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The Rise Of Algorithmic Trading In India: Regulatory Challenges, Institutional Response, And The Road Ahead

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Abstract:

Purpose of the Article: The current research explores the evolution, regulatory framework, and future development of AT in India. It focuses on how the creation of an algorithmic trading ecosystem is impacted by legislative actions and technology advancements.

Methodology: The study follows a qualitative and exploratory research design and uses secondary data found in academic publications and guidelines for regulations. Content analyses are utilized to derive insights, with a focus on India's regulatory approach and its alignment with global standards.

Result of the Research: The outcomes show the revolutionary role of algorithmic trading in Indian financial markets and indicate the importance of SEBI regulations to make the base for transparent and technology-driven trading in the markets. This could bring certain future developments as the adoption of advanced technologies like AI.

Research Limitations: The research provided here is based on the secondary data, thus depriving from the most updated advancements. The limitation, as specified earlier-and is that the research is specific to the Indian markets only and not applicable to other contexts.

Index Terms - Algorithmic Trading, SEBI Regulations, Financial Technology, Artificial Intelligence.

I. INTRODUCTION

AT is computerized rule-based system responsible for executing Purchase or sale orders a given asset (Johnson, B. 2010). Algorithmic trading employs highly complicated mathematical models in decision-making involving an investor in the financial markets. There are stringent guidelines that specify when an order should be issued, changed, or canceled in order to minimize the impact on the share price and guarantee liquidity for prospective participants. A paradigm changes in financial markets, algorithmic trading is the meeting point of cutting-edge technology and sound financial practices. (Addy et al. 2024)

Algo-trading is a method of trading with the financial market using a pre-programmed trade to monitor the market and execute it accordingly. A major role of algo-trading is to automate trades across all asset classes and market segments. As this happens with zero manual processes, the trades are executed based on pre-written conditions set by the professionals. Fundamentally, algorithmic trading uses pre-programmed instructions to carry out trade orders under ideal circumstances. (Yadav, 2018).

AT refers to the use of computer programs to automatically generate and execute large orders in financial markets that offer electronic trading access. It is commonly used by institutional investors, mutual funds, hedge funds, and trading desks of major banks and brokerage firms. These systems rely on technical, mathematical, or statistical models that analyze every quote and trade in the market. By identifying patterns and opportunities for liquidity, the algorithms help traders make informed and timely decisions. Also known as computer-directed trading, algorithmic trading offers several benefits. It reduces transaction costs, enhances

efficiency, and gives investment managers greater control over the execution of trades. However, its primary objective is not always to maximize profits directly. Instead, it focuses on minimizing execution costs and managing market risks effectively. The development of an algorithmic trading system typically involves translating a trading strategy into a computer code. This algorithm is then back-tested using historical data to evaluate its potential profitability and performance before being deployed in live markets. (Khandelwal, 2018).

The Evolution of Algorithmic Trading and its Indian Context

Algorithmic trading, often referred to as algo-trading, has dramatically reshaped the financial markets over the past few decades. Its origins can be traced back to the 1970s and 1980s when traditional exchanges began to shift from manual trading methods to electronic platforms (Dananjayan et al., 2023). The initial algorithms were fairly basic, designed to follow simple instructions based on market variables such as price and volume. While rudimentary, these early systems laid the groundwork for the sophisticated, high-speed trading strategies we see today.

The development of algorithmic trading is deeply intertwined with technological progress. A key turning point was the shift from the open outcry system—where traders shouted bids and offers on the trading floor—to fully electronic trading. This change allowed for faster execution of trades and improved market efficiency, setting the stage for more complex and high-speed trading practices.

By the late 1990s and early 2000s, high-frequency trading (HFT) emerged as a dominant force. These systems could process and execute trades in microseconds, exploiting even the tiniest inefficiencies in the market. As computing technology advanced and became more affordable, the scope of algorithmic trading expanded. Traders began to use intricate statistical models, technical indicators, and advanced quantitative techniques to design intelligent trading algorithms (Nti et al., 2020). This period also witnessed the rise of proprietary trading firms that relied heavily on technology to maintain a competitive edge in increasingly fast-paced markets.

