



TRADE AUTOMATION, MARKET EFFICIENCY AND PERFORMANCE OF SECURITIES MARKETS IN EAST AFRICAN COMMUNITY, WITHIN MEMBER STATES

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Abstract

While trade automation is expected to streamline operations and improve price discovery, its implementation in the EAC has produced mixed results, with some studies suggesting it aggravates market instability. The interplay between trade automation, market efficiency remains inadequately understood, specifically in emerging markets like the EAC. In particular, the research aimed to assess the impact of trade automation on performance of securities markets, to find out the influence of market efficiency on the link between trade automation and performance of securities markets in EAC. Utilizing a descriptive cross-sectional research design, secondary data were collected from the four established securities exchanges in the

EAC for the period 2015 to 2024. The analysis employed regression techniques using Stata software to evaluate the relationships among the variables. The results indicated that trade automation had a statistically significant but negative effect on market performance, suggesting that increased automation significantly led to reduced market performance of securities in EAC. Conversely, market efficiency was discovered to play a partial mediating role in the connection between trade automation and the performance of security markets within the EAC. Based on the findings, the study recommends prioritizing measures including implementing streamlined processes and cost-effective policies to enhance market efficiency to improve the performance of securities markets in the EAC. Policymakers and regulators should focus on the efforts to enhance market efficiency through improved trading systems and better dissemination of market information, as efficiency positively influences market outcomes.

Keywords: Trade automation, Emerging markets, Market efficiency, Market Performance, Securities exchange, Mediation analysis, East African Community

INTRODUCTION

Trade automation refers to the application of computer-driven systems to execute trading instructions in financial markets, based on pre-programmed parameters such as timing, price, and volume. As defined by Dimov (2022), trade automation encompasses the digital infrastructure and algorithmic logic that support electronic trading, thereby reducing human intervention and enabling high-frequency trading. Bouchaud and Potters (2022) extend this definition by viewing trade automation as the transition from discretionary trading to data-driven execution supported by real-time analytics and low-latency platforms. Similarly, Abdullahi and Peters (2023) define trade automation as the deployment of automated trading systems to execute buy and sell orders across multiple trading venues with minimal human input.

On the other hand, market efficiency refers to the extent to which asset prices in financial markets accurately and promptly reflect all available information. It is a central tenet in financial economics, foundational to understanding investor behavior, asset valuation, and market predictability. According to recent empirical work, an efficient market incorporates new data into asset prices quickly, limiting opportunities for investors to earn abnormal profits without assuming proportional risk (Angelidis & Sakkas, 2022; Zhang & Wang, 2023). The concept underscores the idea that when markets operate efficiently, prices function as reliable signals for capital allocation, guiding investors towards value-generating opportunities and facilitating optimal resource distribution.

The performance of securities markets is a multifaceted concept that reflects the ability of financial markets to facilitate capital formation, liquidity provision, and efficient pricing of securities. A well-performing securities market enables investors to buy and sell financial assets with minimal friction, fostering both investor confidence and economic stability. In evaluating market performance, key indicators include trading volume, stock market index returns, and market capitalization. According to Kumar and Sinha (2023), trading volume is an essential metric because it reflects the level of investor participation and market activity, which are critical for ensuring liquidity and efficient price discovery.

The interplay between trade automation, market efficiency and securities market performance has gained growing attention in recent financial literature, especially in the context of emerging and frontier markets. According to Oyeniyi, Ugochukwu, and Mhlongo (2024), algorithmic trading has significantly reduced latency and bid-ask spreads, improving execution quality in both developed and developing economies. Similarly, Herman and Oliver (2023) found that digital trade rules and automation have had a statistically significant effect on trade costs and efficiency, especially in low- and middle-income countries. However, while automation contributes to price accuracy and market dynamism, its influence on volatility and systemic risk remains contested. This study addresses the empirical gap on how trade automation interacts with market efficiency to influence market performance, particularly within the East African Community (EAC), a region characterized by fragmented infrastructure and regulatory disparities.

