EXPLORING LEGAL LIABILITY IN AUTOMATED AND ALGORITHM-BASED FINANCIAL MARKETS

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ABSTRACT

One of the most important technological changes in the contemporary financial markets has been the algorithmic trading. It is the application of advanced computer algorithms and robotic systems to carry out the trading orders in accordance with specified rules in terms of the price dynamics, market environment, timing, and trading volume. The adoption of algorithmic and high-frequency trading has become widespread in all financial markets worldwide over the last 20 years due to the rapid development of the high-speed computer, electronic trade platforms, and artificial intelligence technologies. Large trading institutions like the National Stock Exchange of India and the New York Stock Exchange have now become major players in automated systems to conduct large amounts of transactions at an astonishing rate and efficiency. Although algorithmic trading has led to a dramatic increase in liquidity in the market, efficiency in operations, as well as, the speed at which a trade can be executed, there have been complex legal and regulatory issues brought about by algorithmic trading. This is one of the main issues connected with the problem of legal responsibility in case of automated trading systems failures, distortion of the market, or systemic failures. The paper investigates the legal consequences of algorithmic trading in automated financial markets with special focus on liability sharing between various parties. It examines the technology that lies behind automated trading systems, the economic benefits and systemic risks of their utilization and regulatory reactions that have been taken by financial regulators including the Securities and Exchange Board of India and the U.S. Securities and Exchange Commission. Finally, the paper suggests the establishment of more robust regulatory regimes and more effective compliance systems to promote transparency, accountability and stability in more automated financial markets.

Introduction

The technological revolution of the digital technology has drastically changed the financial market globally and has seen the introduction of automated trading also known as algorithmic trading. Algorithms trading entails applying complex computer programs and mathematical models to make financial transactions fast and in large quantities, without involving human intervention.[1] These systems are grounded on the characteristic instructions depending on the price, timing and market conditions to automatically execute a buy or sell order. In recent 20 years, algorithmic trading has taken over as a new characteristic of the financial markets, especially in the developed economies, where a significant percentage of trade is performed using automatic methods.[2] This has been further enhanced by the creation of superior computing infrastructure, high internet connectivity speed, and artificial intelligence technologies.

The development of algorithmic trading may be linked to the growing demand of efficiency, precision, and velocity in the work of financial markets. The manual trading techniques were usually constrained by the human ability, slower trading and prone to emotional choices. In comparison, algorithmic systems enable a financial institution and a trader to read and make transactions within milliseconds on vast amounts of data. The large world stock markets including the New York Stock Exchange and the National Stock Exchange of India have incorporated advanced electronic trading systems that facilitate automated trade plans. These changes have led to an improved market availability, lesser transaction expenses and efficiency in operations.

Over the past few years, the use of artificial intelligence and machine learning methods in financial markets has increased the scope of automation therein. Trading algorithms can more and more analyse the complex market trends, forecasts of price fluctuations, and make independent trading options through the real-time information analysis. HFT or high-frequency trading (HFT) is a specialised algorithmic trading that uses exceptionally fast computer systems to make a vast number of trades in fractions of a second. This is because such technological breakthroughs have fundamentally altered the format and operations of financial markets and

[1] Gregory Scopino, *Algo Bots and the Law: Technology, Automation, and Regulation in Financial Markets* (Cambridge University Press 2020)
[2] Terrence Hendershott et al., supra note 3

have led to the development of a highly interconnected and data-driven trading environment.

The increasing use of automated trading systems has, however, also brought with it the serious legal and regulatory issues, despite its multitude of benefits. The problem of legal liability also leads to one of the greatest challenges in case of the malfunctioning of algorithmic systems or when these systems disrupt the market. In contrast to the conventional trading where it is easy to blame the human factor, automated trading systems use many stakeholders, such as financial institutions, algorithm developers, software engineers, and trading platforms. It is a complicated legal problem to decide the liability in situations where there is manipulation of the market, errors of the algorithm, or failure of the system. As an example, the famous Flash Crash of 2010 showed that automated trading algorithms might cause sudden and unprecedented market volatility that in a very short span could cause billions of dollars of short-term losses. These events demonstrate the possible dangers of automated financial markets and underline the necessity of the effective regulation.

Legal liability in algorithmic trading is hence of great importance to study. As the financial markets are increasingly automated, the law should adapt to tackle the problems of accountability, transparency or market integrity. Securities regulators in various parts of the world such as the Securities and Exchange Board of India and the U.S. Securities and Exchange Commission have started providing guidelines and regulatory systems that are designed to regulate algorithmic trading. Nevertheless, most of the legal regimes currently in place were built to accommodate traditional trading conditions and therefore might be insufficient to deal with the complexities posed by autonomous trading technologies. This poses a great problem in establishing a party to shoulder the loss of money, market manipulation, or breaking of the rules and regulations that are perpetrated by automated systems.