Despite the global growth of algorithmic trading and the rich body of literature surrounding it, several dimensions remain underexplored—particularly in the context of India. Much of the existing research is focused on developments in Western markets, especially the United States and Europe. There's a noticeable gap when it comes to understanding how algorithmic trading is evolving within India's unique financial ecosystem.

India presents its own set of regulatory, infrastructural, and technological challenges and opportunities. While studies have addressed the broader impact of algorithmic trading on market efficiency and volatility, there is a need for deeper exploration of how India's regulatory policies influence the adoption and implementation of algo-trading. For example, the role of the Securities and Exchange Board of India (SEBI) in shaping algorithmic practices remains a relatively untapped area of research.

Moreover, emerging technologies such as artificial intelligence (AI) and machine learning (ML) are beginning to influence trading strategies worldwide, but their potential in the Indian market is still not well-documented. These technologies could redefine how algorithmic systems learn, adapt, and make decisions in real time, but their practical implementation in India, with its diverse investor base and evolving infrastructure, warrants closer investigation.

In summary, while algorithmic trading has achieved significant global milestones, the Indian scenario presents a promising yet underexplored avenue for research. Understanding its evolution within this distinct regulatory and technological framework can provide valuable insights for academics, policymakers, and market participants alike.

In this paper, we review the Evolution and future directions of algorithmic trading in India and the regulatory framework for algorithmic trading in India.

REVIEW OF LITERATURE

Numerous studies have explored the impact of algorithmic trading (AT) on market liquidity, volatility, and overall market quality across global markets.

Hendershott et al. (2011) analyzed the causal effects of AT on market liquidity in the New York Stock Exchange, observing reduced bid-ask spreads, adverse selection, and trade-related price discovery for large stocks. **Hendershott and Riordan (2013)** examined liquidity supply and demand in the Deutsche Boerse, highlighting that algorithmic traders strategically react to market conditions, supplying liquidity during wider spreads and consuming it when spreads narrow. **Jones (2013)** emphasized the dual role of HFT in improving liquidity and market quality while raising concerns about speed-driven advantages. He noted that regulatory

issues with HFT mirror those of manual markets, suggesting similar causes for market crashes. In the Indian context, **Aggarwal and Thomas (2014)** used a difference-in-difference approach to study co-location facility impacts on the NSE. Their results revealed that higher AT activity improves market quality by reducing impact costs and price volatility, contradicting regulatory concerns about extreme price movements. **Brogaard, Hendershott, and Riordan (2014)** investigated HFT in the US equity market, addressing key questions about activity drivers, profitability, and herding behavior, while identifying both opportunities and challenges linked to HFT strategies. **Frino et al. (2017)** examined the Italian Stock Exchange, showing reduced bid-ask spreads and increased depth during earnings announcements in firms experiencing higher AT activity post-co-location. Similarly, **Boehmer et al. (2018)** studied 42 equity markets globally and found consistent improvements in liquidity and informational efficiency, though short-term volatility increased. These studies collectively highlight the transformative role of AT in enhancing liquidity and market quality, while raising regulatory and volatility concerns, particularly in high-frequency contexts.

RESEARCH OBJECTIVES

- To analyse the historical evolution of algorithmic trading (AT) in India and its trajectory of adoption across different investor categories and asset classes.
- To evaluate the regulatory framework established by the SEBI, focusing on its impact on market integrity and the challenges posed by regulatory gaps.
- To investigate the potential for emerging technologies, such as artificial intelligence and blockchain, to shape the future of AT in India.
- To examine the ethical and societal implications of AT, particularly for retail investors and small-cap stocks.
- To provide recommendations for a balanced regulatory approach that fosters innovation while addressing market risks.