This study is anchored on Trade Automation Theory, which posits that the integration of digital technologies in trading processes (such as algorithmic systems, electronic platforms, and real-time data analytics) reduces transaction friction, enhances execution speed, and promotes transparency in financial markets (Ford, 2015; Jiang et al., 2023). To explain the price discovery and efficiency aspects, the study adopts the Efficient Market Hypothesis (EMH) by Fama (1970) as refined by Zhang and Wang (2023), which asserts that security prices fully reflect all available information, thus minimizing the potential for consistent abnormal returns. Together, these theories form a comprehensive foundation for examining the interaction between trade automation, market efficiency, and the performance of securities markets in the EAC region.

Empirical literature has emphasized that trade automation enhances execution speed and minimizes human error. Mugo and Kiragu (2024) found that electronic trading systems in Kenya and Rwanda improved transparency and investor confidence, while Mutua and Kaburu (2024) highlighted the influence of technological integration on liquidity and market depth. Yet, structural and regulatory bottlenecks persist in the EAC. Despite the automation of clearing and settlement systems, challenges such as information asymmetry, inconsistent investor

protections, and varying levels of technological adoption continue to hinder integration and efficiency (Chacha & Gekara, 2023; Mugambi & Sudi, 2024). As a result, they further contribute to unequal market participation and suboptimal price discovery, issues that are particularly acute in thinly traded markets like the Uganda Securities Exchange (USE).

Within this evolving regional context, the Nairobi Securities Exchange (NSE) has implemented several technological innovations, including the Automated Trading System (ATS) and the Broker Back Office system. While these tools have improved market operations, their impact has not been uniform across the region. Bukenya and Odhiambo (2024) assert that Rwanda's RSE and Tanzania's DSE have made strides in automation, but they still face challenges in attracting liquidity and achieving scale. Furthermore, the implementation of the East African Capital Markets Infrastructure Project (EACMIP) seeks to integrate trading platforms and harmonize regulatory regimes across member states. However, evidence on the effectiveness of such integration remains limited and warrants empirical investigation.

Securities markets in the EAC have evolved significantly since the establishment of the Nairobi Securities Exchange (NSE) in 1954 under the former British Protectorate of East Africa. Initially serving companies in Kenya, Uganda, and Tanzania, the NSE functioned as a regional trading platform. However, the collapse of the EAC in 1977 led to the nationalization and delisting of foreign firms in Uganda and Tanzania, causing the NSE to operate solely as a Kenyan institution (Moh'd, 2021; Matanda & Karugia, 2023). The 1990s witnessed the re-emergence of national stock exchanges, with Tanzania launching the Dar es Salaam Stock Exchange (DSE) and Uganda establishing the Uganda Securities Exchange (USE). Rwanda, a later entrant to the EAC, initiated the Rwanda Stock Exchange (RSE) in 2011 to facilitate capital mobilization and attract foreign direct investment (Basu & Michayluk, 2022; Bukenya & Odhiambo, 2024).

Today, the EAC is served by four primary stock exchanges: Kenya's NSE, Tanzania's DSE, Uganda's USE, and Rwanda's RSE. According to Makau, Njeru, and Musyoka (2021) these exchanges vary in market size and level of technological sophistication. As of 2020, the total market capitalization of the four exchanges reached approximately USD 42 billion, with the NSE accounting for more than half of the total (Wambugu & Githinji, 2022). This dominance has reinforced Kenya's position as the financial hub of the region. Despite this growth, disparities persist across EAC markets in terms of investor participation, technological adoption, liquidity levels, and regulatory structures (Bwakira & Mwangi, 2023). These differences pose a challenge to the full realization of integrated capital markets across the bloc and present concerns for performance and efficiency.

Efforts to harmonize securities markets within the EAC are ongoing, spearheaded by initiatives such as the East African Securities Regulatory Authorities (EASRA). This platform aims to foster collaboration among national regulators, standardize trading practices, and enhance cross-border investments (Ndung'u & Mugambi, 2024). One of the key interventions under this framework is the promotion of trade automation, which includes the deployment of electronic trading systems and automated clearing and settlement platforms. Automation has led to improvements in market transparency, execution speed, and cost efficiency (Akech & Otieno, 2023). However, challenges such as low internet penetration in some areas, and uneven technological capabilities remain significant barriers to efficiency and market integration.

