A STUDY ON EVOLUTION OF TRADING FROM RING TRADING TO ALGO TRADING IN INDIA

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Abstract : *Artificial Intelligence combined with algorithms has changed the method of trading across the globe. This mixture of technological advancement has led to the minimization of risk and maximization of return for the market participants. The objective of this research paper is to study the growth of algo trading; and to understand the current scenario of algo trading in India. The study concludes that the transaction speed of algo trading orders specially in the cash segment and equity derivatives segment results in more trades than non-algo trading orders.*

Keywords: Algorithmic Trading, Direct Market Access, Financial Market, Equity, Derivatives.

INTRODUCTION

Fintech (Financial Technology) has directed to the transformation in the landscape of Indian financial market. Data analytics, Internet of Things (IoT), mobile, Artificial Intelligence (AI), Machine Learning (ML), block chain and robotic process automation are revolutionary Fintech leading to opening up of financial markets for revolution and disruption. One of the revolutionary innovations in Fintech has given birth to Algorithm trading. As per SEBI, Algorithm Trading is defined as "any order that is generated using automated execution logic shall be known as algorithm trading." Johnson (2010) defined algo trading as a computerized rule based process for placing large orders in the market which almost eliminates manual human intervention of a trader. The computerization of trading based on machine artificial intelligence brings in speed, accuracy, lower transaction cost, back testing and improves market liquidity. Speed of appropriate decision making in terms of algo trading is based upon dynamic monitoring of securities and co-location, since all the algorithms are coded in advance and are processed automatically.

WHAT IS ALGORITHMIC TRADING?

Algorithmic trading is the use of programs and computers to generate and execute (large) orders in markets with electronic access. Orders come from institutional investors, funds and trading desks of big banks and brokers. These statistical, mathematical or technical models analyze every quote and trade in the stock market, identify liquidity opportunities, and turn the information into intelligent trading decisions.

Algorithmic trading, or computer-directed trading, cuts down transaction costs, and allows investment managers to take control of their own trading processes. The main objective of algo trading is not necessarily to maximize profits but rather to control execution costs and market risk.

ALGORITHMIC TRADING AND ITS COMPOSITION IN INDIAN MARKETS

Around 50% plus of total orders at both NSE and BSE are algo trades on the client side. Prop side algo trades are 40% plus of total orders placed at both the exchanges. More than 80% of the algorithmic orders are generated from colocation at both the exchanges. In developed markets it stands at about 80%.

KINDS OF ALGORITHMS

Algorithms are used extensively in various stages of the trading cycle. We can classify them into pretrade analytics, execution stage, and post-trade analytics.

Depending on their usage, Algorithms can also be broadly classified into Agency trading algorithms, Proprietary Trading algorithms and High Frequency Trading (HFT) algorithms.

Execution Algorithms - Execution algorithms mean to systematically split a larger order into many smaller orders based on the available liquidity. These amounts are often larger than what the market can absorb without impacting the price. For instance, Time Weighted Average Price (TWAP) algorithmic strategy will break an order up into many smaller equal parts and execute them during the trading day, normally at 5 minute intervals. Another example is of the Volume Weighted Average Price (VWAP) strategy that will estimate the average volume traded for each 5-minute interval the order is traded using historical trading information, with the ultimate goal to split the order into smaller pieces based on an average weighted volume.

Proprietary Trading Algorithms - Proprietary trading (also "prop trading") occurs when a trader trades stocks, bonds, currencies, commodities, their derivatives, or other financial instruments with the firm's own money, as opposed to depositors' money, so as to make a profit for itself. Proprietary Trading algorithms are typically used with the strategies that involve directional bets on the markets – Net Long or Short depending on the market direction. Within this subset, we have Momentum, Mean Reversion and Trend Following strategies. Besides, another popular set of strategies called as Spread strategies or Market Neutral (both Long/Short) is also part of this suit of algorithms.

HFT Algorithms - High-frequency trading (HFT) is a subset of automated trading. Here, opportunities are sought and taken advantage of on very small timescales from nanoseconds up to iv milliseconds. Some high-frequency strategies adopt a market maker type role, attempting to keep a relatively neutral position and proving liquidity (most of the time) while taking advantage of any price discrepancies. Other strategies invoke methods from time series analysis, machine learning and artificial intelligence to predict movements and isolate trends among the masses of data.

Bertsimasa and Lob (1998) suggest that algo trading reduces the transaction cost as it eliminates the human requirement to monitor the market, which in turn reduces the cost of the trading members. Ellis, Michaely and O'Hara (2000) suggest that automatic execution of trade eliminates manual punching avoiding human error. Furthermore, a computer based algorithm usually gets checked twice or thrice before coding and executing the same so that the correct order could be placed. The study further highlights the importance of using stochastic dynamic programming for trading strategies to minimize the cost of execution. Historical

replication of trading strategies computes the series of returns and losses is also one of the features of algo trading. This ability of back testing in algo trading enables the trader to run the algorithms on historical data, which further helps in removing any mistake of a trading system before executing it live (Bailey, Borwein, Lopez and Zhu, 2014). In terms of accuracy, algorithm trading is considered to be an advantage. Hendershott, Jones and Menkveld (2011) study the interrelation between algo trading and liquidity at the NYSE (New York Stock Exchange).

The study suggests that algo trading has increased over the period of last 5 years and capital markets have become more liquid. Further, in order to establish the relationship between algo trading and liquidity, auto quoting represented algo trading as an instrumental variable. Moreover, the study suggests that increase in algo trading decreases adverse selection and further lowers the amount of price discovery that is correlated with the trading. The study further point out towards the likelihood of algo trading can also improve interlinkages between securities markets, generating positive spillover effects in other markets. In addition to this algo trading and its strategies are painstaking to be decision support tool about timings, pricing and quantification of the trading orders.