RESEARCH METHODOLOGY

1. Research Design

The research adopts a qualitative and exploratory approach to examine the evolution, regulatory framework, and future directions of algorithmic trading in India. The study focuses on understanding the dynamic interplay between technological advancements, financial strategies, and market regulations.

2. Data Collection

The research relies on secondary data obtained from the following sources:

- **Academic Publications:** A comprehensive review of journal articles, conference papers, and industry reports relevant to algorithmic trading.
- **Regulatory Documents:** Policies, guidelines, and circulars issued by Indian regulatory authorities such as the SEBI.
- **Historical Data:** Analysis of stock market trends and trading volumes over time to identify the impact of AT on market efficiency and volatility.

3. Data Analysis

- **Content Analysis:** Qualitative content analysis was employed to extract key themes and patterns from regulatory documents, academic papers, and industry reports. This method helps in understanding the historical context and evolution of algorithmic trading in India.
- **Trend Analysis:** Examination of stock market data to evaluate the influence of algorithmic trading on liquidity, market depth, and volatility.

Algorithmic Trading in India

Algorithmic Trading (AT) in India was launched by Credit Suisse's Advanced Execution Services (AES) on 22nd June 2009. The launch of AT was focused around the Indian equities. The momentum for AT in India was gained by the allowance of co-location4 facilities by NSE in June 2010. Co-location allows broker member servers' to be placed side by side to the exchange server in order to reduce latency. It was aimed at

reducing the time taken in the transmission of data (orders) from broker terminals to exchange servers. Since speed is the key for AT, most of the brokerage firms adopted for the co-location of their server terminals.
The rise of trading in the Indian market, coupled with the Internet and computational technologies, worked together to form a new trading method. This trading is referred to as algo-trading, which works faster.
Algorithmic trading (AT) in India began in 2008, initially adopted by institutional investors, with retail investors increasingly participating in recent years. AT utilizes automated, preprogrammed trading instructions based on variables like price, timing, and volume, allowing for emotion-free decision-making. SEBI is actively working to protect investors from potential harms associated with AT and has released a consultation paper on the subject for retail investors as of December 19, 2021 (Mohan et.al.,2023).
Algo-trade has covered up the maximum place in the stock market. In India, the percentage of traders who use algorithms for trading ranges from 50 to 55 per cent. But in other markets, the percentage of algo-trading is around 80–85% of trade. In the United States, Europe, and other Asian markets, the percentage ranges from 60 to 70% of the total trading volume. As algo-trading has been on the rise in the US and all over the world, the number of trades using algorithmic methods is growing day by day.Algo trades on the client-side account for more than half of all orders at the NSE and BSE. Over 40% of all orders made at both exchanges are prop side algorithm trades. Colocation at both exchanges generates more than 80% of algorithmic orders. It is almost 80% in developed markets.

Growth of AT in India:

- **2008**: SEBI introduced algorithmic trading, initially permitting it primarily for institutional investors (**Reuters** 2024).
- **2010-2016**: Studies indicate a notable increase in algorithmic trading during this period. For instance, at the Bombay Stock Exchange (BSE), program trading rose from 3.4% of total turnover in April 2010 to 32.4% in December 2016 (**ResearchGate** 2021).
- **2024**: Reports suggest that algorithmic trading accounted for approximately 50% to 55% of the total trading volume in India. This is in contrast to higher percentages observed in markets like the U.S. and Europe, where AT constitutes around 80% to 85% of trading volumes (**Share India** 2024)