The first aim of the study is to research the legal aspects of algorithmic trading and discuss the issues linked to the responsibility allocation in automated financial markets. The paper further aims to discuss the technological underpinnings of algorithmic trading, the risks and regulatory issues that come with its popularization, and the changes in the legal landscape that regulate automated trading. Additionally, the study is to assess the roles and duties of different stakeholders in the algorithmic trading such as traders, financial institutions, algorithm developers, and stock exchanges.

This research also covers the analysis of both domestic and international regulatory strategies towards algorithmic trading and with specific references made to the question of accountability, market manipulation, and systemic risk. It is expected that the study will help to obtain a detailed picture of what legal frameworks may do to adequately address the challenges of automated financial technologies elicited by effective responses of the legal system to them. Finally, the study will also aim to add to the current discussion of financial regulation by offering legal and policy changes that guarantee the responsible and transparent usage of the algorithmic trading systems in the contemporary financial markets.

Concept and Evolution of Algorithmic Trading

The algorithmic trading is one of the most important technological changes that occurred in the recent financial markets. It can be defined as the application of computer algorithms and automation of trading requests based on preset guidelines and mathematical formulas.[3] These directions are set in accordance with the variables of the movements of the prices, markets timing, trade volume, and complicated statistical trends. The main aim of algorithmic trading is to maximize the efficiency, speed, and the accuracy of financial transactions and reduce human intervention in the trading decisions.[4]

In its purest form, algorithmic trading entails the application of computer software that automatically trades in financial markets by either selling or buying upon the fulfilment of certain requirements. The systems are made to process large amounts of data that cover the markets in real-time and react instantly to any changes in price or market behaviour. In comparison to the traditional manual trading where the process relies a lot on human judgment and physical availability in the trading agriculture, the algorithmic trading allows the execution of transactions in a matter of milliseconds. Consequently, automated trading strategies are becoming more popular among financial institutions, hedge funds and professional traders to acquire competitive advantages in global markets.

The idea of algorithmic trading has appeared in the late twentieth century when the electronic trading systems and electronic financial infrastructure were rapidly evolving. Most trading systems before the introduction of automated systems used to be performed using the open

[3] Gregory Scopino, *Algo Bots and the Law: Technology, Automation, and Regulation in Financial Markets* (Cambridge University Press 2020)
[4] Rakhi Trading Pvt Ltd. v. Securities and Exchange Board of India, (2018) 13 SCC 753

outcry systems in the trading floors, with the brokers manually executing the orders of their customers. But as computer technology was able to develop, financial markets began to digitise and in turn the manual processes in financial markets were phased out in favour of electronic trading platforms. With these technological advancements, it was possible to create computerised algorithms that can analyse market data and make trades faster than ever before.

Automated trading systems began to evolve much faster in the 1990s and the early 2000s, as the financial markets became equipped with sophisticated computing and electronic communication networks. Financial institutions and investment banks started developing their own trading algorithms which were able to analyze large volumes of financial information and implement complicated trading rules.[5] These systems enabled traders to have more efficient means of using these strategies, which were arbitrage, trend following, and statistical analysis, in comparison to the traditional means. Accordingly, automated trading over time became part and parcel of the financial markets across the world.

An important aspect of algorithmic trading development was the development of the high-frequency trading (HFT), a type of automated trading with an exceptionally high trading frequency and significant capacity to carry out large amounts of transactions at extremely short times. High-frequency trading is based on the use of strong computer architecture, modern data analysis, and ultra-low-latency communication networks as a means of taking advantage of minor price variations across financial markets. The traders who trade HFT schemes tend to stay in their positions only a few seconds or milliseconds which make them gain profits by buying and selling goods at a very fast rate.

The prosperity of high-frequency trading has turned the composition and operations of financial markets to a large extent. In most of the developed markets, automated trading algorithms have now contributed a significant ratio in the total trading volume. These systems also help in the creation of higher liquidity of the market and reduced bid-ask spreads, which increases the efficiency of the market. Nevertheless, market stability, equity, and regulation have both become questionable due to the growing influence of high-frequency trading. The critics also believe that ultra-fast trading system can provide unfair advantages to technologically superior market individuals and compound systemic risks in the financial

[5] Michael Lewis, *Flash Boys* (2014)

markets.

The historical process of the evolution of algorithmic trading is also strongly connected with the creation of advanced electronic trading systems run by large stock markets. The current exchanges offer extremely sophisticated technological systems that allow automated trading systems to communicate directly to market data feeds and order-execution systems. Indicatively, the National Stock Exchange of India has established state-of-the-art algorithmic trading infrastructure to enable institutional investors and professional traders to use automated trading programs in controlled market markets. Likewise, the New York Stock Exchange currently has one of the most sophisticated trading systems in the world that accommodates massive algorithmic and high-frequency trading.

