

Role of Information Technology in the Finance Domain

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ABSTRACT

Technological innovations have changed the face of the financial world. One such advancement is the introduction of algorithmic trading in the stock markets. This paper tries to analyse how technology initially got introduced in the stock market by analysing the major milestones for technology for twelve major stock exchanges based on domestic market capitalisation. It further discusses in detail the meaning of algorithmic trading and the use of the same in today's stock market. While doing so various algorithms like ZIP and GD developed during the initial phases of algorithmic trading have been highlighted. An analysis has been done towards drawing a conclusion on whether technology can replace human traders completely.

Key words: Financial Markets, Information Technology, Stock Exchange

Introduction

The technology has left such a footprint on the financial world that today we speak only about plastic money, demat accounts, online banking and e-commerce. The invisible world where trillions of rupees get exchanged between their owners is today's stock exchange. We cannot imagine the long forgotten days when trading happened with actual scrips and no demat accounts.

This paper tries to study the way the technology evolved in this complex stock market. It also tries to express the need towards sustainability measures as one small mistake can lead to monetary damages worth millions of rupees. Also along with the monetary damage a small technical glitch can lead towards damaging the investor's confidence.

We cannot forget the NASDAQ's technical malfunction during the Face book's Initial Public Offering (IPO) that made the Face book's first day of trading quite a matter of discussion for reasons unasked for the Tokyo stock exchange also faced some technical glitches cause of which on 2nd February 2013 the Tokyo Stock Exchange knocked out trading in 241 Japanese stocks for almost four hours. Also we need to remember that this is only the tip of the iceberg.

Past Research

When literature is being surveyed on this topic which includes research papers by eminent authors, articles of substances, books and more, one cannot overlook the website of the New York Stock Exchange (NYSE) which draws a timeline of the entire technological revolution dating back to 1844 when the telegraph was introduced, to 2004 when automatic trading was allowed to 2008 where the uniform trading platform gets introduced.

There is wide ranging literature on this topics dating back to the eighties. The only difficulty being that most of the literature available dominates the changes in the developed economies. It extends from analysing the beginning of the IT revolution in the stock exchange domain to the very recent developments in the field. The 1986 Big Bang theory has been well analysed and the screen based market well supported by Clemens and Weber (1980). Bart Hobjin and Boyan Jovanovic (April 2000) emphasis the IT revolution's impact on the stock market right through the inception.

The internet changed the way people transacted. Nicholas Economides has expressed the multifaceted and profound impact of the internet on the financial markets. Similarly Terrence Hendershotthas detailed the electronic Trading in Financial Markets. Yesol Huh in his paper on algorithmic trading analyses the increase in liquidity and volatility in the stock market and attributes the same to increase in algorithmic trading and per se the hybrid market in the New York Stock Exchange.

From electronic trading we try to become more focussed on non-human intervention trading or algorithmic trading where the work of Prof.Dave Cliff(1996-97) is introducing the "ZIP" algorithmic can be named to be one of the first of its kind algorithm to be used as a trading strategy. Also the "GD" algorithm invented by Steven Gjerstad & John Dickhaut (1997-98) also proved to be of tremendous importance in the field of algorithmic trading. The GD algorithm was later modified to form the MGD. While naming the authors or owners of the algorithm the corporate giants backing the research IBM and HP cannot be overlooked. Going further down the timeline , beyond the 1990s , reference can be found towards ample of investment banks spending huge amount of money towards developing algorithms and the related trading strategies including Credit Suisse , Deutsche Bank and Goldman Sachs to name a few.

Sample size for discussion

The population to discuss algorithmic trading would be the stock exchanges around the world. The major international stock exchanges around the world would be more than 54 in

number. For this study analysis has been done on the major 12 stock exchanges based on the equity domestic market capitalization as below –

Table 1: Equity Domestic market capitalization (USD millions)

Sr.No.	Exchange	December 2012
1	NYSE Euronext (US)	1,40,85,944.00
2	NASDAQ OMX	45,82,389.10
3	Tokyo SE Group	34,78,831.50
4	London SE Group	33,96,504.90
5	NYSE Euronext (Europe)	28,32,188.50
6	Hong Kong Exchanges	28,31,945.90
7	Shanghai SE	25,47,203.80
8	TMX Group	20,58,838.70
9	Deutsche Börse	14,86,314.80
10	Australian SE	13,86,874.00
11	BSE India	12,63,335.50
12	National Stock Exchange India	12,34,492.00

Introduction of computers to the trading floor

Below is tabulated a brief overview of the introduction of technology in the 12 stock exchanges and moving from the traditional floor system of human outcry to the computerised sophisticated trading floors of today.