In addition to capital market-specific interventions, the broader EAC integration strategy has seen the implementation of the Single Customs Territory (SCT) to streamline intra-regional trade. While the SCT and customs automation efforts have reduced some procedural bottlenecks, non-tariff barriers (NTBs) still hamper trade flows across member states (UNECA, 2024). These include bureaucratic delays, inconsistent quality standards, and varying regulatory frameworks. Moreover, despite the introduction of tools like the EAC Trade Information Portal and the NTB Reporting System, information asymmetry and limited capacity among small-scale traders continue to limit the impact of these reforms (Nyanzi & Rurangwa, 2024).

The region's securities markets are still characterized by limited liquidity, underrepresentation of retail investors, and inadequate product diversification, which hampers market efficiency. Addressing these constraints will require sustained policy coordination, capacity building, and technology investment tailored to the diverse contexts of EAC member states. A data-driven understanding of how trade automation, and market efficiency interact in the EAC context is essential to formulating effective strategies for enhancing securities market performance.

Empirical studies have produced mixed findings on the impact of trade automation. In developed economies, research has consistently shown that algorithmic trading enhances liquidity (Brogaard et al., 2020). However, in emerging markets, results are far from conclusive. Owade (2023) observed that automation improved trading volumes and market access at the Nairobi Securities Exchange, while Nalwenge and Jagongo (2021) reported no significant performance improvements at the Uganda Securities Exchange, attributing this to weak infrastructure and limited investor participation. The effect of automation is thus highly context-dependent, influenced by underlying market maturity and regulatory readiness.

Market efficiency outcomes are similarly inconsistent. While the efficient market hypothesis posits that automation should improve informational efficiency, several African market studies reveal persistent price anomalies and delayed adjustments, especially in low-

liquidity settings (Onyuma, 2021; Patel & Singh, 2024). In contrast, evidence from the Johannesburg Stock Exchange and Indian markets shows automation narrowing bid-ask spreads and improving responsiveness to public information (Rindi, 2020). These contradictions raise questions about whether EAC markets are efficient enough to internalize the gains from automation, or whether structural bottlenecks continue to undermine the expected benefits.

In addition to these conceptual and empirical inconsistencies, methodological limitations remain. Many studies rely on cross-sectional data or single-year case studies, limiting the ability to observe evolving market behavior or disentangle causal effects. Few studies have adopted a holistic framework that accounts for the joint and interactive effects of automation, and market efficiency (Hossain, 2022; Easley & O'Hara, 2022). This fragmented evidence base hampers the development of sound policy responses tailored to the EAC context. Hence, this study sought to address the following research question: How does market efficiency impact the relationship between trade automation and performance of securities markets within EAC member states? The following hypothesis was tested, H01: Market efficiency does not mediate significantly the influence the relationship between trade automation and performance of securities markets within EAC member states.

LITERATURE REVIEW

Literature offers a broad yet comprehensive understanding of the relationship between trade automation, and market efficiency securities market performance. Several studies have affirmed that algorithmic and AI-driven trading systems play a transformative role in improving liquidity, narrowing bid-ask spreads, and enhancing execution speed. Addy et al. (2024) and Degryse and Nguyen (2020) demonstrated that automated systems can improve price discovery and reduce friction in trading, particularly when integrated with real-time data analytics. Similarly, Jiang and Wang (2021) highlighted how high-frequency trading contributes to market efficiency through liquidity provision.

Empirical studies such as those by Dubey (2022) and Tremacoldi-Rossi (2022) reveal that trade automation often leads to improved trading outcomes by facilitating smaller trade sizes and reducing price impact. However, these benefits are not uniformly experienced across all markets. For instance, while algorithmic trading may perform well in developed economies with deep liquidity and strong regulatory oversight, its effects in emerging markets can be more volatile and uncertain. Courdent and McClelland (2022), in their analysis of the Johannesburg Stock Exchange, illustrated this dual effect by showing that although algorithmic trading enhanced liquidity, it also increased short-term volatility.