The use of technologies based on artificial intelligence and machine learning is another significant element of the development of algorithmic trading. The trading algorithms that are used nowadays resort more to the development of sophisticated data analysis methods that allow detecting the trends existing in the financial markets and forecasting the prices in the future. Machine learning algorithms can adjust to new market conditions and enhance their capabilities as time passes by analyzing the data constantly. This advancement signifies a change in the form of rule-based trading systems to self-learning with adaptive trading models which can only augment the complexity of automated financial markets.

The increased use of algorithmic trading in the financial markets of the world reveals how it has revolutionized the contemporary finance. Automated trading strategies are becoming increasingly popular among financial institutions, hedge funds and investment firms to help them manage large investment portfolios and react swiftly to changes in the market. With the ongoing development of automated trading systems that has improved in the development of artificial intelligence and digital infrastructure, it is crucial to gain the conceptual basis and historical development of automated trading systems in order to understand its legal implications.

To sum up, algorithmic trading is another important technological development that has transformed the nature in which financial markets are performed. The fact that it has been developed over time to be a simple automated order execution to highly advanced high-frequency trading systems is a sign of the digital transformation of the entire global financial sector. Though algorithmic trading does have significant advantages as far as efficiency and

liquidity in the market are concerned, it is also rapidly developing, and thus, proper regulatory control is essential to provide transparency, fairness, and stability in the contemporary financial markets.

Technological Infrastructure of Automated Financial Markets

Automated financial markets rely essentially on the advanced technological infrastructure that facilitates fast data processing, instant decision-making, and real-time processing of the trading orders. The use of algorithmic trading systems is based on the sophisticated combination of computer software algorithms, high-performance computer networks, feeds of data, and electronic trading systems.[6] This technology helps financial institutions, as well as professional traders to process high amounts of transactions in a fraction of a second, which makes the market highly efficient and liquid. The emergence of such infrastructure has made the contemporary financial markets very automated and technologically oriented where computers systems dominate the trading activities.[7]

Trading algorithms and trading systems are the core of automated financial markets. Trading algorithm is a computer program that is used to process financial market data to produce trading instructions according to some pre-decided rules or mathematical models. Some of the trading strategies that can be included in these algorithms include trend-following, statistical arbitrage, index arbitrage, and market-making strategies.[8] The algorithm takes into account real-time information on the market, such as price changes, trading amounts, and order book movements, and decides whether to sell or purchase financial assets. As soon as the algorithm finds an appropriate trading opportunity, the execution system transmits the order to the appropriate exchange automatically, without any human intervention.

Execution systems are critical towards ensuring trading orders are done with high accuracy and speed. These systems aim at streamlining trade execution by reducing the effects of the market and the cost of transactions. Further execution algorithms can be used to divide large orders into smaller parts and conduct them progressively so as to prevent abrupt price changes. Also known as algorithmic order slicing, the technique is used to ensure market stability, but also enables traders to make large transactions. Trade platforms in the modern world have complex

[6] Gregory Scopino, *Algo Bots and the Law* (2020)
[7] SEC v. Knight Capital Americas LLC, Exchange Act Release No. 70694 (Oct. 16, 2013)
[8] Álvaro Cartea et al., *Algorithmic and High-Frequency Trading* (2015)

risk management systems to track the activities of the algorithms and automatically pause trading when abnormal market behaviour is observed.

The automated trading systems have also been further advanced by the use of artificial intelligence and machine learning technologies. The old trading algorithms were more dependent on the instructions that were fixed and based on economic rules and mathematical statements, with trading rules. Nevertheless, the recent progress in artificial intelligence allowed creating adaptive trading systems capable of learning new data based on historical data and improving their performance in the long run. Machine learning models process large data sets of data on the historical movements of the prices, macroeconomic factors, market sentiment and financial news with the view of recognising complex trends and correlations that could be difficult to detect by human traders.

The other important element of the technology infrastructure that is beneficial in the automated trading is the presence of high-speed market data feeds. Market data feeds are real-time reports on the prices of assets, trading volumes, order book depth and other market related indicators. These data streams are very crucial to trading algorithms to make informed trading decisions. Financial trades disseminate market information via specialised electronics channels transmitting data to the trading companies with minimum delay. The speed of transmission and processing of market data is an important aspect of algorithmic trading especially in a high frequency trading setting where competitive advantage can be gained in micro seconds.

To achieve an informational advantage over competitors, trading firms often allocate a lot of resources to acquiring faster and more dependable market data feeds. Co-location services provided by stock exchanges enable the trading firms to have physical proximity to their computer servers, in relation to the exchange data centre. This setup lessens the delays in communication between the trading systems and the exchange servers and this facilitates quicker transfer of the trading orders. Technological infrastructure, therefore, is the conclusive factor in defining the potential of algorithmic trading strategies to be effective and profitable.

Automated trading also includes high-performance trading servers as an important component. These servers handle market data processing, trading algorithms and send orders to financial exchanges. They are normally loaded with super-fast processors, fast memory systems and specialised networking hardware to reduce latency. This is because even slight delays in the execution of orders can lead to lost trade opportunities in highly competitive trading conditions.

