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A Critical Analysis of Functioning of Algorithmic Trading

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Abstract

The present paper attempts to critically analyse the algorithmic trading in India. Beginning with the background of algorithmic trading, it moves further to dig deep into the concept. It further elucidates high frequency trading and controversies revolving around it. Exploring the challenges of algorithmic trading, it highlights the amplification of systemic risks and provides several recommendations to combat the risks of algorithmic trading

1. Introduction

Technology plays an increasingly important role in the functioning of financial and securities market. The current volatile securities market requires timely trade executions and precise data analysis. This requires the assistance of technology through algorithms and computer programs. The growth of technology, computing power, data collection, connectivity and machines has enabled efficient monitoring of prices in the securities and financial market. In 2012, traders in the USA issued almost 2 billion offers to buy and sell shares and other securities resulting in 74 million complete trades. Comparatively, during the rise of the internet in 2000, around 5 million quotes were sent out resulting in the conclusion of 3 million trades. 2012 saw 460 times the quotes that in 2000.[1] Therefore, untethered by human cognitive limitations, algorithmic trading facilitates high volume and high-speed trading, with traders employing strong arrays of financial models, statistics and quantitative techniques.

[1] Yesha Yadav, 'How Algorithmic Trading Undermines the Efficiency in Capital Markets' (2015) 68 (1607) Vanderbilt LJ < https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2400527> accessed 1 October 2020.

Concerns have been raised and reports for public comments have been issued by the Securities and Exchange Board of India regarding the market integrity and fairness due to increased use of algorithmic trading.[2] What concerns most is that algorithmic trading and its subset set high frequency trading results in a 'rigged' market where these systems tend to prey on institutional and traditions investors.[3] If not rigged, the market is subject to deceptive and unfair practices carried out by some algorithmic and high frequency trading market makers.[4] These technological changes and evolutions in the securities market prompt "*fresh reflection about the ability of markets to continue to perform their most basic function: supplying capital to the real economy."*[5]

2. Background of Algorithmic trading

Various developments in the financial market let to the rise of algorithmic trading over the last two decades. Firstly, financial systems have grown over time to become more complex as a result of globalisation and economic growth. The need for technologically advanced algorithmic trading arose in order to keep up with the growing complexity of the finance sector.

The second development is the set of breakthroughs in the quantitative modelling of financial markets, the "financial technology" pioneered over the past modelling of financial markets, the "financial technology" pioneered over the past three decades by the giants of financial economics.[6]

The third development was that of computer technology including hardware, software and development of programs, telecommunication. The exponential advancement in data availability, collection, storage and organisation has resultantly changed the way the financial market functions.

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[2] State Bank of India, 'Discussion paper on 'Strengthening of the Regulatory framework for Algorithmic Trading & Co-location' (5 August 2016, Report) <https://www.sebi.gov.in/reports/reports/aug-2016/discussion-paper-on-strengthening-of-the-regulatory-framework-for-algorithmic-trading-and-co-location-_32940.html?QUERY> accessed 2 October 2020.

[3] Michael Lewis, *Flash Boys: A Wall Street Revolt* (W.W. Norton & Co. 2014).

[4] Steven R. McNamara, 'The Law and Ethics of High-Frequency Trading' (2016) 17 (1) Minnesota JL, Science & Technology <https://scholarship.law.umn.edu/cgi/viewcontent.cgi?article=1001&context=mjlst> accessed 2 October 2020.

[5] Yesha Yadav (n1).

[6] ibid.

3. What is Algorithmic Trading?

Algorithmic Trading is a system of trading which facilitates decision making in the financial market using advanced mathematical tools.[7] It involves step by step instructions taken by computers to determine trading activities.[8] This system requires minimum human intervention thus making the decision-making process quicker. Any profit-making opportunities are detected faster by the algorithmic tools as compared to a human broker. This makes the system is better suited for institutional investors who deal in large amounts of shares. Algorithmic trading system also benefits from being testable and repeatable, with differing rules in every transaction. This system is increasingly popular among clients and trading brokers since it enables speedier, anonymous decision making and generates larger output in a smaller interval of time.