LITERATURE REVIEW

"The evolution of the securities markets in India in the 1990s"
By:- Ajay Shah, Susan Thomas
we review the changes which took place on India's equity and government
bond markets in the decade of the 1990s. In understanding these experiences, we focus on four interesting questions: (a) Why did NSE succeed? (b) Why did the equity market lurch from crisis to crisis? (c) Why did reforms on the GOI bond market falter? (d) How important are crises as a mechanism for obtaining reforms? Looking forward, we argue that the transformation of the market design of the equity market is largely complete, and that the major question that now faces the equity market is that of improvements to investigation and enforcement at SEBI. In contrast, some major questions about market design on the GOI bond market have yet to be addressed. We offer proposals for principles that should be used at RBI in moving forward on the GOI bond market. Finally, we try to address questions of human capital and organisational design at SEBI and RBI.

"Awareness in MBA students about Capital Market"
By:- Miss. Hetal N. Bhinde
Capital market is a market where buyers and sellers engage in trade of financial securities like bonds, stocks, etc. It is observed that most of the Management courses perusing students are ignorant of Capital and Money markets. The research tries to bring out the consciousness of Capital Markets among the MBA perusing students. The research aims to motivate the MBA perusing students to invest in Capital Markets so that they can get acquainted with the current economic scenarios and global trade markets.

"A comprehensive study of Bombay Stock Exchange Indices"
By:- Achal Awasthi, Dr.Oleg Malafeyev
How an investor invests in the market is largely influenced by the market efficiency because if a market is efficient, it is extremely difficult to make excessive returns because in an efficient market there will be no undervalued securities. However, there is a possibility of making excess returns if the market is not efficient. This article analyses the five popular stock indices of BSE. This would not only test the efficiency of the Indian Stock Market but also test the random walk nature of the stock market. The study which was undertaken in this paper has provided strong evidence in favour of the inefficient form of the Indian Stock Market. This article also covers the post-election period when the new government came into power and boosted the investors' confidence. The series of stock indices in the Indian Stock Market are found to be biased random

time series and the random walk model can't be applied in the Indian Stock Market. This study confirms that there is a drift in market efficiency and investors can capitalize on this by correctly choosing securities that are undervalued.

" Evolution Of Algo Trading and Its Future in India"
By:- Dr. Geetika Arora, Dr. A. M. Sherry
National Institute of Financial Management

Artificial Intelligence combined with algorithms has changed the way of trading across the globe. This combination of technological advancement (Algorithm Trading)1 has led to the minimization of risk and maximization of return for the market participants. The objective of this research paper is to study the evolution of algo trading; and to understand the present scenario of algo trading in India. The study concludes that the transaction velocity of algo trading orders especially in the cash segment results in more trades than non-algo trading orders. The proliferation of algo trading has been staggering at Dalal Street.

"Comparative Analysis of Indian Stock Market with International Markets"
By:- Debjiban Mukherjee
T. A. Pai Management Institute, Manipal, India

The stock market is witnessing heightened activities and is increasingly gaining importance. In the current context of globalization and the subsequent integration of the global markets this paper captures the trends, similarities and patterns in the activities and movements of the Indian Stock Market in comparison to its international counterparts. This study covers New York Stock Exchange (NYSE), Hong Kong Stock exchange (HSE), Tokyo Stock exchange (TSE), Russian Stock exchange (RSE), Korean Stock exchange (KSE) from various socio- politico-economic backgrounds. Both the Bombay Stock exchange (BSE) and the National Stock Exchange of Indian Limited (NSE) have been used in the study as a part of Indian Stock Market. The time period has been divided into various eras to test the correlation between the various exchanges to prove that the Indian markets have become more integrated with its global counterparts and its reaction are in tandem with that are seen globally.

"Stock Market Simulation and Analysis"
By:- Steve Marshall, Matthew Rosi, Jacob Wahlgren

A seven-week stock market simulation was performed using different techniques with the aid of online and text resources. The specific techniques used in this project were long-term growth investing, short-term income investing, and selling short. This seven-week simulation and trading experience gave us some initial training to use those techniques and tools in the future as we gain wealth and look to invest in the stock market

"Algorithmic trading"
By:- Giuseppe Nuti, Mahnoosh Mirghaemi, Philip Treleaven, Chaiyakorn Yingsaeree

In electronic financial markets, algorithmic trading refers to the use of computer programs to automate one or more stages of the trading process: pretrade analysis (data analysis), trading signal generation (buy and sell recommendations), and trade execution. Trade execution is further divided into agency/broker execution (when a system optimizes the execution of a trade on behalf of a client) and principal/proprietary trading (where an institution trades on its own account). Each stage of this trading process can be conducted by humans, by humans and algorithms, or fully by algorithms.

"Algorithmic Trading - The Financial Super Car of Next Generation"
By:-Rishi Mehra & Srishti Vajpayee
National Institute of Financial Management, Haryana, India

This piece of write up discusses about the present state of capital markets of India which are over influenced by the use of algorithmic and high frequency trading in secondary market. These may be necessary to provide enough liquidity and striking the balance, but India is lagging behind in terms of real capital formation as

against mere trading of securities as futures & options or otherwise. Further, it also discusses economic in-equality under Gini Co-efficient of India as provided by IMF, pressing us to address the fundamental issues of our country's capital markets for ensuring stability and growth in the future .

"A Study on the significance of algorithms tradings in Indian stock market"

By:_ Gowtham Ramkumar

Madras Christian College East Tambaram, Chennai

Stock Markets are the integrated part of not only the Indian economy but also global economy. The significance of the stock markets is felt by the global economies in different phases ranging from stock market crash 1929 in United States of America to the Harshad Mehta Scam in Indian stock markets. Different trading strategies are followed by large scale institutional investors to reap the maximum benefits from the markets. Algorithmic trading, commonly referred to as Algo-trading, is now of the emerging and trending trading strategies followed by institutional investors in Indian stock market. It is a trading based on computers being given pre-determined instructions so that transactions are carried out in a speed and frequency that is impossible for human traders. There are different platforms available for Algo-trading and this paper seeks to identify the major benefits of Algo-trading and seeks to communicate the reasons for the growth of Algo-trading not only in India but also in a global scenario. Further this paper identifies the most preferred platform for Algo-trading and challenges encountered by the investors adopting these strategies. Finally, this study arrives at a meaningful conclusion and provides scope for further research in this area of study.