As a result, trading companies keep on upgrading their hardware infrastructure to attain greater processing speed and reduce latency.

The last step of the technological process of trading is automated order placement. As soon as a trading algorithm detects that a specific market situation meets its preset requirements, it autonomously generates a trading order and submits it to the electronic trading platform of the exchange. The order is then counter-paired to a buy or selling order in the order book of the exchange. All these take place in milliseconds and therefore huge amounts of trades can be done virtually in seconds. Automation of order placement removes the necessity to have a manual intervention and ascertains that the trading decisions can be implemented with the highest degree of efficiency and accuracy.

The automated financial markets have thus been supported by the technological infrastructure which has provided a platform through which trading activities are dominated by computer systems and not by the human traders. Although this change has brought efficiency to the markets and lowered the cost of transactions, it has also brought various challenges that are associated with the reliability of the systems, cybersecurity threats, and regulations. The growing complexity of the algorithmic trading systems is likely to further grow as the financial markets keep adopting artificial intelligence and other sophisticated computing technologies. The technological background of automated trading is consequently a crucial consideration in determining the economic gain as well as the legal issues related to algorithmic trading in recent financial markets.

Advantages and Economic Impact of Algorithmic Trading

Improved Market Efficiency

- The automatic trading systems process large volumes of financial information and conduct trades using a set of rules and mathematical formulas.

- Such systems are very responsive to the market data like the prices, economic indicators, and volumes.

- Algorithms trading assists in correcting the price discrepancies through the identification of the price variation across the markets and implementing arbitrage strategies that assist in the effective price discovery.

Enhanced Market Liquidity

- The algorithmic trading boosts the quantity of purchases and sales within the financial industries, and thus enhances the total trade.
- Market makers are high-frequency trading companies that usually keep making orders in the markets.
- Such an ongoing process helps to keep the financial assets accessible to the investors who can easily sell or buy it without significant effects on its price fluctuation.
- The advantages of algorithmic trading to major financial exchanges like New York Stock Exchange and National Stock Exchange of India are that it contributes to the active and liquid markets.

Faster Trade Execution

- The use of algorithmic trading allows executing a trade within a matter of milliseconds, occasionally.
- Machine-generated systems are able to handle large amount of data and handle thousands of transactions at a speed much quicker than human traders.
- This speed enables traders to get opportunities with the market in the short run and be able to respond quickly to the change in the conditions of the market.

Lower Transaction Costs

- Automated trading eliminates human intervention hence minimizing the operation cost of financial institutions.
- The algorithms have the ability to break down huge orders and carry out several smaller orders as part of the bigger trade and perform them over time to minimize market effects.
- Effective execution of orders assists in reducing trading expenses as well as enhancing profitability to investors.

Reduction of Human Errors

- Mistakes by human traders can be caused by emotional bias or fatigue as well as misunderstanding of market data.
- The algorithmic trading systems are pre-specified and operate the trades with maximum accuracy and predictability.
- This automation minimizes the chances of mistakes in the working processes and enhances dependability in the trading activities.

Better Risk Management

- Several financial instruments can be monitored by automated systems at the same time, and risk control measures including stop-loss orders can be applied.
- The systems assist the investors in dealing with market risks more efficiently and trading in a disciplined manner.

Global Market Connectivity

- Through algorithmic trading, investors are able to engage in trading in a variety of international markets at the same time using electronic trading platforms.
- This innovation facilitates the increased integration of the international financial markets as well as increases investment opportunities.

Risks and Challenges of Algorithmic Trading

Market Volatility

- The systems in algorithmic trading are very fast and can react to a signal in the market in a matter of milliseconds automatically.
- Large amounts of buy or sell orders can be triggered historically when several algorithms are responding to the same market information in parallel.

- Such a general response can enhance the price swings and make the market volatile in the short run.

- When there are large numbers of trading algorithms all employing similar strategies they can act in a coordinated manner to produce systemic risks that can lead to the destabilization of financial markets when there is uncertainty.

Flash Crashes and Market Incongruities

- Among the key issues related to automated trading systems, one can distinguish sudden and drastic crashes on the stock market.

- One of such instances was the Flash Crash of 2010 that took place on May 6, 2010, in the United States financial market.

- In this event, there was a sudden fall in prices in the stock market and the Dow Jones Industrial Average fell about 1,000 points in the course of minutes and then soon regained itself.

- The reaction of high-frequency trading algorithm with other algorithms was found to have led to the abrupt breakdown of the market.

- This incident suggested the possibility of the dangers of unregulated automated trading systems.

Technological Malfunctions and System malfunctions

- The trading systems of the algorithmic trading are based on sophisticated software, trading servers and electronic communication networks.

- There is a possibility of any technical failure, malfunction, computer issue, or coding mistake that can cause the wrong trading instructions and unwanted market orders.