4. What is High Frequency Trading?

High Frequency Trading [hereinafter "**HFT**"] is a subset of algorithmic trading that "*comprises latency-sensitive trading strategies and deploys technology including high speed networks, colocation, etc. to connect and trade on the trading platform.*"[9] It can to react to trading opportunities that last for only a fraction of a second and is highly technologically driven. It is also understood as computer assisted trading that "*exploits incredibly small-time differences to yield profits at minimal risk to those employing it*."[10] While this facility is highly attractive and significant in the securities market, it has been considered somewhat controversial during the financial crisis of 2008-2009 in the United States of America. Another important term to understand while analysing the challenges of algorithmic trading is *Co-Location.* Co-location is of the first tangible manifestation of HFT. It is the "*exchanges' practice of renting space in the facilities that house their computer servers to traders who believe they can benefit from this proximity.*"[11]

5. Other types of Algorithmic Trading Strategies

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[7] 'Definition of Algorithmic Trading' *The Economic Times* (Mumbai, 2 October 2020) <https://economictimes.indiatimes.com/definition/algorithm-trading> accessed 2 October 2020.

[8] State Bank of India, 'Discussion Paper' (n2).

[9] ibid.

[10] Maureen O'Hara, 'High Frequency Market Microstructure' 2015 J Financial Economics 257, 262 <https://doi.org/10.1016/j.jfineco.2015.01.003> accessed 4 October 2020.

[11] Jerry Adler, 'Raging Bulls: How Wall Street Got Addicted to LightSpeed Trading' (*Wired*, 8 August 2012) <http://www.wired.com/2012/08/ff_wallstreet_trading/> accessed 5 October 2020; Geoffrey Rogow, 'Colocation: The Root of All High-Frequency Trading Evil?' (*Wall Street Journal: Market Beat Blog*, 20 September 2012), <http://blogs.wsj.com/marketbeat /2012/09/20/collocation-the-root-of-all-high-frequency-trading-evil/> accessed 5 October 2020.

Index Arbitrage is one of the most commonly used algorithmic trading strategies. The most substantial benefit of this program is speed. During a profitable opportunity which many traders will attempt to grasp at a certain price, the pre- programmed will pick it up it in a matter of milliseconds.

Trigger Trades is an algorithmic program that sends electronic orders to trade securities in accordance with pre-set strategies.[12] It observes patterns in price of stocks and buys or sells stocks at a trigger price decided by human traders. This held buyers engage in sweeps wherein a large number of shares are bought at a set price, across multiple marketplaces.

6. The Flash Crash of 2010

Before we proceed to the next part of the article identifying the risks and challenges of algorithmic trading, it is important to understand the background of when red flags of this system arose. On 6th May 2010, the financial market saw prices of several US equity drastically fall and rebound in a matter of minutes. Future and securities marker, which were already down 4% from the closing the night before, suddenly plunged a further 5-6% in a few minutes, only to recover almost as quickly.[13]

A total of about 8,000 exchange trade funds and equity securities which were traded that day experience similar plummeting of prices up to 5%, 20% and even as high as 15% followed by a rebound within a few minutes.[14] Other equities however, saw even more severe price changes, both up and down. Over 20,000 trades across more than 300 securities were executed at prices more than 60% away from their values just moments before. Furthermore, several trades took place at prices and low as a penny or less, or as high as $100,000, before prices of those securities returned to their precrash levels. By the end of the day, major futures and equities indices recovered to close at losses of about 3% from the prior day.[15]

A report on this peculiar incident by the Securities and Exchange Commission and the Commodity and Futures Trading Commission observed that:

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[12] Terrence Hendershott et al., 'Does Algorithmic Trading Improve Liquidity?' (2011) 66 (1) J Finance 1, 2 <http://faculty.haas.berkeley.edu/hender/Algo.pdf> accessed 6 October 2020.

[13] International Organization of Securities Commission, 'Regulatory Issues Raised by the Impact of Technological Changes on Market Integrity and Efficiency' 11 (July 2011, Consultation Report) <https://www.iosco.org/library/pubdocs/pdf/IOSCOPD354.pdf > accessed 6 October 2020.

[14] ibid.

[15] ibid.

"Under stressed market conditions, the interaction between automated execution programs and algorithmic trading strategies can quickly erode liquidity and result in disorderly markets. High trading volume is not necessarily a reliable indicator of market liquidity, especially in times of significant volatility."[16]

This incident has become notable for bringing to light the connection between the securities and derivatives market, especially with regard to index products. There exists a strong interconnection between various financial markets and the algorithms operating across markets can carry affects from one to the next, thereby amplifying the systemic risk.