Kian –Pinhg Lim & Robert Brooks (2011) provides a systematic review of the weak-form market efficiency literature that examines return predictability from past price changes, with an exclusive focus on the stock markets. Our survey shows that the bulk of the empirical studies examine whether the stock market under study is or is not weak-form efficient in the absolute sense, assuming that the level of market efficiency remains unchanged throughout the estimation period. However, the possibility of time-varying week-form market efficiency has received increasing attention in recent years. We categorize these emerging studies based on the research framework adopted, namely non-overlapping sub-period analysis, time-varying parameter model and rolling estimation window.

Anju Bala (2013) evaluated that stock market is one of the most vibrant sectors in the financial system, marketing an important contribution to economic development. Stock market is a place where buyers and sellers of securities can enter into transaction to purchase and sell shares, bonds, debentures etc. In other words, stock market is a platform for trading various securities and derivatives. Further, it preforms an important role of enabling corporate, entrepreneurs to raise resource for their companies and business venture through public issues. Today long-term investors are interested to invest in the stock market rather than invest anywhere.

Ross Levine & Sara Zervos empirically evaluate the relationship between stock market development and long-term growth. The data suggest that stock market development is positively associated with economic growth. Moreover, instrumental variables procedures indicate a strong connection between the predetermined component of stock market development and economic growth in the long run. While cross-country regressions imply a strong link between stock market development and economic growth, the results should be viewed as suggestive partial correlations that stimulate additional research rather than as conclusive findings. Much work remains to be done to shed light on the relationship between stock market development and economic growth. Careful case studies might help identify causal relationships and further research could be done on the time-series property of such relationships. Research should also be done to identify policies that facilitate the development of sound securities markets.

Samveg Patel is an Assistant Professor in S. K. Patel Institute of Management and Computer Studies, Gandhinagar. His areas of interest include Financial Econometrics and Financial Management. His most recent publication was in IUP Journal of Applied Finance. The study investigates the effect of macroeconomic

determinants on the performance of the Indian Stock Market using monthly data over the period January 1991 to December 2011 for eight macroeconomic variables, namely, Interest Rate, Inflation, Exchange Rate, Index of Industrial Production, Money Supply, Gold Price, Silver Price & Oil Price, and two stock market indices namely Sensex and S&P CNX Nifty.

Aman Srivastava (2010) evaluated that Stock market is an important segment of the financial system of any country as it plays an important role in channelizing savings from deficit sector to surplus sector. These stock markets have always been an area of serious concern for policy makers, economists and researchers. They are often defined as the barometer of any economy because they reflect the change and direction of pressure on the economy. The movement and volatility in stock markets often reflect the direction of any economy. The available literature suggests that since the inception of stock markets researchers are making attempts to establish relationship between change in macroeconomic factors and stock market returns.

Charles K.D, Adjasi, Nicholas B. Biekpe (2006) studies the effect of stock market development on economic growth in 14 African countries in a dynamic panel data modelling setting. Results largely show a positive relationship between stock market development and economic growth. Further analyses, based on the level of economic development and stock market capitalization, are also conducted. The results reveal that the positive influence of stock market development on economic growth is significant for countries classified as upper middle-income economies. On the basis of market capitalization groupings, stock market developments play a significant role in growth only for moderately capitalized markets. The general trend in results shows that low-income African countries and less developed stock markets need to grow more and develop their markets to elicit economic gains from stock markets.

L.M.C.S. (2006) study investigates the effects of macroeconomic variables on stock prices in emerging Sri Lankan stock market using monthly data for the period from September 1991 to December 2002. The multivariate regression was run using eight macroeconomic variables for each individual stock. The null hypothesis which states that money supply, exchange rate, inflation rate and interest rate variables collectively do not accord any impact on equity prices is rejected at 0.05 level of significance in all stocks. The results indicate that most of the companies report a higher R^2 which justifies higher explanatory power of macroeconomic variables in explaining stock prices.

Roman Horvath& Dargan Petrovski (2012) examine the international stock market commovements between Western Europe vis-à-vis Central (Czech Republic, Hungary and Poland) and South Eastern Europe (Croatia, Macedonia and Serbia) using multivariate GARCH models in the period 2006–2011. Comparing these two groups, we find that the degree of comovements is much higher for Central Europe. The correlation of South Eastern European stock markets with developed markets is essentially zero. An exemption to this regularity is Croatia, with its stock market displaying a greater degree of integration toward Western Europe recently, but still below the levels typical for Central Europe.

Najeb M.H. Masoud (2013) tries to explore the causal link between stock market performance and economic growth in terms of a simple theoretical and empirical literature framework. Researchers hold diverse opinions regarding the importance of stock markets playing a significant role in economic growth processes by performing the following functions: improving liquidity, aggregating and mobilising capital, observing managers and exerting corporate control, providing risk-pooling and sharing services including investment levels. The growing theoretical literature argues that stock markets are crucially linked to economic growth. The findings suggest a positive relationship between efficient stock markets and economic growth, both in short run and long run and there is evidence of an indirect transmission mechanism through the effect of stock market development on investment. They are seen as providing a service that boosts economic growth.

Rafaqet Ali and Muhammad Afzal (2012) devastating global financial crisis started from United States, spread all over the world and adversely affected real and financial sectors of developed as well as developing countries. This crisis is called the first largest crisis after the recession of 1930s. The prime aim of this study is to envisage the impact of recent global financial crisis on stock markets of Pakistan and India. For this purpose, daily data from 1st January 2003 to 31st August 2010 of KSE-100 and BSE-100 indices, representing stock markets' indices of Pakistan and India respectively, are used.

Avijan Dutta, Gautam Bandopadhyay & Suchismita Sengupta (2012) use logistic regression (LR) and various financial ratios as independent variables to investigate indicators that significantly affect the performance of stocks actively traded on the Indian stock market. The study sample consists of the ratios of 30 large market capitalization companies over a four-year period. The study identifies and examines eight financial ratios that can classify the companies up to a 74.6% level of accuracy into two categories – "good" or "poor" – based on their rate of return.

Gagan Deep Sharma & B.S Bodla (2010) states that financial markets of the world for foreign capital has led to the increased financial integration among different countries. This paper reviews and summarizes the research on the subject of integration and dynamic linkages between stock markets in different parts of the world. Majority of the studies suggested that market integration has increased significantly over the years, within an international context. We find that not many studies have concentrated on the interaction of Indian markets with the foreign markets, and most of the studies concerning Indian have concentrated at the inter-relationship of Indian stock market with those of the Developed nations. Therefore, there is a scope to study the inter-linkages between Indian stock markets and those of the other SAARC nations.