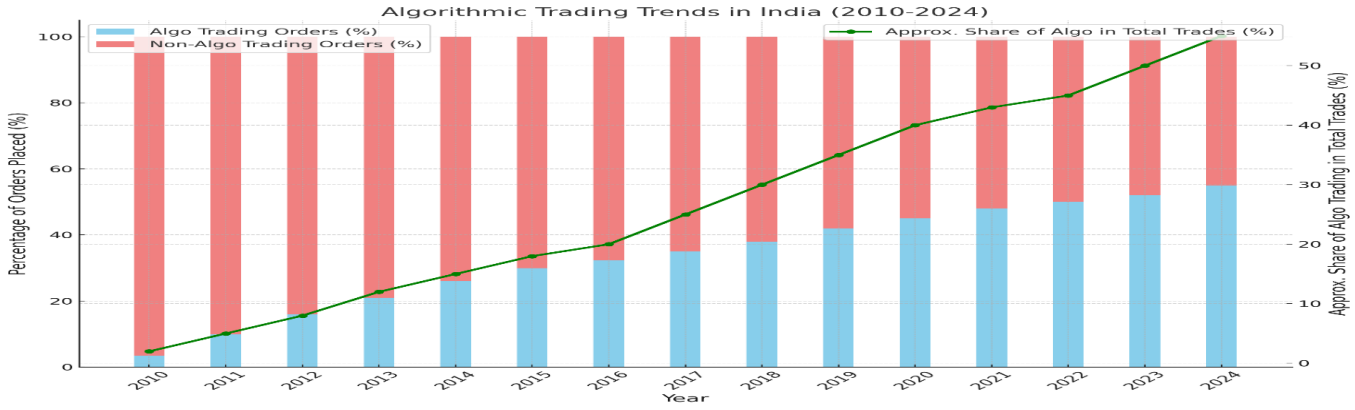
Market Share and Projections:

- In 2024, India's algorithmic trading market generated revenues of approximately USD 1.051 billion, representing about 5% of the global algorithmic trading market. Projections estimate this market will grow to USD 2.312 billion by 2030, with a CAGR of 14.3% from 2025 to 2030 **Grand View (Research** 2024).

Regulatory Developments:

- In December 2024, SEBI proposed a framework to allow retail investors to participate in algorithmic trading through stock brokers. This initiative aims to broaden access to AT while ensuring market integrity and investor protection (**Reuters** 2024).

Year-wise Distribution of Algorithmic and Non-Algorithmic Trading in the Indian Equity Market (2010-2024)



Source: All computations are done by author

Analysis

1. Growth of Algorithmic Trading (2010–2024)

- **Initial Adoption (2010–2015):**
  i. Algo trading started with only 3.4% of orders placed in 2010 and grew steadily, reaching 30% by 2015.
  ii. This period marked the introduction and initial acceptance of algorithmic systems, driven by institutional traders like mutual funds and foreign institutional investors (FIIs).
  iii. SEBI's supportive stance and increased market awareness played a crucial role.
- **Rapid Expansion (2016–2020):**
  i. The share of algo trading rose from 32.4% in 2016 to 45% in 2020.
  ii. This phase saw technological advancements, improved market infrastructure, and higher participation by domestic institutional investors.
  iii. Increased use of AI and machine learning in trading strategies enhanced efficiency and adoption.
- **Maturity Phase (2021–2024):**
  i. By 2024, algo trading accounted for 55% of all orders placed, marking a significant shift in the Indian equity market landscape.
  ii. Retail investors began to adopt algorithmic systems, facilitated by user-friendly trading platforms and broker-provided tools.