Challenges in Algorithmic trading- Model Risks

Algorithmic Trading system outperformers human traders as they can only respond in a matter of seconds. Yet, this system comes with its set of risks. Efficient Market Hypothesis, a classical finance theory suggests that it is close to impossible to consistently surpass the market without incurring additional risk[17] The infamous "flash crash" that occurred in the US in 2010 is the accurately represents how terribly wrong an instance can go with algorithmic trading.[18]

7. Amplification of the Present Systemic Risks

As also evident from the occurrence of the Flash Crash in 2010, it is clear that algorithms functioning across markets can cause shock that transmit from one market to another in a short span of time thereby amplifying the systemic risk. Errors, uncertainties and drastic changes could pose a serious challenge to traders.[19] These factors are amplified in an algorithmic system which is high data sensitive, where trades are moving as quickly as in milliseconds with gigabytes of data being crunched withing this short span of time, without the easy possibility of human intervention in the event of an error. Negative impact of data gaps, and high volatility in the market is amplified in an algorithmic system. Therefore, in a circumstance of an error or crisis, the algorithmic system would have acted before any human

[16] ibid.

[17] Nicholas Burgess, 'An Introduction to Algorithmic Trading: Opportunities & Challenges within the Systematic Trading Industry' (23 September 2019) SSRN < https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3466213> accessed 6 October 2020.

[18] Jill Treanor, 'The 2010 'Flash Crash': How it Unfolded' *The Guardian* (London, 22 April 2015) <https://www.theguardian.com/business/2015/apr/22/2010-flash-crash-new-york-stock-exchange-unfolded> accessed 6 October 2020.

[19] Dennis Bams et al., 'An Evaluation Framework for Alternative VaR Models' (EFA Annual Conference Paper No. 111, Glasgow, August 2003) (showing the challenges of modelling credit risk).

intervention could take place. It is close to impossible to rectify the model risks and the informational deficient, a challenge that could gravely distort capital allocation.

Erroneous Algorithms: While algorithmic trading efficiently functions on pre-programmed strategies, it takes place at an extremely high speed leaving limited opportunities for intervention. Under this circumstance, an erroneous instruction in the system, a faulty bug or any technical glitch, even if identified immediately, will stack up millions in losses in a short amount of time. A notorious example of this is the incident at the Knight Capital who in a short span of 45 minutes lost $440 million in 2012. A new trading. A new algorithmic trading adopted by the market maker made millions of erroneous trades in over 150 stocks. It bought them as a high ask price and sold them at a lower bid price. Due to the hyper-efficiency of the algorithmic trading system, which is always observing the market for such price discrepancy, other traders took advantage of the dilemma. By the time the traders at Knight could recognise and isolate the source of the problem, Knight had suffered irreparable losses and was pushed into bankruptcy.[20]

Ripple Effect: given the growing degree of integration and inter-connection between assets and markets in the global economy, a breakdown in in one major assets or market has the potential to cause a ripple effect across other interlinked markets and assets as well.

Highly Intense Volatility: As discussed above, algorithms react instantly to any change in the market condition. Resultantly, during a turbulent market will react instantaneously by either widening their ask in a particular bid or might just stop trading all together. This not only diminishes liquidity, but also exacerbated volatility. This volatility can cause humongous loss to investors, like in the Flash Crash and Knight crisis.

Uncertainty: Volatility of the market is significantly exacerbated by the contribution of the algorithmic trading strategies like HFT. In the short term it can stoke investors uncertainty and in the long term can affect consumer's trust. In the event of the market abruptly crashing, investors are often left pondering why and how such drastic shifts occurred. More downward pressure is added to the markets when big traders like HFT firms cut their trading positions to

[20] Nathaniel Popper, 'Knight Capital Says Trading Glitch Cost It $440 Million' (*The New York Times: DealBook*, 2 August 2012), <https://dealbook.nytimes.com/2012/08/02/knight-capital-says-trading-mishap-cost-it-440-million/> accessed 8 October 2020.

scale back risks during the news gap that often occurs at such times. Resultantly, more stop losses are triggered as the market moves lower, and this causes a loop of negative feedback leading to a downward spiral. The trust and confidence of a consumer is disturbed by the collapse of the stock market and recessionary signals emanate from a massive meltdown of the market is a bear market develop.