- Since algorithmic systems are fast, these errors can propagate fast and lead to massive losses of money before humans can take actions.

Cybersecurity Threats

- Automated trading platforms reply on digital infrastructure which makes them vulnerable to various types of cyber threats.
- Hackers can even seek to tamper with trading algorithms, steal trade secrets, and disrupted trading.
- An effective cyberattack on the financial trading systems would result in significant financial damages and it would damage the confidence of the investors with the market.

Unpredictable Behaviour and Algorithmic Errors

- The mathematical models and previous statistics form the basis of trading algorithms and do not always give an accurate forecast of the market situation in the future.
- Algorithms can produce inaccurate trading information due to unexpected economic events or any unusual market behaviour.
- The regulation over the use of artificial intelligence or machine learning may also be challenging since it may make it difficult to interpret the decision-making process.

Regulation of Algorithmic Trading in Modern Financial Markets

The high growth of algorithmic financial markets has led to the establishment of all-inclusive legal and regulatory frameworks that will support integrity of the market, protection of the investors and financial stability. Since algorithmic trading systems are fast and can process a high number of transactions in a few milliseconds, the regulatory mechanisms which are effective in a manual trading environment are not always applicable. As a result, governments and financial regulators in all parts of the world have established specialised legal frameworks and compliance standards and regulatory tools designed to oversee automated trading practices and alleviate the risks encountered by algorithmic systems.

Securities regulation and financial compliance is at the center of the regulatory framework of algorithmic trading. Securities laws exist to guarantee fairness, transparency and accountability of a financial market and to curb unfair trading practices which are fraudulent or

manipulations.[9] The application of algorithmic trading is not outside the area of these regulations since it deals with buying and selling of financial instruments including stocks, derivatives, and commodities. The trading trading companies, financial institutions, and trading agents that utilize algorithmic trading techniques are therefore obliged to abide by numerous legal requirements such as licensing policies, disclosure policies, risk management policies and even market surveillance policies.

Regulation on the securities markets normally obligates trading companies to establish strong internal control measures to thwart market manipulation and to institute that the scope of algorithmic trading systems is in accordance with the law. The regulatory bodies require pre-trade risk scrutinies, algorithm testing processes and monitoring tools to identify abnormal trading behaviour. These compliance rules are aiming at reducing the probability of the algorithmic error, technology failures, or manipulative trading, which might lead to the destabilisation of the financial markets. Also, trading companies have frequently been requested to keep comprehensive documentation of algorithmic deals so as to impose the regulation into the issue and to guarantee responsibility.

In India, the primary regulatory authority in the area of algorithmic trading is the Securities and Exchange Board of India (SEBI) which is the main authority that controls the securities market. SEBI has presented a number of regulatory actions to regulate the risks of the algorithmic trading and so the technologies can be innovatively developed in the financial market.[10] As an example, SEBI stipulates that trading firms are supposed to seek prior approval of the use of algorithmic trading systems on stock exchanges. Algorithms have to pass through strict testing and certifying programs until they are allowed to run their functions on live markets. The necessity guarantees that trading algorithms are regulated as per the regulatory standards, and that they are not going to create excessive risks to the market stability.

Equally, in the United States, algorithmic-trading regulations are regulated by the U.S. Securities and Exchange Commission (SEC) which regulates the securities markets and enacts federal securities regulations.[11] The SEC has also come up with several regulation tools that are intended to make sure that the automated trading machines are run in a responsible and

[9] Int'l Org. of Sec. Comm'ns, *Regulatory Issues Raised by Technological Changes in Market Structure* (2011)
[10] Securities & Exchange Board of India, *Algorithmic Trading Guidelines* (2012), https://www.sebi.gov.in
[11] U.S. Securities and Exchange Commission, *Regulation Systems Compliance and Integrity (Reg SCI)*, 17 C.F.R. § 242.1000 (2014)

transparent way. As an illustration, the SEC mandates the trading firms to abide by the market access requirements that provide stringent risk management of electronic trading operations. These regulations will ensure that the broker-dealers have measures in place which will prevent misplaced orders being introduced into the market and that the trading systems are put in place with risk parameters.

The regulatory system of the United States also focuses on the market surveillance and enforcement systems. Advanced monitoring technologies are employed by exchanges and regulatory bodies to trace abnormal trading patterns and allow the recognition of possible security law violation. In the event that algorithmic trading systems are viewed as being involved in manipulation activities or creating instabilities in the market, regulators can institute investigations and apply sanctions on the people involved. These enforcement activities are used as a deterrent to irresponsible and unethical use of automated trading technologies.

In addition to national regulatory systems, global collaboration is an increasingly significant issue in the regulation of algorithmic trading. Financial markets are strongly interrelated by national borders, and the automated trading systems will be usually located in various jurisdictions at the same time. Consequently, to combat cross border trading activities, the regulatory bodies have been forced to cooperate with international organisations and foreign regulators in order to secure uniform standards of regulation. Multilateral efforts to enhance the transparency of markets, sharing of information and coordination of supervision are thus necessary in addressing the global implication of the algorithmic trading.