Peter Sellin (2002) gives a comprehensive view on the interaction between real stock returns, inflation, and money growth, with a special emphasis on the role of monetary policy. This is an area of research that has interested monetary and financial economists for a long time. Monetary economists have been interested in the question whether money has any effect on real stock prices, while financial economists have investigated whether equity is a good hedge against inflation. Empirical studies show that money can be helpful in predicting future stock returns. Empirical evidence also suggest that equity is not a good hedge against inflation in the short run but may be so in the long run.

Alok Kumar Mishra (2004) attempts to examine whether stock market and foreign exchange markets are related to each other or not. The study uses Granger's Causality test and Vector Auto Regression technique on monthly stock return, exchange rate, interest rate and demand for money for the period April 1992 to March 2002. The major findings of the study are (*a*) there exists a unidirectional causality between the exchange rate and interest rate and between the exchange rate return and demand for money; (*b*) there is no Granger's causality between the exchange rate return and stock return.

Mara Madaleno & Carlos Pinho (2011) accounts for the time-varying pattern of price shock transmission, exploring stock market linkages using continuous time wavelet methodology. In order to sustain and improve previous results regarding correlation analysis between stock market indices, namely FTSE100, DJIA30, Nikkei225 and Bovespa, we extend here such analysis using the Coherence Morlet Wavelet, considering financial crisis episodes. Results indicate that the relation among indices was strong but not homogeneous across scales, that local phenomena are more felt than others in these markets and that there seems to be no quick transmission through markets around the world, but yes, a significant time delay.

Vivek Rajput & Sarika Bobde (2016) study different techniques to predict stock price movement using the sentiment analysis from social media, data mining. In this paper we will find efficient method which can predict stock movement more accurately. Social media offers a powerful outlet for people's thoughts and feelings it is an enormous ever-growing source of texts ranging from everyday observations to involved

discussions. This paper contributes to the field of sentiment analysis, which aims to extract emotions and opinions from text. A basic goal is to classify text as expressing either positive or negative emotion. Sentiment classifiers have been built for social media text such as product reviews, blog posts, and even twitter messages. With increasing complexity of text sources and topics, it is time to re-examine the standard sentiment extraction approaches, and possibly to redefine and enrich the definition of sentiment.

Vanita Tripathi & Shruthi Sethi (2010) evaluated the financial integration is one of the buzz words in financial world. The co movement of share prices across the stock markets in the world is a frequently experienced phenomenon. Especially during the times of crisis, it is observed that the stock markets crash together. The oil crisis of 1973, the October 1987 crash, the South East Asian crisis of 1997 and the present financial crisis evidence the same.

Marxia Oli Sigao (2007) investigated the effect of weather (temperature) factor, on the returns and volatility of the Indian stock indices (BSE Sensex and S&P CNX Nifty). This study examined how weather (temperature) affected the volatility of top stock market indices in India. The study used the monthly data of weather in five sample cities (Chennai, Mumbai, Delhi, Kolkata and Hyderabad) in India. This study applied statistical tools like Descriptive Statistics, ADF Test and GARCH (1, 1) model and found that the returns of sample stock market indices were influenced by weather (temperature) factor in Chennai, Mumbai, Kolkata and Hyderabad in India. But the returns of stock indices were not influenced by the temperature in Delhi City.

Juhi Ahuja (2012) presents a review of Indian Capital Market & its structure. In last decade or so, it has been observed that there has been a paradigm shift in Indian capital market. The application of many reforms & developments in Indian capital market has made the Indian capital market comparable with the international capital markets. Now, the market features a developed regulatory mechanism and a modern market infrastructure with growing market capitalization, market liquidity, and mobilization of resources. The emergence of Private Corporate Debt market is also a good innovation replacing the banking mode of corporate Nance.

Suresh G Lalwani (1999) emphasized the need for risk management in the securities market with particular emphasis on the price risk. He commented that the securities market is a 'vicious animal' and there is more than a fair chance that far from improving, the situation could deteriorate.

Debjit Chakraborty (1997) in his study attempts to establish a relationship between major economic indicators and stock market behaviour. It also analyses the stock market reactions to changes in the economic climate. The factors considered are inaction, money supply, and growth in GDP, scal debit and credit deposit ratio. To and the trend in the stock markets, the BSE National Index of Equity Prices (Natex) which comprises 100 companies was taken as the index. The study shows that stock market movements are largely influenced by, broad money supply, ination, C/D ratio and scal decit apart from political stability.

Bhanwar Singh, Sahil Narang, (2020) in his study examines the impact of the COVID-19 outbreak on the stock markets of G-20 countries. We find statistically significant negative ARs in the four sub-event windows during the 58 days. Negative ARs are significant for developing as well as developed countries. The findings of this study reveal that cumulative average abnormal return (CAAR) from day 0 to day 43, ranging from –0.70 per cent to –42.69 per cent, is a consequence of increased panic in the stock markets resulting from an increased number of COVID-19 positive cases in the G-20 countries.

Rosy Call (2020) examines the herding behaviour at the industry level from national stock exchange (NSE). Using daily stock closing prices of 191 firms, which constitute the 12 industry indices for the period from 1 January 2015 to 1 June 2020, the results for the full sample period (1 January 2015 to 1 June 2020) and before COVID-19 outbreak period (1 January 2015 to 29 January 2020) indicate the non-existence of herding

formation at the industry level, but they do suggest a strong evidence of anti-herding behaviour. Further, the findings suggest that COVID-19 pandemic caused the formation of herding behaviour at the industry level. The study facilitates investors to devise their trading strategies in the regime of the COVID-19 pandemic.