8. Pre-set Programmed Constraints

Algorithmic trading requires traders to input pre-set programs, methods, risk assumptions etc. this comes with the several constraints. Due to such pre-set programs, the algorithms cannot reflect information that falls beyond the scope of the programs inputted but the trader. This is important in terms of the quality of price that may be produced by the market. Due to this constraint, algorithms can find it difficult to handle out of the ordinary, unforeseen situations that law beyond their programming. Despite the sophistication of the system, algorithmic strategies are characterised by a certain degree of risk due to reliance of personalised programming and devising to capture unorganised practical human behaviour. Considering the enormous costs of building algorithms, there is little incentive for traders to precisely program algorithmic strategies to deal with exceptional circumstances which rarely occur. Rather, it was more logical for traders to simply withdraw from a market in case of a crisis or disruption, burdening other traders with the load. While this may be helpful for independent individual traders, it is disruptive for the market in its entirety. If algorithmic traders are able to exit the market cheaply and are able to avoid for unexpected risks, algorithms may not be successful in accurately pricing these risks into the programming that drives everyday trades.[21]

High Operational Costs

The operational costs pose a significant challenge for the usage of algorithmic trading in the trading industry. The cost involved is high as timely tests, updates and improvements are required to be made to the system. The system needs to be optimised to keep up with the ever-evolving market. The increasing competition and the A suitable instance of operational issues in the trading system is in the 2006 Amarnath case. Amarnath was an A-list fund

[21] Yesha Yadav (n1).

operation with an up to date trading system till 2005. However, in 2006, they lost nearly 6 billion 2006 when natural gas future prices plunged, due to faults in the trading system.[22]

Lack of fairness and a level playing field

One of the most frequent concerns expressed by the public regarding the increasing reliance of algorithmic trading is the lack of fairness and integrity involved in the system. The foremost complaint in this regard is that some players using algorithmic trading strategies and colocations to trade are at an advantage in a market as compared to non-colo or non-HFT players. The idea of level playing field in a securities market indicates that players should be treated and be able to function alike. This means that the players should have the required prerequisites of investments of time, knowledge and material to successfully compete in a securities market, and these prerequisites should be available to all. Of course, realistically not all traders would be able to invest the same number of requirements. In context of an algorithmic trading system, a level playing field would require equal access to information and knowledge. Further for strategies like HFT, a level playing field also involve "*speed and processing power, and equal treatment by the law and key market institutions.*"[23] Therefore, algorithmic traders with speed advantage can have the upper hand in a highly competitive securities market, while traders facing initial delays have little to no scope to recover.

Naturally slower traders struggle to compete with co-located HFT traders for the best, most profitable trades. This has result in the idea that the emergence of algorithmic trading has created a two-tiered market. A level playing field is an idealistic notion, and not a realistic vision. The unbalanced distribution information in the securities market is significant, despite there being regulations in place attempting to create a fair market.[24] Most of this unbalance and asymmetry can be attributed to the difference in investments, time, technology, research and human capital. Behind these facets rests a variance in human endowments itself with differing levels of intelligence, understanding, ambition and interest which also contribute to the level of success. Evidently only the more sophisticated players have the ability to not only have access to technology and information, but also have to ability, interest and knowledge to use it to achieve a higher level of success. Therefore, while a fair and level playing field in a

[22] Jonathan Davis, 'Amaranth: how to lose $6 billion in a Fortnight' (*The Spectator*, 28 October 2006) <https://www.spectator.co.uk/article/amaranth-how-to-lose-6-billion-in-a-fortnight> accessed 8 October 2020.
[23] Tara E. Levens, 'Too Fast, Too Frequent? High Frequency Trading and Securities Class Actions' (2015) 82 (3) U Chicago LR 1511.
[24] Haim Bodek, 'HFT Checkmate The Alpha in Order Types' (*Tabb Forum*, 21 January 2013), <http://tabbforum.com/opinions/hft-checkmate-the-alpha-in-an-order-type> accessed 9 October 2020.

securities market is more idealistic that realistic, the high costs and know-how involved algorithmic trading amplifies the disparity that already existed in the securities market.

Lack of Transparency

Experts believe that the lack of transparency involved in algorithmic trading is the core problem of the system. While some algorithmic strategies are comparatively simpler, others are far more complex, based on methods of machine learning or deep learning. Even developers and traders might not fully understand the complexity of a mechanical "black box" and how outputs are produced. this makes is very difficult for outsiders to understand, let alone explain the process. This problem is further aggravated by people's unwavering and blind faith in the reliability of the system and the big data is outputs also known as "*digital realism"*. The growing opacity in the process results in an increasing lack in human accountability. This system only confirms the dangerous reality of power, authority and responsibility shifting from people to machines