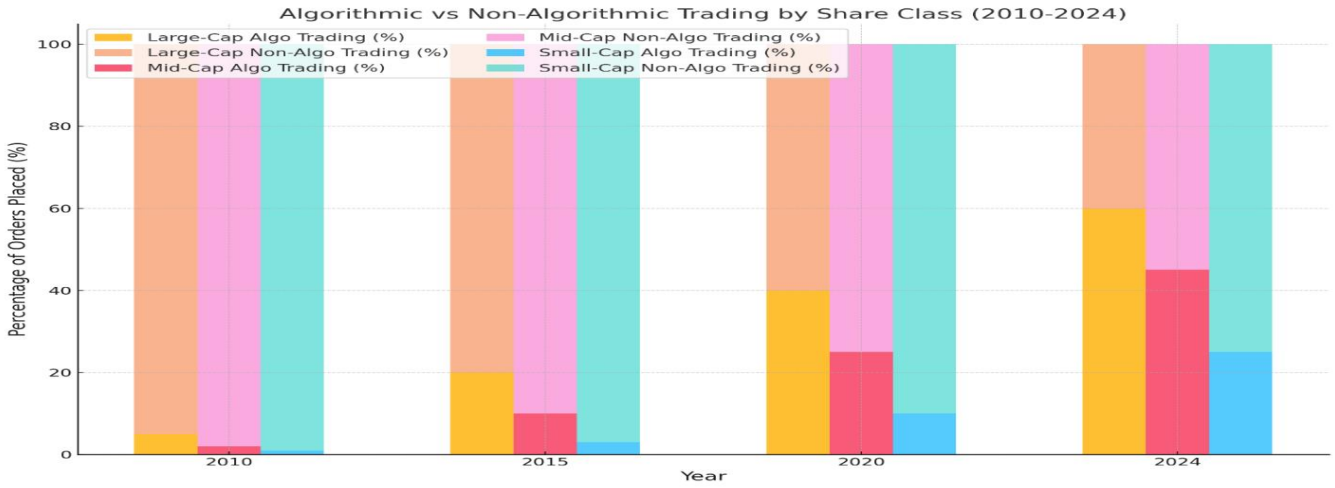
2. Decline in Non-Algorithmic Trading (2010–2024)

- The proportion of non-algorithmic trading (manual or discretionary trading) consistently declined from 96.6% in 2010 to 45% in 2024.
- This trend indicates a growing reliance on technology for speed, precision, and scalability in trading operations, diminishing the appeal of manual trading.

3. Share of AT in Executed Trades

- The share of AT in actual executed trades grew more gradually compared to orders placed, reflecting the nature of algo systems that dynamically cancel or modify orders.
- From only 2% of total trades in 2010, algo trading reached 55% by 2024, showing how the execution effectiveness of these systems improved over time.

Year-wise Distribution of Algorithmic and Non-Algorithmic Trading Across Different Share Classes in the Indian Equity Market



Source: All computations are done by author

Analysis

1. **Large-Cap Stocks**:
   - Algorithmic trading has seen the highest adoption in large-cap stocks due to their high liquidity and tighter bid-ask spreads.
   - By 2024, approximately 60% of orders in large-cap stocks are placed using algo trading systems.
2. **Mid-Cap Stocks**:
   - Algo trading adoption in mid-cap stocks lags behind large-caps but has grown steadily due to increasing liquidity and interest from institutional investors.
   - By 2024, 45% of orders in mid-cap stocks are algorithmically placed.
3. **Small-Cap Stocks**:
   - Adoption in small-cap stocks remains the lowest due to lower liquidity and higher volatility, which pose challenges for effective algorithmic execution.
   - Even so, algo trading in small-caps has grown significantly, reaching 25% by 2024.

Algorithmic Trading in Different Asset Classes in India (2024)

Asset Class	Estimated Share of Algorithmic Trading in India	Key Characteristics & Trends
Equities	50%–55%	Algorithmic trading dominates the equity markets in India, accounting for about 55% of total equity trading volumes. Predominantly used in high-frequency trading, market-making, and arbitrage strategies.
Foreign Exchange (Forex)	40%–50%	Algo trading is prevalent in the forex markets, particularly with the USD/INR pair. Used primarily for arbitrage, hedging, and liquidity provision in the currency market.
Commodities	20%–25%	The use of algorithmic trading in Indian commodities (like gold, crude oil, and agricultural futures) is growing. Algorithms are mainly employed for arbitrage and trend-following strategies, particularly on exchanges like MCX (Multi Commodity Exchange).