Krishna Reddy Chittedi examined the stock market integration between India and developed countries such as USA, UK, Japan, France and Australia. The objective is to examine the stock indices of the above-mentioned developed countries with relation to India for a period of 10 years (1 October 1997-1 October, 2007) out the integration between them. For this purpose, Unit Roots, Granger Causality, cointegration and Error correction Mechanism are used. To examine the short-run and long-run relationships between India and the developing counties. The study found that co integration existing between India and developed countries. (USA, UK, Japan, France and Australia)

T. P Madhusoodan in his study applies the variance ratio tests under the null hypotheses of homoscedasticity as well as heteroscedasticity, to the Indian stock market. The tests are conducted at the aggregate level of market indices and disaggregate level of individual stocks. The results indicate that random walk hypothesis cannot be accepted in the Indian market. Both the market indices the author tested showed persistent behaviour, while most of the individual stocks also showed evidence on persistence. The variance ratios were significant under heteroscedasticity in most of the cases where it was significant under homoscedasticity assumption. This implies that heteroscedasticity does not play a major role in the Indian market.

OBJECTIVE AND METHODOLOGY

The objective of this research paper are,

> ➤ To study the evolution of algo trading.
> ➤ To recognize the current scenario of algo trading in India.

The study has taken into consideration comprehensive literature review to identify the research gaps. The annual data for representing the present scenario of algo trading in India has been collected from the SEBI Handbook of Statistics (2021). The time period of data set ranges from 2014 to 2022.

This part is in respect to the first objective of this paper i.e., to study the evolution of algo trading, with special reference to U.S. and India.

The focus of financial institutions, market intermediaries, market participants, securities regulators and different exchanges have shifted towards algo trading. The trading game has changed extremely due to automation and innovations in technology. The speed of financial information has outpaced predictions with time. Advancements in financial engineering has led to higher networking speed, which in turn has led to demand for lower transaction cost and automated model-based trading by market participants and traders. Furthermore, this increase in competition for lower cost due to algo trading has forced various firms or traders to invest hugely in their processing and trading structure. The creation of algo trading at Dalal Street has been amazing. Considering the scenario in the past, there were limited opportunities to interact directly with exchanges or apply innovative technology to the process of trading. But the present scenario has changed intensely across the globe with the beginning of programming, direct market access, and algo trading/high frequency trading.

The source of the word 'Algorithm' is credited to Al Kwharizmi, a Persian mathematician from circa presently known as Uzbekistan wrote a 'Treatise on the Calculation with Arabic Numerals' in 820 AD. The concept of 'algorithm' is essential for multitude of disciplines and provides foundation for the creation and computation of almost all the computer software. The earliest origin of the first algorithm trade can be traced back to the

world's first hedge fund in 1949. Thereby, giving the first stirring to quant finance by Alfred Winslow Jones who used an approach of balancing short and long positions with a ratio of 70:30 or short to long simultaneously in the U. S. In 1970s, computers were considered to be mainstream for block trading. The actual origination of algo trading as it is now apparent can be credited to the invention of 'Pair Trading' now known as statistical arbitrage. The immensely profitable pair trading almost became a Wall Street success in 1970s. And the 'Black Box' was born. With the increasing power of computer, the power of computerized algo trading also increased. In 1980s, the next invention of the direct market access came in the U.S., thereafter, all the trading desks were running algos.

The inception of algo trading in India can be dated back to 3rd April 2008, when SEBI allowed Direct Market Access (DMA) for the first time in India. DMA enables institutional clients to directly access the exchange trading system through broker's infrastructure without manual intervention of broker. CTCL (Computer to Computer Link) by NSE (National Stock Exchange of India) and IML (Intermediate Messaging Layer) by BSE (Bombay Stock Exchange) provides DMA facility which allows members to provide direct trading terminals to Institutional Clients through various connectivity modes. This facility provide clients with various advantages such as direct control of orders, faster execution of orders, reduction in errors associated with manual entry, transparency, liquidity, lower transaction cost of large orders and better audit trails. Furthermore, by July 2009, Brokerage firms like Citi group, Morgan Stanley, JP Morgan, Merrill Lynch, Goldman Sachs and many more started holding pilot testing runs for their DMA software to sync their systems with NSE and BSE platforms. On 24th February 2009, SEBI took the next move to boost algo trading by opening up of DMA platform for Foreign Institutional Investors (FIIs).

Credit Suisse's Advanced Execution Services (AES) unit were the initial one to launch algorithmic trading in Indian equities segment on 22nd June 2009. The AES unit firstly included VWAP (Volume Weighted Average Price) strategy which separated the order into smaller pieces based on the weighted average of the volume. Subsequently, Indian capital market also selected equity derivatives and currency derivative segments in the algo trading. Further, the momentum for algo trading in India was gained by the allowance of co-location facilitates by NSE in June 2010. Co-location permits broker member servers' to be placed side by side to the exchange server in order to decrease latency. It was aimed at dropping the time taken in the transmission of data (orders) from broker terminals to exchange servers. Since speed is the important factor for algo trading, most of the brokerage firms adopted for the co-location of their server terminals. Furthermore, co-location provides liquidity as Frino, Mollica and Webb (2014) suggest that co-location improvise efficiency with which liquidity providers are able to style markets. Initially in June 2010, Morgan Stanley, Goldman Sachs, Citi, Deutsche Bank and MF Global were among the foreign broking firms which availed the co-location facility.

Currently in India, BSE provides the fastest co-location service in India with round trip network latency of less than 10 microseconds. Additionally, at BSE co-location response for an order has round latency of about 16 microseconds (including 10 microseconds of co-location network latency). Based on the response and acceptance of the algo trading between 2008 to 2010 by various trading members and market participants in India; Stock exchanges started improvising their automated trading domains, Fintech companies started developing and offering trading platforms and SEBI continued to increase its surveillance and regulate the markets.