The other important aspect of the framework of the legal regulation of algorithmic trading is the compliance requirements of trading companies and financial institutions. Companies that use automated trading systems generally need to have detailed compliance programmes which incorporate periodic testing of algorithms, some form of internal audit and constant monitoring of trading. The compliance officers are obligated to make sure that the trading algorithms comply with the current securities laws and rules. Secondly, companies usually have to keep a record of algorithmic trading methodologies, such as a record of algorithm development, testing process, and application performance.

Regulatory supervision of algorithmic trading also applies to the technological framework applied in automated financial markets. The stock exchanges should make sure that their

trading platforms are well prepared with a good security system, large capacity data processing capacity and good risk management controls. Exchanges also have a role to play in ensuring equal access to trading facilities and not allowing technological advantage to provide unfair market competition.

To summarize, the regulatory and legal environment of algorithmic trading is highly essential in ensuring the stability and integrity of the contemporary financial markets. By enacting extensive securities regulation, national regulators and global collaboration, the regulators are trying to strike a balance between the advantages of technological innovation and the necessity to oversee the market and protect investors. Various regulatory authorities like the Securities and Exchange Board of India and U.S. Securities and Exchange Commission have enacted diverse compliance requirements, monitoring tools and enforcement measures to deal with the special demands of the automated trading systems. With the ever-growing advancement of algorithmic trading technologies, the regulation frameworks are required to keep up with it, to make sure that the financial markets will be fair, transparent, and strong enough to handle the speeding technological change.

Legal Liability in Automated Financial Markets

The modern financial markets have been greatly changed due to the rapid growth of the algorithmic and automated trading systems. These systems trade at very high speeds with pre-programmed algorithms with the least amount of human interaction. Although this kind of technological innovation has brought market efficiency and liquidity, it has also introduced some complex questions about the issue of legal liability in case the automated systems go wrong, manipulate the markets or lead to huge financial losses.[12] In automated financial markets, it is specifically difficult to define who is responsible since various parties are engaged in the development, implementation, and execution of trading algorithms.[13]

Among the main questions is the liability of traders and financial institutions that implement the systems of algorithmic trading. Automated systems are applied by investment firms, hedge funds, and brokerage houses to execute huge amount of transactions within a few seconds. Although trading decisions can be conducted by machines, the institutions running these algorithms have the legal responsibility of ensuring that they adhere to the financial regulations

[12] Coscia v. United States, 866 F.3d 782 (7th Cir. 2017)
[13] Gregory Scopino, *Algo Bots and the Law*, supra note 4, at 210–225

and the market integrity rules. In case an algorithm indulges in manipulation, creates unnatural market behaviour, or contravenes trading rules, the company that implements the algorithm can be fined by the regulatory authority, face civil liability, and suffer reputational losses. Trading firms are usually held responsible by financial regulators due to the fact that they are charged with the responsibility in overseeing the development of their automated systems, testing and implementation of the automated systems.

The other dimension of liability is associated with the responsibility of algorithm developers[14] and software engineers. Specialized programmers and quantitative analysts usually design modern trading algorithms and create complex models, which are based on financial data and predictive analytics. Wrong coding, ineffective algorithmic logic or poor risk controls can result in unintended trading behaviour and significant financial losses. There are concerns in this situation that the developers who made the algorithm should also be liable. The developers are not generally direct participants in the financial markets but can become subjects of blame in case negligence or faulty programming or lack of provision of suitable safeguards cause any detrimental market results.

Liability can also be in financial transactions and trading platforms that support automated trading activities. Stock exchanges are the technological base on which trading algorithms deal with financial markets. Failure by an exchange to establish adequate monitoring mechanisms, risk management systems, or circuit breakers, could help to cause systemic market disruptions. In its turn, this means that the transactions are frequently demanded to have strong surveillance systems that could identify the abnormal trading trends and eliminate market manipulation. Indian case in point, the securities and exchange board of India mandates the exchanges to implement risk management systems and algorithm approval, before allowing automated trading. On the same note, the U.S. Securities and Exchange Commission provide compliance requirements to trading firms and exchanges in a bid to maintain a stable market and to protect investors.

The speed and complexity of the algorithmic trading systems give rise to a major challenge in deciding the liability in automated financial markets.[15] Algorithms are capable of conducting thousands of trades on a milliseconds scale, and regulators and courts have a hard time tracking

[14] Gregory Scopino, supra note 2, at 230–235
[15] Gregory Scopino, *Algo Bots and the Law: Technology, Automation, and Regulation in Financial Markets* 210–218 (Cambridge Univ. Press 2020)

the unique point of an error or even a manipulative action. Moreover, automated trading is often conducted in more than one jurisdiction and has other legal complexities in the area of the law and regulation. Such considerations render the conventional law principles of negligence, fault, and causation hard to execute in the sphere of automated financial markets.