Bonds	5%–10%	Algorithmic trading in bonds is still limited in India, though it is gaining traction, especially in government securities and large corporate bond trades. Bond market liquidity is relatively low compared to equities, limiting algo trading activity.
Derivatives (Futures and Options)	40%–50%	Algo trading is highly prevalent in Indian derivatives markets, particularly in equity index futures and options. Algorithmic strategies are used for hedging, arbitrage, and execution of large institutional orders.

Source: All computations are done by author

Analysis of Algorithmic Trading Across Asset Classes in India:

1. **Equities (50%–55% of Total Trades in 2024):**
   - Algorithmic trading has seen the largest share of market activity in Indian equities, especially after the rise of institutional trading and technological advancements.
   - It is most prominent in NSE and BSE, with high-frequency strategies and market-making activities leading the way.
2. **Foreign Exchange (40%–50% of Total Forex Trading in 2024):**
   - The foreign exchange market in India, especially for INR/USD and other major currency pairs, has seen growing participation from algorithmic traders.
   - Algorithmic trading in forex is used mainly for hedging and arbitrage, given the volatility and large trading volumes in the currency market.
3. **Commodities (20%–25% of Total Trading Volume in 2024):**
   - Although still less prevalent compared to equities, algorithmic trading is emerging in India's commodity exchanges, such as MCX.
   - The use of algo trading in commodities involves arbitrage strategies, particularly in volatile assets like gold and crude oil.
4. **Bonds (5%–10% of Total Bond Trading in 2024):**
   - The bond market in India has a relatively small share of algorithmic trading, mainly limited to large institutional investors and government securities.
   - Bond market liquidity remains lower compared to equity markets, which limits the scope for algorithmic strategies.
5. **Derivatives (40%–50% of Total Derivatives Trading in 2024):**
   - Derivatives markets, especially index futures and options, see a significant proportion of algorithmic trading.
   - These markets are well-suited to algorithmic strategies, which are commonly used for hedging, arbitrage, and large institutional trades.

Algorithmic Trading in India – Regulatory Framework

1. SEBI mandates half-yearly audits for algorithmic trading firms, ensuring compliance with execution-related regulations and risk control measures specific to commodity markets.
2. Audit requirements include maintaining logs for orders, trades, and control parameters.

SEBI's Current Regulations on Algo Trading in India (for big institutions)

After SEBI permitted algo trading in 2008, certain brokerage firms, banks, or investment firms in India have used algos or high-frequency trading systems to generate profits for their clients (mostly HNIs or large corporations). In response to this development:

- **System Audits for Algo Trading Platforms**: Firms and platforms offering algorithmic trading services are required to undergo a system audit every six months. These audits must be conducted by SEBI-authorized agencies and serve as a compliance checkpoint to assess whether the technological and operational aspects of the trading systems meet regulatory standards. Regular audits help identify vulnerabilities, enforce best practices, and ensure that the prescribed SEBI requirements are being effectively implemented.

- **Surveillance and Trade Monitoring**: To minimize the risks of market manipulation through algorithms, stock exchanges are instructed to implement rigorous surveillance and monitoring mechanisms. These include real-time transaction monitoring, enforcement of position limits, and pre-trade risk controls. Such protocols help detect anomalous trading behavior, limit the exposure of rogue algorithms, and promote a secure trading environment. Exchanges are also expected to periodically assess and update their surveillance systems to stay ahead of evolving manipulation tactics.
- **Order-to-Trade Ratio (OTR) Restrictions**: Another crucial control is the Order-to-Trade Ratio (OTR), which is defined as the ratio of the number of all orders placed (including modifications and cancellations) to the actual trades executed. To curb excessive order placements and prevent market congestion caused by high-frequency bulk orders, SEBI has instituted specific OTR thresholds. If a trader exceeds these limits on any given trading day, they are subject to financial penalties. This regulation acts as a deterrent against the misuse of algorithmic systems for market distortion through order spamming or quote stuffing.
- **Co-location guidelines**: SEBI has framed these guidelines to ensure equal access to the trading infrastructure, thereby enhancing equal opportunity in the market. [Co-location is a feature offered by stock exchanges that enables certain brokers to maintain their servers in the same structure as the exchange]

What are SEBI's Regulations on Algo Trading for Retail Traders?