Table 2: 12 stock exchanges

Sr. No.	Exchange	Initial technological milestones
1	NYSE Euronext (US)	1878 marks then the first telephone installed on the NYSE, 1978 Inter-market Trading System (ITS) is inaugurated. ITS provides an electronic link between the NYSE and competing exchanges, enabling brokers to access all markets nation- wide to find the best purchase or sale price for a security and currently a unique blend of floor based auction and electronic trading is introduced through the hybrid market.
2	NASDAQ	In 1976 NASDAQ purchased the assets of the automated quotation NASDAQ System from its builder and operator, Bunker Ramo Corporation and slowly by the start of the 20 th century a state of art market platform is launched.
3	Tokyo SE Group	1982 can be marked as the start of the computer phase for the Tokyo SE & exchange saw a full-fledged computerisation by 1999.
4	London SE Group	The market deregulated in the 1986 termed as the ‘Big Bang’ where instead of human outcry for trades the computers were introduced and screen based trading started.

5	NYSE Euronext (Europe)	Technology wise it would be similar to the NYSE. In 2007 a merger between NYSE and the Euronext created a truly global marketplace.
6	Hong Kong Exchanges	Two important dates for the same being 1986 with the launch of CATs and 1993 with the introduction of AMS. (CAT – Computer Assisted Trading systems and AMS – Automatic Order Matching and Execution System)
7	Shanghai SE	Shanghai SE heavily relies on HP for the servers and other computer related equipment. It's an entirely paperless trading mechanism. There are terminals on the trading floor as well as the member firms.
8	TMX Group	The TMX group consists of two stock exchanges the Toronto SE and the TSX Venture exchange. In 1977 Toronto Stock Exchange launched the world's first Computer Assisted Trading System (CATS) and in 1997 Toronto Stock Exchange became the largest stock exchange in North America to choose a floorless, electronic (or virtual trading) environment when its trading floor closed.
9	Deutsche Borse	Headquarter in Germany this Stock exchange introduced electronic trading for a limited amount of equity in 1991 and in 1992 BOSS, an order routing system was introduced to support trading. Banks and firms were able to forward orders electronically with this feature. The earlier system outcry was abandoned future onwards. A lot of trading systems including the Xetra have been seen used since then.
10	Australian SE	Stock Exchange Automated Trading System (SEATS) was introduced in 1987. In 1998 the SE was demutualized and it was the first SE in the world to do so. Today it works on the following trading platforms ASX Trade (equity securities) and ASX Trade24 (derivative securities trading).
11	BSE India	In the year 1995 the electronic trading was introduced within a time span of 50 days. This fully automated computerized mode of trading is known as BSE Online Trading (BOLT), a system both order and quote driven. BOLT was operational using screen based trading and it switched over to the direct online access facility in September 1997. In the infant stages BOLT was available to brokers of the BSE based in Mumbai through leased lines. Today, it is available all over the country and even abroad. The year 2000 witnessed the introduction of derivatives on the market platform.
12	National Stock Exchange India	The National Stock exchange (NSE) was incorporated for the first time in November, 1992. A significant milestone from the technology front is that the National stock Exchange has received the BEST IT USAGE award by the computer Society of India in the year November, 1996. It has also received an award for the TOP IT USER in the name of "Dataquest award" in year December, 1996.

Moving from the automated trading floors to automated trading itself

This part forms the crux of the paper. By the start of the 21st century the computer had dramatically changed the way the world trades and this financial engineering still had to make some revolutionary changes. The 21st century witnessed algorithmic trading – a new financially engineered product for automated trades without human intervention.