Conclusively, the legal liability in the automated financial markets is a complicated relationship between traders, financial institutions, algorithm developers, and trading platforms. Proper regulation entails a proper distribution of duty among these actors in conjunction with a high level of compliance along with algorithm testing and regulations. With the financial markets becoming more and more dependent on automated technologies, it is necessary to adjust the legal frameworks to guarantee accountability and safeguard investors and the stability and integrity of financial systems worldwide.

Market Manipulation and Compliance Problems

The problem of market manipulation has become a major issue related to algorithmic trading and automated financial markets.[16] The fast pace and technological advancement of algorithmic systems allow some traders to participate in unjust trading activities making the market conditions unrealistic and misleading other investors. Spoofing and layering are two types of manipulation prevalent with algorithmic trading.[17]

Spoofing is the practice in which traders submit large buy or sell orders when they are not intending to carry out the orders. Such orders are employed to give a false impression about the demand or supply in the market, and it therefore affects other traders to respond to the artificial signal. When the market price starts moving in the preferred direction the manipulator will cancel the fake orders and will be able to make a profit with the help of real trades.

Equally, there is layering, which is the process of making several orders at varying prices in the attempt to give the impression of a high order volume. The traders are trying to manipulate the perception of the other investors on market trends by strategically positioning these orders. Once the market price changes in line with their expectations, the false orders are withdrawn and real transactions made. These activities have been viewed as market abuse since they are

[16] Commodity Futures Trading Commission v. Michael Coscia, No. 14-cv-1887 (N.D. Ill. 2014)
[17] Andrei Kirilenko, Albert Kyle, Mehrdad Samadi & Tugkan Tuzun, The Flash Crash: High-Frequency Trading in an Electronic Market, 72 *J. Fin.* 967 (2017)

aimed at artificially interfering with the natural discovery of the price and giving undue advantages to the technologically advanced traders.

Besides spoofing and layering, algorithmic trading can also support other manipulative behaviors like stuffing of quotes and momentum ignition that can also more destabilize the market. In order to keep such abuses at bay, regulators in the financial sector have established stringent compliance and enforcement controls. The progressive surveillance technologies implemented by the regulatory bodies to track the trade patterns and identify the presence of suspicious algorithmic behaviour in real time are used to track the trade patterns.

In India, the algorithmic trading is regulated by the Securities and Exchange Board of India, which acts as a controlling body of the market manipulation with the help of the regulations. On the same note, trading practices are followed and individuals or institution practicing manipulative activities are subject to penalties by the U.S. Securities and Exchange Commission. Robust compliance frameworks, and therefore, effective regulatory oversight, are thus needed to bring on board fairness, transparency, and integrity in automated financial markets.

Cross-Border Regulation and Jurisdictional Problems

The high pace of evolution of algorithmic trading has made financial markets extremely globalized. Automated trading systems enable traders and financial institutions to conduct their transactions in various international markets in a matter of fractions of a second.[18] This has led to the creation of efficient financial market and increased investment opportunities worldwide, but at the same time it has also presented sophisticated regulatory and jurisdictional issues. Because the algorithmic trading systems tend to run across multiple jurisdictions at the same time, ascertaining the legal system that is applicable to a specific transaction is a major problem.[19]

The global nature of automated trading is one of the main issues. Trading algorithms are often instituted in a country, housed on a server in a different jurisdiction and applied to transact on international stock exchanges. This decentralised form implies that an automated trade can

[18] Morrison v. National Australia Bank Ltd., 561 U.S. 247 (2010)
[19] Douglas W. Arner, Janos Barberis & Ross Buckley, *The Evolution of Fintech: A New Post-Crisis Paradigm?*, 47 Georgetown Journal of International Law 1271 (2016)

simultaneously constitute a number of various legal systems. An example includes a trading algorithm that could be run by a financial company and sell or buy in large markets like New York Stock Exchange or National Stock Exchange of India, but use international data networks and remote trading servers. Consequently, it becomes hard to determine the exact point in which the trading activity is being done.

Conflict of laws and jurisdiction is also due to the international nature of automated trading. Where algorithmic trading has caused a disruption in the market, manipulation, or a loss of money, regulators in many countries may strive to assert jurisdiction over the situation. The circumstance causes legal confusion on which country to apply the laws and which legal institution has the mandate to probe and impose punishment.

In a bid to respond to these issues, an increasing awareness to have international regulation coordination is growing. The financial regulators in the world are cooperating more to provide uniformity in the supervision of automated trading. The regulators in different countries, including the U.S. Securities and Exchange Commission and the Securities and Exchange Board of India, often collaborate with other regulators internationally, not only to provide them with information, but also to detect cross-border trading activities and enforce securities laws. Enhancing international regulation cooperation and harmonisation of international financial regulations are thus important measures towards maintaining transparency, accountability and stability within automated financial markets.