A critical insight from the literature is the growing relevance of the Adaptive Market Hypothesis (AMH) in explaining market behavior under automated conditions. Studies such as those by Lekhal and El Oubani (2020) and Mallikarjunappa et al. (2025) confirmed that market efficiency fluctuates over time and is heavily influenced by investor behavior, regulatory interventions, and external shocks. These studies reinforce the need for dynamic strategies in both trading and regulation to ensure stability. Additionally, the work of Mhlongo et al. (2024) and Salehpour and Samadzamini (2023) emphasized how AI-driven trade automation introduces greater adaptability and responsiveness in trading systems, although challenges related to model transparency, algorithmic bias, and ethical oversight persist.

While the positive effects of automation on efficiency are well-documented, the literature also identifies significant gaps. Much of the existing evidence is based on studies conducted in mature financial systems, with limited empirical attention paid to developing economies like those in the EAC. Even though automation technologies such as blockchain and smart contracts are touted as solutions for transparency and settlement efficiency, studies like those by Roeck, Sternberg, and Hofmann (2020), Shah and Allam (2020), and Qian and Dong (2025) are largely conceptual or theoretical and do not provide detailed empirical analyses of their impacts in under-resourced market settings.

Another critical limitation is the lack of research that holistically examines the interaction between trade automation, and market efficiency. Many studies tend to isolate one or two of these variables without addressing their interdependencies. For example, while Cao and Wei (2020) confirmed the cost-reduction benefits of algorithmic trading, their work did not delve into how efficiency influenced market resilience or investor behavior over time. Similarly, van Kervel and Menkveld (2020) observed both positive and negative impacts of high-frequency trading around large institutional orders but did not investigate these outcomes in emerging markets with limited liquidity and weaker regulatory frameworks.

The literature also reveals a theoretical gap in applying frameworks such as institutional theory in the analysis of trade automation's market-level implications. Studies like those by Cuypers et al. (2021) and Zhu, Bai, and Sarkis (2022) emphasize the importance of grounding automation research in robust theory, yet practical applications of these theories in the securities trading context remain sparse. This limitation is particularly pressing in contexts where regulatory capacity is evolving and where automation may amplify market fragmentation or systemic risk. Inferred from the study gaps, the conceptual diagram in figure 1 shows how the study variables relate to each other.