In May 2010, NSE implemented Financial Information eXchange (FIX) protocol on its trading platform to boost the speed of transaction for investors located outside India using DMA. Furthermore, BSE gradually adapted the same. FIX protocol is a series of messaging specifications for electronic communication protocol developed for international real-time exchange of securities transactions in the finance markets. It has been developed through the collaborations of banks, broker-dealers, exchanges, industry conveniences institutional investors, and information technology providers from around the world. FIX is open and free, but it is not

software. FIX is a description around which software developers can create commercial or open-source software. FIX was first developed in 1992 at Salomon Brothers to simplify equity trading between Fidelity Investments. With due course of time, both NSE and BSE has provided an appropriate environment for algo trading to grow in India over the previous few years. This has given much needed boost to Indian capital market by placing Indian exchange (BSE & NSE) in top 10 exchanges of the world in terms of trading volume, moreover, BSE is considered to be the fastest exchange in the world with a speed of 6 microseconds. Moreover, almost 50% of trading in Indian capital markets is through algo trading as on August 2017. Algo trading in itself has changed multi-fold by development and introduction of different type of algo trading strategies in past few years. Some of the conventional algos currently are 'Black Lance'- Search for Liquidity, The Peg – Stay Parallel with the Market, Iceberg – Large Order Hiding, VWAP – Volume Weighted Average Price, TWAP – Time Weighted Average Price and POV – Percentage of Volume. Some of the hybrid algo strategies derived from the basic trading algos include Recursive Algos, Serial Algos, Parallel Algos and Iterative Algos. And lastly, the introduction of high frequency algo trading has also changed the way of trading at exchanges in India and abroad.

PRESENT SCENARIO OF ALGO TRADING IN INDIA

This part is in respect to the second objective of this paper i.e., to study the present scenario of algo trading in India. The present scenario of algo trading has been denoted in comparison with different trading modes. The data has been further bifurcated in terms of cash segment and equity derivatives segment at BSE and NSE, separately.

Mode of Trading in the Cash Segment at NSE and BSE (as a percentage of Total Turnover):

The current statistics of algo trading has been compared with the statistics of additional modes of trading. The analysis of the same has been done using the annual data of various mode of trading in the cash segment. The time period of the same was decided basis the availability of data from 2014 to 2022.

The following charts below gives a brief glimpse of evolution of Indian Stock Market in terms of Trading in the cash segment at NSE and BSE (as a percentage of total turnover) on annual basis from 2014 to 2022.

Chart 1: Mode of Trading in the Cash Segment at NSE (as a percentage of Total Turnover)
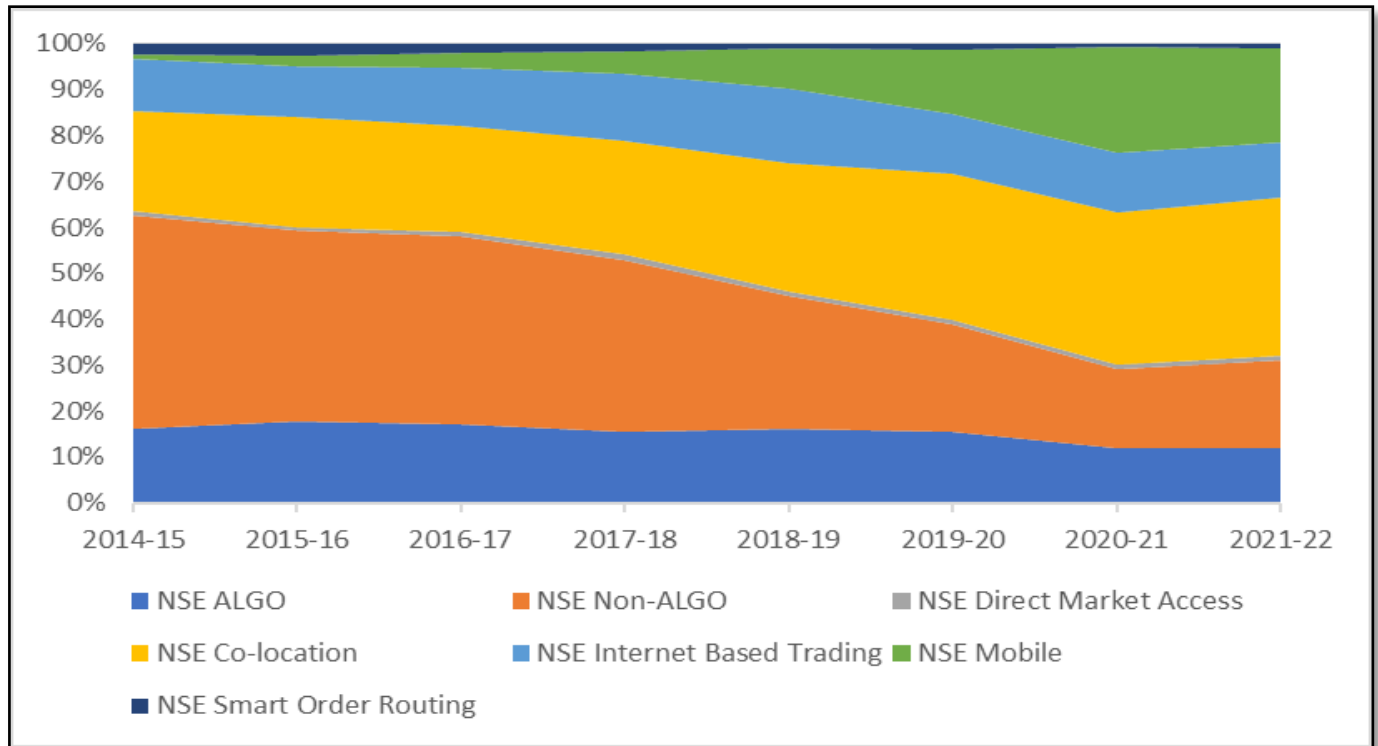
Source: SEBI and Analysis by Authors