Negative effect on Institutional Integrity

Repeated and growing volatility if the marker has shaken the confidence of various investors and traders who participated in financial markets with the confidence and faith that market remains integral. In the last decade, lack of efficient regulation and policies has resulted in not only system errors, but also violation of securities laws and egregious trading disruptions. For instance, in 2012, there were numerous delays in confirmations and technological problems with Facebook's IPO.[25] In 2014, after a computer malfunctioned at the Intercontinental Exchange Group's U.S. Exchange, almost 20,000 faulty trades had to be cancelled.[26] In 2013, Nasdaq had to stop trading for 3 hours due to issues with its trading software.[27]

Practices have immerged to manipulate and trick to the market that have led to the loss of institutional integrity. The infamous lone trader Navinder Sarao, operating from the United

[25] Dominic Rushe, 'Facebook IPO: Five Things That Went Wrong With the Social Network's Debut' *The Guardian* (London, 24 May 2012) <https://www.theguardian.com/technology/2012/may/24/facebook-ipo-mark-zuckerberg-nasdaq> accessed 8 October 2020.

[26] Callie Boost et al., 'NYSE Computer Error Prompts Cancellation of Almost 20,000 Trades' (*Bloomberg Business,* 30 April 2014) <https://www.bloomberg.com/news/articles/2014-04-29/nyse-options-markets-cancel-almost-20-000-trades-following-error> accessed 8 October 2020.

[27] Chuck Mikolajczak & Rodrigo Campos, 'Nasdaq Market Paralyzed by Three Hour Shutdown' (*Reuters*, 22 August 2013) <https://in.reuters.com/article/us-nasdaq-halt-tapec/nasdaq-market-paralyzed-by-three-hour-shutdown-idUSBRE97L0V420130822> accessed 9 October 2020.

Kingdom manipulated "spoof" orders which is believed to have caused such an imbalance in the market that it triggered to famous Flash Crash.[28] **Spoofing** involves intentionally manipulating prices to cheat investors by placing a high number of fake orders of an assets or a derivative that get cancelled before they are filled in only to conduct a trade in the opposite direction of the cancelled order.[29] Another practice emerged called "**Layering**" wherein a sequence of limited orders are placed by the traders themselves in order to increase and decrease the process of assets to create and appearance of the change in demand and get innocent investors to pay a desirable price. Once the trade takes place the orders are cancelled. The difference between these scams and the traditional, non-algorithmic trading "pump-and-dump" is that the former has the advantage of speed and advanced electronic means to be conducted with. Therefore, schemes and manipulations can be conducted in a matter of milliseconds- for example, the Securities and Exchange Commission a spoof and layering scheme conducted in 839 milliseconds. This cannot be done manually by a human trader. Therefore, algorithmic trading can magnify these scams and risks that tarnish the integrity of the financial markets resulting in investors being weary to participate and invest their money. Another major incident like the Flash Crash could destroy investors' confidence in the integrity of the financial markets.

9. Regulatory Challenges

Technological changes in the financial market is often faces with regulatory challenges are old laws become redundant and do not develop as fast as technology does. Therefore, in the face of sharp evolving algorithmic trading systems, laws and policies struggle to keep up and stay relevant.

One of the main regulatory challenged faced by the financial market is that of resources. Regulators and policy makers lack the resources to keep up with high tech programs and developments. Firms regularly invest money, time and human capital into developing and updating their technology in order to achieve greater profits. Policy makers and regulators on the other hand function on public funds and have greater constraints based on political

[28] John Cassidy, 'The Day Trader and the Flash Crash: Unanswered Questions' *New Yorker* (New York, 23 April 2015) <http://www.newyorker.com/news/john-cassidy/the-day-trader-and-theflash-crash-unanswered-questions> accessed 9 October 2020.

[29] Andrei A. Kirilenko & Andrew W. Lo, 'Moore's Law v. Murphy's Law: Algorithmic Trading and its Discontents' (2013) 27 (2) J Economic Perspectives <https://www.aeaweb.org/articles?id=10.1257/jep.27.2.51> accessed 8 October 2020.

considerations.[30] Therefore, lack of sufficient resources causes regulation to fall behind. They are unable to keep up with the market schemes and manipulative scams possible with the complex algorithmic trading system.

Additionally, regulators may find it extremely difficult to detect changes in the technology and in the market that takes place at a much higher pace, requiring specific technical knowledge. Algorithmic trading has drastically accelerated the speed at which transactions happen in the financial markets making it harder for regulators to identify manipulative schemes in the market. Therefore, rather that prevention, regulators via investigations, resort to identifying schemes after they are already done.

