% | 49.5% | Spot | 50.8% | 49.2% | Spot |
| DRRD | 53.6% | 46.4% | Spot | 51.8% | 48.2% | Spot | 49.5% | 50.5% | Future |
| EIM | 54.2% | 45.8% | Spot | 54.7% | 45.3% | Spot | 45.9% | 54.1% | Future |
| GAIL | 52.8% | 47.2% | Spot | 48.2% | 51.8% | Future | 52.1% | 47.9% | Spot |
| GRASIM | 54.1% | 45.9% | Spot | 51.1% | 48.9% | Spot | 51.8% | 48.2% | Spot |
| HCLT | 53.7% | 46.3% | Spot | 47.9% | 52.1% | Future | 55.5% | 44.5% | Spot |
| HDFC | 53.8% | 46.2% | Spot | 46.5% | 53.5% | Future | 55.8% | 44.2% | Spot |
| HDFCB | 55.6% | 44.4% | Spot | 49.1% | 50.9% | Future | 54.9% | 45.1% | Spot |
| HMCL | 53.3% | 46.7% | Spot | 50.6% | 49.4% | Spot | 51.3% | 48.7% | Spot |
| HNDL | 57.1% | 42.9% | Spot | 52.7% | 47.3% | Spot | 52.2% | 47.8% | Spot |
| HUVR | 53.9% | 46.1% | Spot | 51.0% | 49.0% | Spot | 53.2% | 46.8% | Spot |
| ICICIBC | 55.0% | 45.0% | Spot | 45.7% | 54.3% | Future | 58.1% | 41.9% | Spot |
| IDEA | 52.9% | 47.1% | Spot | 45.2% | 54.8% | Future | 57.7% | 42.3% | Spot |
| IIB | 54.9% | 45.1% | Spot | 53.9% | 46.1% | Spot | 48.0% | 52.0% | Future |
| INFO | 55.3% | 44.7% | Spot | 49.7% | 50.3% | Future | 53.0% | 47.0% | Spot |
| ITC | 54.3% | 45.7% | Spot | 50.6% | 49.4% | Spot | 50.2% | 49.8% | Spot |
| KMB | 55.5% | 44.5% | Spot | 51.1% | 48.9% | Spot | 53.3% | 46.7% | Spot |
| LPC | 54.7% | 45.3% | Spot | 53.8% | 46.2% | Spot | 46.8% | 53.2% | Future |
| LT | 53.4% | 46.6% | Spot | 51.9% | 48.1% | Spot | 48.1% | 51.9% | Future |
| MM | 55.8% | 44.2% | Spot | 53.5% | 46.5% | Spot | 49.7% | 50.3% | Future |
| MSIL | 55.3% | 44.7% | Spot | 49.8% | 50.2% | Future | 52.3% | 47.7% | Spot |
| NTPC | 53.9% | 46.1% | Spot | 49.9% | 50.1% | Future | 52.4% | 47.6% | Spot |
| ONGC | 53.0% | 47.0% | Spot | 48.8% | 51.2% | Future | 49.6% | 50.4% | Future |
| PWGR | 53.2% | 46.8% | Spot | 49.1% | 50.9% | Future | 51.9% | 48.1% | Spot |
| RIL | 54.3% | 45.7% | Spot | 54.3% | 45.7% | Spot | 44.7% | 55.3% | Future |
| SBIN | 52.8% | 47.2% | Spot | 51.2% | 48.8% | Spot | 46.8% | 53.2% | Future |
| SUNP | 54.8% | 45.2% | Spot | 50.8% | 49.2% | Spot | 53.3% | 46.7% | Spot |
| TATA | 56.6% | 43.4% | Spot | 49.0% | 51.0% | Future | 55.1% | 44.9% | Spot |
| TCS | 53.9% | 46.1% | Spot | 48.5% | 51.5% | Future | 53.6% | 46.4% | Spot |
| TECHM | 54.2% | 45.8% | Spot | 45.9% | 54.1% | Future | 58.6% | 41.4% | Spot |
| TPWR | 56.1% | 43.9% | Spot | 58.3% | 41.7% | Spot | 43.7% | 56.3% | Future |
| TTMT | 55.6% | 44.4% | Spot | 53.4% | 46.6% | Spot | 49.0% | 51.0% | Future |
| UTCEM | 51.9% | 48.1% | Spot | 47.2% | 52.8% | Future | 55.6% | 44.4% | Spot |
| WPRO | 55.3% | 44.7% | Spot | 47.9% | 52.1% | Future | 56.5% | 43.5% | Spot |
| YES | 55.7% | 44.3% | Spot | 46.7% | 53.3% | Future | 58.6% | 41.4% | Spot |
| Z | 54.9% | 45.1% | Spot | 53.4% | 46.6% | Spot | 48.4% | 51.6% | Future |