Chart 2: Mode of Trading in the Cash Segment at BSE (as a percentage of Total Turnover)
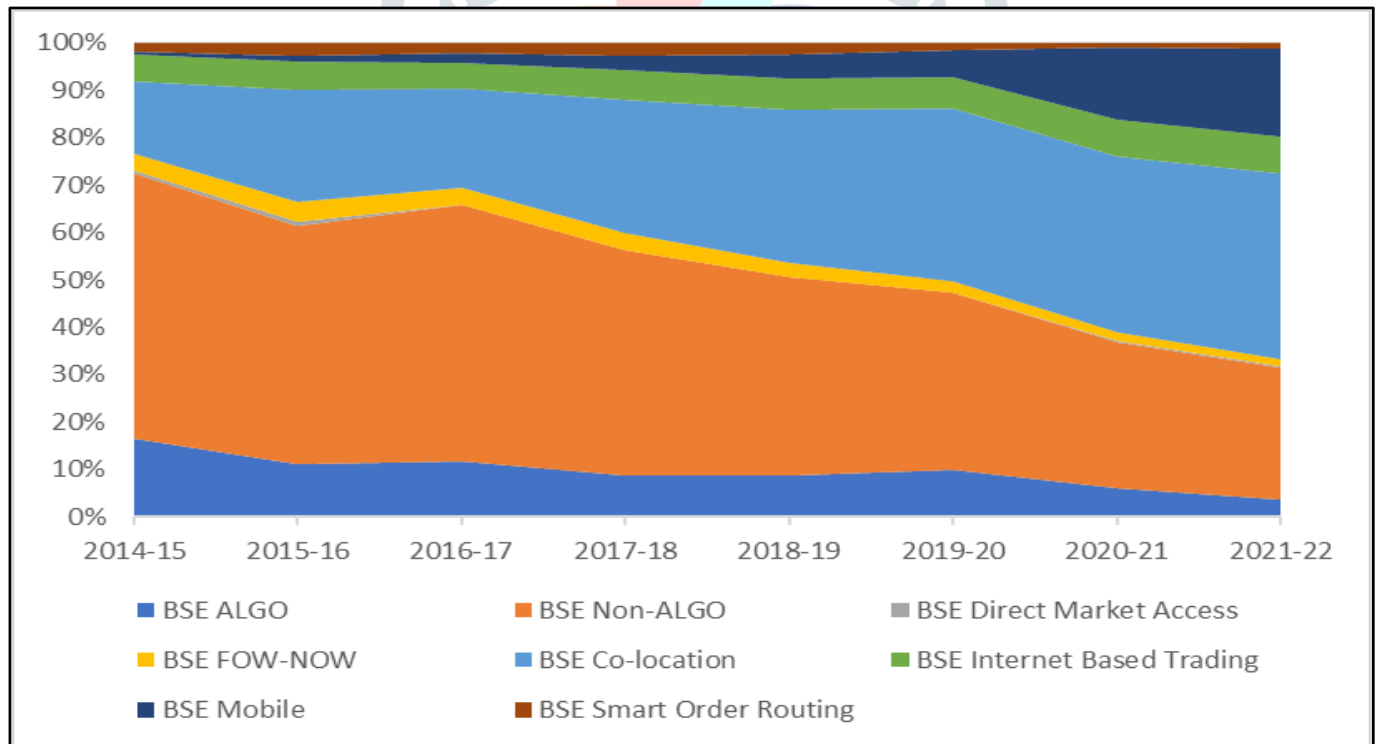
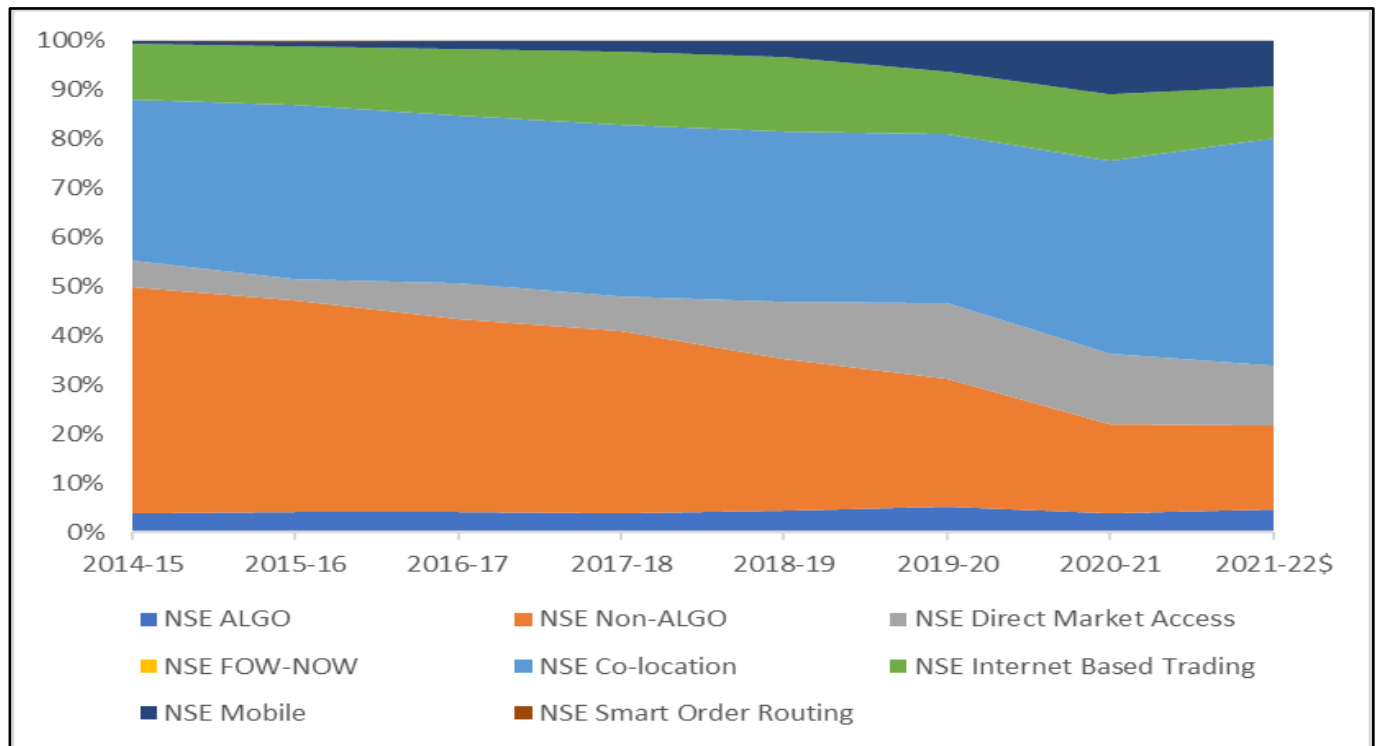Source: SEBI and Analysis by Authors

In Chart 1, NSE shows a clear upward trend in algo trading and co-location in the last few years and reduction in the non-algo trading in the cash segment. In Chart 2, mode of trading in the cash segment at BSE as a percentage of total turnover exhibits clear pattern of reduction in non-algo trading i.e., Co-location trading, in 2014 was 22% of the total turnover of the cash segment as compared to 34% in 2022 at NSE. Same way Co-location trading, in 2014 was 15% of the total turnover of the cash segment as compared to 39% in 2022 at BSE.