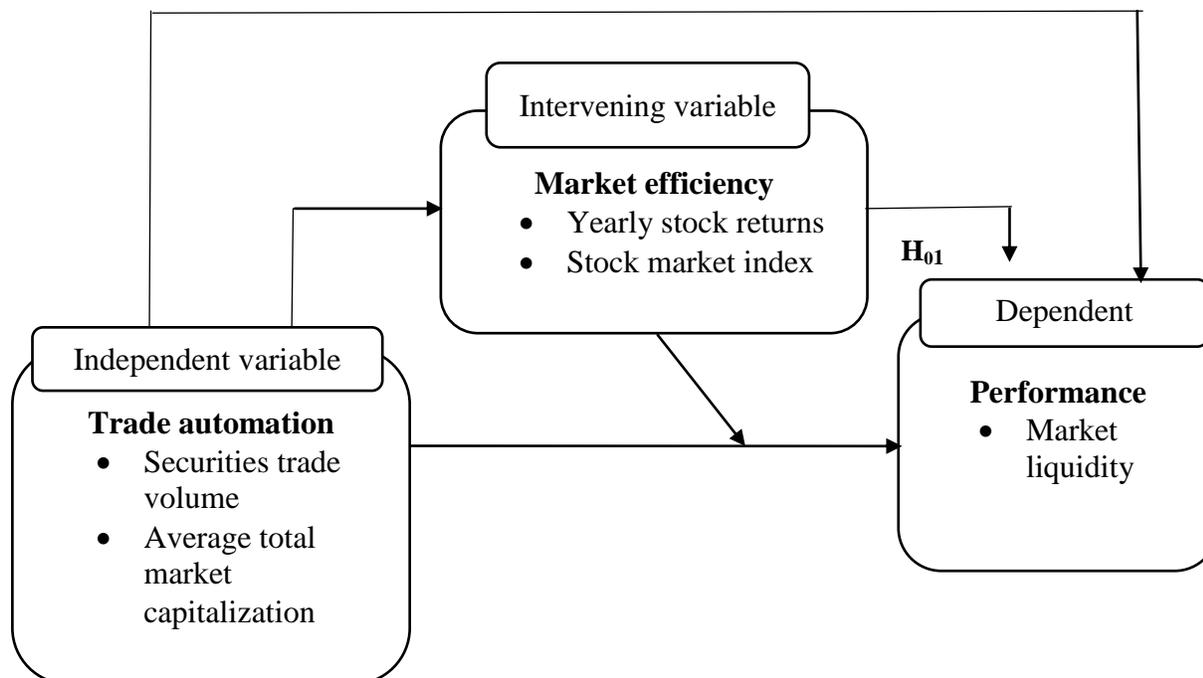


Figure 1: Conceptual Framework

METHODS AND DATA

In order to explore the relationships between trade automation, market efficiency, and the performance of securities markets within the EAC, a descriptive cross-sectional research design was employed. The descriptive design was particularly suited to this study as it allows for a detailed exploration of these relationships at a specific point in time. Given that the variables of interest such as trade automation and market efficiency were influenced by market dynamics, the cross-sectional approach enables the capture of a snapshot of these variables as they interact within the securities markets. Employing this design allowed the study to effectively explore and describe the associations among the variables without necessitating intervention or manipulation from the researcher, thus offering a detailed understanding of the underlying market changing aspects.

The securities markets in the EAC during the study period served as the unit of analysis. Specifically, the study focused on the four active securities exchanges in the region (refer to Appendix One), which include the NSE, USE, DSE and RSE. These markets were chosen because they are the only operational securities exchanges within the EAC member states, offering a thorough representation of the market dynamics in the region. Given the limited number of securities markets within the EAC, the study employed a cross-sectional survey covering all four of these exchanges. The small sample size allowed for an in-depth analysis of each market,

ensuring that the study captured the unique characteristics and dynamics of securities trading within each exchange. The cross-sectional survey approach was particularly suitable for this research, as it enabled the collection of data from all relevant markets within a specific time frame, allowing for comparative analysis across the different exchanges (Möttus et al., 2020).

It is imperative to keep in mind that the securities markets in Somalia, Burundi, South Sudan, and the DRC were excluded from this study. These countries, although part of the broader East African region, did not have functioning securities exchanges at the time and therefore did not meet the criteria for inclusion in this analysis. The exclusion of these markets ensured that the study remained focused on the operational securities exchanges within the EAC, allowing for a more precise and relevant analysis of market performance in the region. In the context of this research, the securities exchanges were relatively well distributed within the EAC, making it feasible to conduct a comprehensive cross-sectional survey. This approach not only maximized the depth of analysis but also ensured that the findings were representative of the securities markets within the region.

The study collected secondary data from annual audited financial documents, annual capital markets authorities' publications, and daily trading reports of the securities exchanges for the ten-year period from 2015 to 2024. The study selected the 2015–2024 period to capture a full decade of data, which is adequate for observing medium-term trends in the effects of trade automation on securities market performance. This period reflects significant advancements in automation technologies across EAC securities exchanges and covers major policy and regulatory reforms aimed at market integration and modernization. The timeframe also enables analysis of both pre- and post-automation intensification phases, providing a comprehensive basis for examining market efficiency and liquidity dynamics over time.