The tendency of retail traders engaging in AT has been increasing over the last few years, especially since 2019–20. This is due to the fact that a lot of brokers and algo trading platforms provide retail traders with Application Programming Interfaces (APIs) so they can easily execute trades or implement their trading strategies. An API is a collection of tools and protocols that let software communicate with and place orders on various brokers, exchanges, and trading platforms. Therefore, there are no laws or regulations that forbid the use of trading algorithms in India.

It's interesting to note that India has no actual regulations governing algo trading for individual traders. Retail investors using algo trading might not have the right precautions and protections in the absence of particular rules. Because they frequently lack money and knowledge, individual investors may be subject to greater risks and possible losses. In order to protect retail traders from unfair activities or scams in the Indian algo trading market, SEBI has intervened. They came up with a consultation paper (issued on December 9, 2021) to take views and comments from various stakeholders, market intermediaries, and the public on the practice of algo trading done by retail traders/investors, including their use of API and automated trade execution tools.

FUTURE OF ALGORITHMIC TRADING IN INDIA

It is anticipated that algorithmic trading software would continue to expand in India, promoting market liquidity and efficiency. Forecasts suggest that stocks will contribute significantly to market share and that growth will be consistent over the next several years. By 2027, the equity market is anticipated to account for $8.61 billion of the algorithmic trading market share, with a projected compound annual growth rate (CAGR) of 11.23% from 2021 to 2026.

- **Technological Progress:** It is anticipated that ongoing technological developments, especially in fields like big data analytics, machine learning, and artificial intelligence (AI), will support the expansion of AT in India. With the aid of these tools, traders can create increasingly complex trading plans, analyze massive databases instantly, and make more accurate data-driven judgments.
- **Regulatory Environment:** As financial markets change, regulatory frameworks controlling AT are probably going to change as well. In order to maintain the orderly operation of AT activities while addressing issues with market integrity, transparency, and investor protection, regulators like the SEBI may amend current regulations or adopt new ones.
- **Growing Adoption Across Market Segments:** Large trading businesses and institutional investors are no longer the only ones using algorithmic trading in India. Retail investors are adopting algorithmic trading methods more frequently as a result of the introduction of API-based trading platforms and the accessibility of algorithmic trading tools and resources. This democratization of algorithmic trading is expected to contribute to its widespread adoption across various market segments in India.
- **Global Integration:** Opportunities for cross-border trade and investment are being created by India's financial markets' growing integration with international markets. India's algorithmic trading industry is expected to increase as a result of algorithmic trading firms taking advantage of this trend by creating methods that profit from global market movements and arbitrage opportunities. With its ability to

execute trades with efficiency, speed, and accuracy, algorithmic trading software has truly transformed India's financial markets. With continued advancements and regulatory oversight, algorithmic trading in India is poised for further growth and innovation in the Indian market landscape.

CONCLUSION

In India, automation and algorithmic trading have left their mark on the equity market. There has been an improvement in efficiency, decreased transaction costs, and what can only be classified as liquidity has emerged. The number shot up to 55% and 78% across multiple asset classes which span equities, derivatives, forex, and commodities in just four years from 2010's baseline of 3.4%. SEBI has come up with a skeletal regulatory framework to promote fairness and transparency, however lacunae still exist, more so in the retail end. Better institutional investors and larger stocks have enjoyed substantial benefits, however, only a select group have barriers such as little trading volume and limited technical intelligence. In the near future, AI and Blockchain accompanied by suitable regulatory policies is set to be the tide that direction the future of AT.

LIMITATIONS

The analysis uses secondary data, which could not reflect current market patterns or real-time developments. The results may not be immediately relevant to other markets because they are context-specific to India.

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