Mode of Trading in the Equity Derivatives Segment at NSE & BSE (as a percentage of Total Turnover):

The current statistics of Algo trading in the equity derivatives segment has been compared with the statistics of additional modes of trading. The analysis of the same has been done using the annual data of various mode of trading in the equity derivatives segment. The time period of the same was decided basis the availability of data from 2014 to 2022. The following charts below bounces a brief indication of evolution of Indian Stock Market in terms of Trading in the equity derivatives segment at NSE and BSE (as a percentage of total turnover) on annual basis from 2014 to 2022:

Chart 3: Mode of Trading in the Equity Derivatives Segment at NSE (as a percentage of Total Turnover)

Source: SEBI and Analysis by Authors

Chart 4: Mode of Trading in the Equity Derivatives Segment at BSE (as a percentage of Total Turnover)
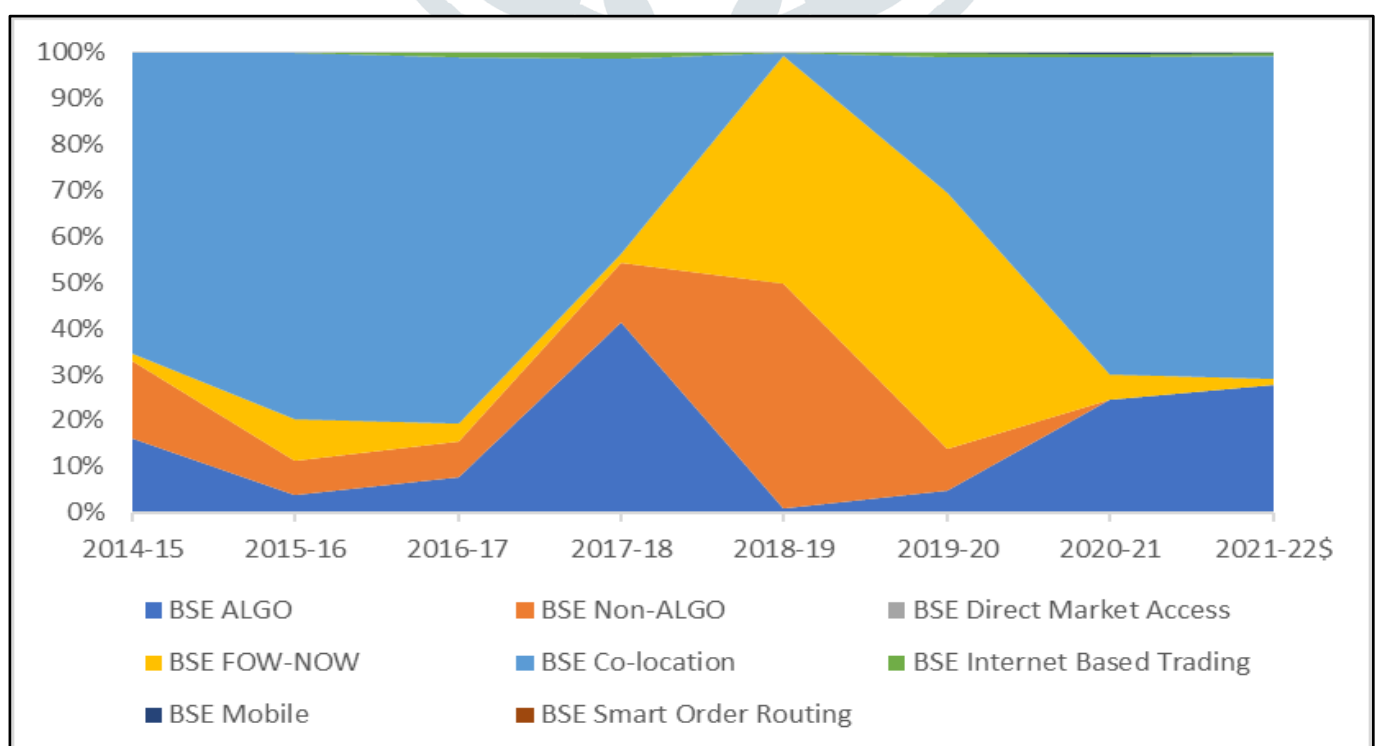
Source: SEBI and Analysis by Authors

The above charts 3 & 4 depicts the judgement between different modes of trading in the equity derivatives segment (as a percentage of total turnover) at NSE & BSE, respectively. In Chart 3, NSE shows simultaneous upward and downward fluctuations in Algo trading in the last few years.

Further, in relations of co-location and mobile trading at NSE has shown an upward trend. In Chart 4, Program trading at BSE also shows an upward trend though followed by moderate fluctuations.

CONCLUSION AND FUTURE AHEAD

In India,

- The volume of algo trading orders in the cash segment are more than non-algo trading orders.
- The number of orders placed by algo traders leads to huge perimeters.
- This huge periphery due to stunning growth of algo trading has raised the enterprises related to price discovery of securities.
- Algo trading, colocation and HFT offer various advantages and disadvantages. It is observed that with algo trading and HFT there have been improvements in transactions costs, volatility, and buy-sell imbalance.

Muniesa (2014) cite that in reality, stock prices aren't discovered they're fabricated. The massive investment conditions for algo and high frequency trading have led to an arms race for better technology (Budish et al., 2015). This further, opens the platform for deformation in the price discovery process by colourful request actors to prize the maximum benefits out of algo and high frequency trading (Ma and McGroarty, 2017). The debate on price discovery medium and life of prices is nowadays ending, but still, the controllers need to keep harmonious surveillance on the request actors so that price discovery medium shouldn't be distorted by some manipulative actors. Algo trading and HFT are infrequently shown in the light of abstraction that they give in terms of trade and unnoticeable dark pools, but the adding use of bared volume by Algo trading reflects a step towards a much more transparent system and clear suggestion of lower impact cost. With the arrival of Algo trading and its amazing growth pace, we can easily see India moving towards effective capital request.

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