Finally, the along with the challenges of resources and detection, new market manipulation and algorithmic trends also result in enforcement challenges. For a while now laws have focused on schemes and trades performed by human with the malafide intent to manipulate, whereas now schemes are largely conducted by computers and algorithmic programs. While one could attempt to apply the old legal regulations to the evolved financial scenario, in reality it is difficult to apply it is difficult to claim that laws that focus on natural legal persons should naturally and seamlessly apply to autonomous, artificially intelligent systems. Further enhancing the complexity, the enforcement issue for regulators is the fact that when the required malafide intention to manipulate the marketplace is absent, some of the algorithmic trading programs are arguably legitimate trading and investment strategies that cannot be easily distinguished from the tactics of illegal market manipulators.[31]

10. Conclusion and Recommendations

The bottom line is that algorithmic trading has a number of risks attached to it, the biggest being the amplification of systemic risks. The repeated bouts of uncertainty and volatility could have negative consequences on the confidence that the investors hold in the integrity of the market. Even traders and firms have recognised that one major error in the system could

[30] Arthur Levitt Jr., 'Don't Gut the SEC' *New York Times* (New York, 7 August 2011) <https://www.nytimes.com/2011/08/08/opinion/dont-gut-the-sec.html> accessed 9 October 2020; Mark Maremont & Deborah Solomon, 'Behind SEC's Failings: Caution, Tight Budget, '90s Exuberance' *The Wall Street Journal* (New York, 24 December 2003) <https://www.wsj.com/articles/SB107223513870781900> accessed 9 October 2020.

[31] Andrew Verstein, 'Benchmark Manipulation' (2015) 56 (1) Boston College LR 215, 217–18 <https://lawdigitalcommons.bc.edu/cgi/viewcontent.cgi?referer=&httpsredir=1&article=3417&context=bclr> accessed 9 October 2020.

result in a disastrous damage not only to that asset or market, but the effect to ripple through all the inter linked financial markets. The impact on the global market as well could be catastrophical.

It is important for developers to foresee situations of crises and develop such backup options in order to prevent major losses in the market. In 2014, Nasdaq OMX Group came up with a "kill switch" option for its member firms. This option cuts off trading instantly when a pre-set risk exposure level is breached. While this "kill switch" option is available to many HFT firm which help them stop all trading activities during a certain circumstance, the Nasdaq switch goes on to further provide an additional level of safety to counter rogue algorithms.[32] Similarly, in 2014 the Commodity Future Trading Group put forth regulations for firms using algorithmic trading system. It required firms to have a system of pre-trade risk controls. More controversially, some provisions required for them to make the source code of the program available to the government if and when requested.

Another recommendation to combat the risks of algorithmic trading is that policy makers should embrace the principle of integrity in their approach to help guide firms and intermediaries towards formulating the best practices that protect and preserve the integrity of the marketplace from threats of manipulation. Financial intermediaries can strengthen the integrity of the market if they to adopt an integral approach in trading. Intermediary practices should endeavour to encourage , neutrality of investors, private supervision, enhanced security, and fair access in its conduct with counterparties and other market participants.[33]

With the rise of algorithmic trading and the growing influence of automation in the financial industry, it is clear that there are several benefits of algorithmic trading, and the profit-making opportunity is widened with gigabytes worth of data being crunched and high volumes of trades being made in a matter of milliseconds. However, from a holistic perspective, it is evident that the risks and costs of algorithmic trading are high and when a problem arises, the damage done is catastrophic and irreparable, and often recovery is long drawn and has a drastic impact on the integrity of the financial market. The rather straightforward relationship between informational and allocative efficiency is also

[32] Muhammad Iqbal, 'Nasdaq To Roll Out 'Kill Switch' To Help Catch Trading Errors' *Business Recorder* (New York, 19 February 2014) <https://www.brecorder.com/news/158755> accessed 9 October 2020.
[33] Tom C. W. Lin, 'The New Market Manipulation' (2017) 66 (6) Emory JL 1253, 1303 <https://law.emory.edu/elj/_documents/volumes/66/6/lin.pdf> accessed 10 October 2020.

considered to suffer. There is growing reliance on pre-programmed algorithmic trading strategies along with a transient, costlier climate for informed investors. The traditional paradigms underlining efficient allocation of capital resultantly grows irrelevant and weaker. There are no obvious or easy solutions to ensure the eradication of all challenges and risks and create a well-balanced and stable financial market with the market set to grow even more reliant on automated algorithmic trading systems, the regulators will have to face the critical questions regarding the rules that regulate them now and in the future.