For any trade to get executed four parameters revolve around the same – Price, Quantity, Market forces and Time of execution. A computer programme that can balance these four parameters without incurring a loss for the trader can be suitably called a successful algorithm. In a computer language a step by step procedure to reach the optimum solution is termed as an algorithm.

The earliest reference available on Algorithmic trading is of Dave Cliff, Janet Brutent (1996-7) developing a ZIP algorithm. People using this algorithm are called the ZIP traders (zero intelligence plus traders). Also the "GD" algorithm by Steven Gjerstad & John Dickhaut (1997-8) proved that algorithm can be counted over human trading behaviour. The GD algorithm many papers were published by them under the umbrella of IBM and HP related to the way automated trading can work in an open market including the ZIP & GD.

If a trace back is done to find out the way stock trading happened, two theories come to limelight. Few traders used fundamental analysis as a benchmark for investing in stocks and few performed technical analysis with tools like oscillators and various charting techniques. The fundamental analyst tries to find the intrinsic value of the company's share based on the financial statements and the annual reports of the company. Depending upon the intrinsic value and the market price the decision is taken of whether the share is undervalued and overvalued. On the same basis it is either bought or sold. Fundamental analysis takes a longer time since it involves a large number of parameters and also judgement.

Technical analysis is more mathematical in nature. By following certain rules and the market movements the decision of buy or sell can be taken. The technical analysis is based on three fundamental assumptions 1. The market discounts everything 2. Price moves in trends and 3. History tends to repeat itself. Based on this certain charts are drawn representing trends, supports, resistances and oscillators. With the help of certain rules mapped to the market movements decisions are taken on buying and selling the stocks.

Algorithmic trading can be said to be an extension of technical analysis with the help of technology. For example one of the most popular trading happening currently is the VWAP trading (Volume Weighted Average Price trading). In this the following calculation is involved,

1. Average price paid per share during a period
2. Volume of shares traded during that period * Avg price = VWAP
3. Fixed number of shares * Price close to VWAP – Decision

In this it is very easy to feed a particular number of shares in the system to be bought and sold. Similarly a computer programme can run to find VWAP for a particular period and then the transaction executed.

In the above Para the algorithm has been tried to be simplified for explanation. But some computational mathematics gets involved as the market forces will be changing in each period, so the past circumstances will not remain stagnant for the execution period, and that should be considered in the algorithm. This is done by using some computational mathematics. Also like we tend to formulate in any theorem "...other things remaining constant the following will happen..." The area of concern with the stock market is that none of the other things remain constant. So a provision needs to be made in the algorithm for the changing parameters.

Algorithmic trading has given rise to High frequency Trading (HFT). Defining HFT academically would be a herculean task as the wall street online journal has quoted "Conflict erupted among some of Wall Street's heaviest hitters over a proposed definition of high-frequency trading, showing rifts that divide big investment firms from the high-octane companies that specialize in the electronic trading" As per the journal a subcommittee working group proposed to define high-frequency trading as a "form of automated trading" that uses "algorithms for decision making, order initiation, generation, routing or execution, for each individual transaction without human direction," according to the rule outlined at the meeting. The trading uses technology that would "minimize response times" and rely on "high message rates."

The market is ideally meant for investors. In the process a few traders will also be investors. But with the emergence of HFT the market will become a trader driven market than an investor driven one. Also HFT can lead to huge volumes of trade which the market may not be capable of handling in terms of volume and liquidity. This may cause the market to collapse. The Flash Crash 2010 occurred on 6 May 2010 has partially been blamed on HFT as computer trading breakdown can cause sudden market volatility. Also an article by David Easley in the Journal of Portfolio Management has called this "order flow toxicity" when high frequency traders with a short trading period land up piling a huge volume of trade in the market.

The answer to the question of whether algorithm trading is used in the real world would be affirmative but the government and regulatory authorities are mulling their concern over the same. In computer related frauds or threats we learn about the Denial of Service Attack (DoS). If we try to relate the same to Stock exchanges and algorithmic trading we may find that if algorithmic trading or HFT is not monitored then DoS can be expected with millions lost at the hands on a man created machine.