Ethical Issues and Future Regulatory Approaches

The growing trend of algorithmic trading and artificial intelligence use in financial markets has brought up critical ethical issues associated with the transparency, accountability, and fairness.[20] Automated trading systems function by extremely difficult algorithms that examine big quantities of financial data and take place trades within a few milliseconds. Although these systems are efficient and fast in financial transactions, they are also complex and therefore to the regulators, investors and even the financial institutions, it is difficult to get a complete picture of how some decisions are arrived at amid trading. Such transparency deficit poses ethical concerns on accountability in cases where automated systems lead to losses in a

[20] SEC v. Citadel Securities LLC, Exchange Act Release No. 96960 (2023)

business, market interruptions or unfair trading benefits.[21]

Lack of transparency and responsibility in algorithmic decision making is one of the major ethical concerns of automated financial markets. A number of trading algorithms have been described as black box systems, i.e. the decision-making processes within an algorithm cannot be easily understood. In case of such systems failure or when they engage in dubious trading practices, it can be difficult to know whoever is at fault. As such, financial institutions should be in a position to provide that there are the right mechanisms of oversight, documentation, and monitoring to uphold accountability in automated trading activities.

The other significant ethical issue is associated with the application of artificial intelligence in financial decision-making. Trading AI systems are able to analyze market trends and predict price changes and undertake them without direct supervision by a human. Although such a technological capacity makes the markets more efficient, it also brings up the issue of fairness and the possibility of prejudice.[22] The large financial institutions having the advanced technological resources might have an advantage in terms of competition with the smaller investors, which might result in the unequal access to the market and the concentration of the financial power.

In order to eliminate these ethical issues, the future governance of automated trading is becoming a point of concern among the regulatory bodies. Regulatory authorities like the Securities and Exchange Board of India and the U.S. Securities and Exchange commission have come up with regulatory measures that necessitate testing of the algorithms, risk management systems and constant monitoring of the trading processes.

To sum up, financial markets that are governed by automated systems must be subjected to transparency, accountability, and sound regulation. The legal reforms of the future should not be overly harsh on technology or protection to the investor since it needs to uphold fairness, stability and integrity in the international financial markets.

Conclusion

The high growth of the algorithmic trading has changed the contemporary financial markets

[21] Frank Pasquale, *The Black Box Society: The Secret Algorithms That Control Money and Information* 190–198 (Harvard Univ. Press 2015)
[22] Michael Lewis, *Flash Boys: A Wall Street Revolt* 54–70 (W.W. Norton & Co. 2014)

fundamentally through the introduction of highly automated systems that can handle high volume of transactions in fractions of a second. During the course of this study, it has been noted that algorithmic trading has greatly enhanced the effectiveness of the market, liquidity, and pace of execution. Financial institutions can use automated trading technologies to analyse large amounts of data, react to market changes in a quicker manner, and to lower the costs of the operation. Nevertheless, regardless of such positive factors, the common use of algorithmic trading has resulted in significant legal, regulatory, and ethical issues that need to be given due attention.

Among the most significant outcomes of this study is that automated financial markets are very complex and have various participants, traders, financial institutions, algorithm developers and financial trading platforms. This intricacy frequently complicates it to establish legal accountability in situations when algorithmic systems trigger market discontinuities, trading mistakes, and manipulations. The flash crashes and algorithmic failures are just some examples of how automated systems can interact in a non-foreseeable manner that may jeopardize the stability of the market place and investor trust. It is therefore necessary to come up with definitive systems of lawful responsibility to ensure that there is trust in the financial markets.

The study also demonstrates the significance of law responsibilities in automated markets. Financial institutions using algorithmic trading systems should be held accountable to the activities of their algorithms, whereas the software developers and technology providers should make sure that the trading systems are properly designed and tested on professional standards. Moreover, financial exchanges need to introduce effective technological protection and control protocols to avoid manipulating the market and provide order trading conditions. The regulatory bodies, including the Securities and Exchange Board of India and the U.S. Securities and Exchange Commission, are important in the controls of the automated trading activities and the adherence to the securities law.

Considering such challenges, a number of policy recommendations can be suggested to enhance the regulation of the algorithmic trading. To begin with, trading algorithms must be put through compulsory testing, certification, and routinely audited by the regulators prior to these algorithms being implemented in the live markets. Second, the financial institutions ought to put in place effective internal compliance frameworks and live tracking systems to identify abnormal trading behaviour. Third, the financial regulators need to work together

internationally to combat the cross-border trading and the issue of jurisdictions in an efficient way.

To sum up, although algorithmic trading has introduced a lot of innovation and efficiency in financial markets, it is mandatory that it has its own legal regulation and responsible management. Investors can make sure that automated financial markets are developing sustainably by enhancing regulatory frameworks, encouraging transparency, and accountability of market participants and reducing risks to investors and financial stability.

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