**Table 4**

Estimation Results with Hasbrouck Information Share as dependant

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Model 1** | **Model 2** | **Model 3** |
| **Dependant Variable** | ***NSE\_S-BSE\_S*** | ***NSE\_S-NSE\_F*** | ***BSE\_S-NSE\_F*** |
| **C** | 1.021380\*  (5.470485) | 0.429063\*  (5.740209) | 0.458946\*  (6.662898) |
| **DTISEVAL** | -0.008418  (-0.799349) | -0.005181  (-1.079510) | - |
| **DTIBEVAL** | -0.012023  (-1.7132733) | - | 2.43E-05  (0.008245) |
| **DTFUTVAL** | - | 0.015020\*  (2.716089) | 0.006315  (0.2206) |
| **F Statistic** | 1.911488\*  (0.00000) | 2.231593\*  (0.00000) | 2.040460\*  (0.00000) |

NOTE: The table presents panel regression coefficients along with t-statistic. “\*” indicates significant coefficient at 5% critical level. P-value is provided along with F-statistic.

NSE\_S-BSE\_S denotes information share of stocks trading on NSE spot market versus BSE spot market.

NSE\_S-NSE\_F denotes information share of stocks trading on NSE spot market versus NSE futures market.

BSE\_S-NSE\_F denotes information share of stocks trading on BSE spot market versus NSE futures market.

**Table 5**

Estimation Results with Gonzalo Granger Component Share as dependant

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Model 1** | **Model 2** | **Model 3** |
| **Dependant Variable** | ***NSE\_S-BSE\_S*** | ***NSE\_S-NSE\_F*** | ***BSE\_S-NSE\_F*** |
| **C** | 0.852888\*  (6.137112) | 0.670305\*  (4.168252) | 0.326442\*  (2.448728) |
| **DTISEVAL** | -0.014629\*  (-1.866181) | -0.018501  (-1.748128) | - |
| **DTIBEVAL** | -0.001235  (-0.239095) | - | -0.005540  (-0.970941) |
| **DTFUTVAL** | - | 0.014526  (1.220979) | 0.019436\*  (1.947838) |
| **F Statistic** | 1.160067  (0.079036) | 2.139785\*  (0.0000) | 1.868135\*  (0.0000) |

NOTE: The table presents panel regression coefficients along with t-statistic. “\*” indicates significant coefficient at 5% critical level. P-value is provided along with F-statistic.

NSE\_S-BSE\_S denotes information share of stocks trading on NSE spot market versus BSE spot market.

NSE\_S-NSE\_F denotes information share of stocks trading on NSE spot market versus NSE futures market.

BSE\_S-NSE\_F denotes information share of stocks trading on BSE spot market versus NSE futures market.

**Table 6**

Estimation Results with Information Leadership Share as dependant

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Model 1** | **Model 2** | **Model 3** |
| **Dependant Variable** | NSE\_S-BSE\_S | NSE\_S-NSE\_F | BSE\_S-NSE\_F |
| **C** | -0.275904\*  (-0.116571) | 0.300625  (1.320094) | 0.753885\*  (3.908903) |
| **DTISEVAL** | 0.030603\*  (-3.391183) | 0.021664  (1.481574) | - |
| **DTIBEVAL** | 0.011167  (1.471901) | - | 0.010495  (1.271374) |
| **DTFUTVAL** | - | -0.016301  (-0.967534) | -0.029172\*  (-2.020858) |
| **F Statistic** | 28.17898  (0.00000) | 2.345766  (0.00000) | 1.977143  (0.00000) |

NOTE: The table presents panel regression coefficients along with t-statistic. “\*” indicates significant coefficient at 5% critical level. P-value is provided along with F-statistic.

NSE\_S-BSE\_S denotes information share of stocks trading on NSE spot market versus BSE spot market.

NSE\_S-NSE\_F denotes information share of stocks trading on NSE spot market versus NSE futures market.

BSE\_S-NSE\_F denotes information share of stocks trading on BSE spot market versus NSE futures market.

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