Algorithmic trading analysis on the selected stock exchanges

As per the NYSE data the algorithmic trading wave which started in 1970s had took a good sprint and by the beginning of the twenty first century 60-70% of the volume traded on the NYSE was done electronically. This also increased the volatility in the market. The below chart from Bloomberg highlights the same showing a sharp increase towards the end of 2011.

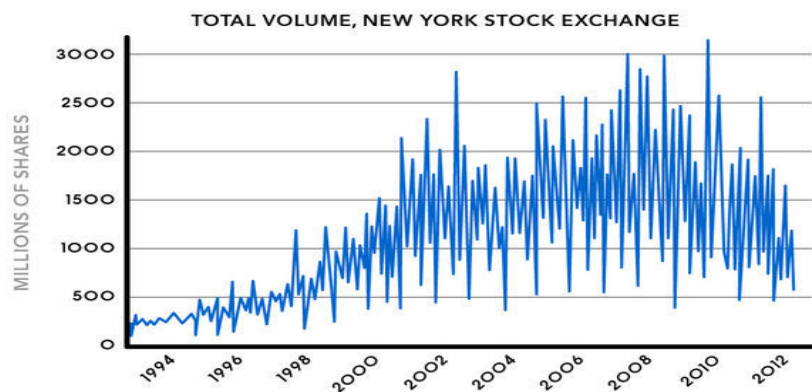


Figure 1: Bloomberg highlights

Though not as high as 60-70% of the volume traded, algorithmic trading is slowly catching up the pace in India also. In one year from November 2011 when the algorithmic trading as a percentage of monthly turnovers was 6.28% to 8.8% in August 2012, we can witness a rise in algorithmic trading.

Similar to India in Shanghai also algorithmic trading is on a rise. The exact percentage of algorithmic trading could not be confirmed but recent news regarding the Apama Capital Markets platforms going into production in June 2012 is sure to boost the algorithmic trading whatever be the current level.

As per the Australian Securities Exchange Review on algorithm trading, there has been a significant increase in trading activity in the recent years and also a reduction in the average trade size. The review co-relates this to the rise in algorithmic trading. (Also the review does a comparison with North America and European markets where due to multiple trade platforms situational algorithms are more prevalent in North America and Europe as compared to Australia. As per a survey done by the Australian Stock Exchange, the buy side

users mentioned the following reasons for using algorithmic trading , we have 28% due to anonymity , 28% due to cost , 23% due to trader productivity , 13% due to speed and 8% due to price movement. If we try to analyse the above the maximum use of algorithmic trading is for cost and anonymity (algorithm implementation and purchase is a onetime exercise as also your trading strategy is quite confidential with no human intervention) , while the least reason is mentioned as price improvement.(human trading strategy can also generate the same amount of profit).

Authorities governing these selected stock exchanges are also having concern over the use of algorithmic trading mainly the sustainability issues. To illustrate a recent example is the Securities Exchange Commission's denial of offering in 2013 to NASDAQ OMX Group Inc the permission to offer algorithmic trading to compete with other broker dealers fearing risk controls. Similarly in India due to a flash crash on NSE in 2012 Securities Exchange Board of India seeks some stricter norms for algorithmic trading including high frequency trading.

Apart from the examples cited above most of the stock exchanges are trying in the form of introduction of norms and strict rules to prevent flash crashes and also trying to maintain the financial sustainability.

**Ban computers: Impossible, Limit computers with required human intervention:
Possible**

Robotic engineering always relays this debate of man vs. machine. We cannot imagine a high end surgery at the hands of the robot without the supervision and the intervention at the much needed times by a surgeon. Similarly we also cannot deny the surgery happening cause of the use of high end technology available.

From the above discussion we cannot imagine going back to the outcry mechanism on stock exchanges but we also cannot deny that computer related actions if not supervised will collapse the financial system. Algorithmic trading should be permitted but with checks and balances in place. Plus restrictions over trade numbers and trade volumes should be ensured to ensure sustainability in the market. Financial engineering should be happen but implementation should be supervised to try and keep the system intact.

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