Table 1: Study Variables, Measurement and Comparison with Previous Studies

Variable	Indicator	Operational Definition	Measurement	Adapted From
Trade Automation	Volume of shares traded in respective security market	This is the total volume of shares that are traded due to trade automation in the security market	Percentage change in volume traded as a result of automation	Hasan, Shamsuddin & Vigne (2021)
Market Efficiency	Yearly stock market returns	Aggregate returns from security market for a period of one year	Expressed in USD Millions	Menkveld (2020)
Performance	Market Liquidity	Market Turnover Ratio	Total Value Traded/ Average Total Market Capitalization	Zhu and Zhang (2020)

In order to analyze the data and produce insightful findings, the study used Stata software. To examine the connections among the variables being studied, regression analysis was utilized. Tests for multicollinearity, normality, linearity, autocorrelation, heteroscedasticity, unit root/stationarity were carried out. On the other hand, the outliers in panel data can distort the results by causing heteroscedasticity or unequal variances (Adams et al., 2019). It is argued that panel fixed-effects models could mitigate issues related to heteroscedasticity by controlling for time-invariant characteristics, thereby providing more accurate estimations in the presence of outliers or unequal variances (deHaan, 2021). Given that panel data included both time series and cross-sectional elements, choosing the suitable model was essential for accurate analysis.

The decision between the suitable models (fixed versus random) is crucial for this study, which used panel data to explore the effects of trade automation and market efficiency. When individual-specific intercepts were associated with the regressors, the fixed-effects model is suitable because it permits management of time-invariant features that could affect the dependent variable (Wooldridge, 2008). This model provides more accurate estimates by taking into consideration the individual effects as a component of the intercept.

The Hausman model selection and specification test looks at whether the individual-specific effects are correlated with the explanatory variables, which aids in choosing between the two models. If the $p < .05$, the fixed-effects model is deemed more appropriate (Baltagi, 2024). This approach helps ensure that the model accurately reflects the dynamic interactions between trade automation, and market efficiency in the panel data setting. The fixed-effects model was used if individual effects are found to correlate with regressors, otherwise, the random-effects model was considered (Hausman, 1978).

The effect of the link between the research variables through regression analysis was evaluated. The research objective, hypothesis, and analytical techniques employed in the estimation is summarized. The tested hypothesis stated as, H01: Market efficiency do not significantly influence the relationship between trade automation and performance of securities markets in East African Community. The analytical technique include use of Baron and Kenny (1986) four step procedure;

Stepwise Regression Analysis

Step 1: $PERF_{it} = f(TA_{it})$

Step 2: $ME_{it} = f(TA_{it})$

Step 3: $PERF_{it} = f(ME_{it})$

Step 4: $PERF_{it} = f(TA_{it}, ME_{it})$, $PERF_{it} = Performance$, $TA_{it1} = Trade Automation$,

$ME_{it2} = Market Efficiency$

If the calculated p-value is less than alpha (0.05), then the overall model is significant. Mediation is indicated if: (i) the effect of trade automation on market performance (from Step 1) is reduced or becomes statistically non-significant when market efficiency is included in the model, and (ii) market efficiency remains statistically significant in the model. This would suggest that market efficiency mediates the relationship between trade automation and securities market performance.

RESULTS AND DISCUSSIONS

The analysis assessed the central tendency and variation within the panel data, providing an overview of the dataset's characteristics and its range of values. The results of the descriptive statistics for the study variables are summarized in Table 2 below.

Table 2: Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
Average Total Market Capitalization	40	6.2999	2.4208	2.2979	11.7974
Percentage change in volume traded	40	.0486	.0170	.02	.09
Annual Bid Ask Spreads	40	.9345	.9560	.0242	3.2124

The descriptive statistics outlined in Table 2 above provide a detailed overview of market capitalization, trading volumes, and transaction fees. The Average Total Market Capitalization (ATMC), which represents the dependent variable, has a mean of approximately 6.3 million USD, with values ranging from a minimum of about 2.3 million USD to a maximum of nearly 11.8 million USD. The standard deviation of 2.42 million USD suggests moderate variability, indicating differences in market sizes across the different securities markets over the 10-year period. These variations reflect the relative differences in market performance and the overall size of each market in terms of listed equity value.

For the Percentage Change in Volume Traded (PVT), the mean is 4.86%, with a standard deviation of 1.70%, indicating moderate fluctuations around the average value. The range (2-9%) demonstrates periods of both low and high trading activity, influenced by market liquidity, investor behavior, and economic conditions that varied across markets and years. Meanwhile, the Annual Bid-Ask Spreads (ABAS), an indicator of market efficiency, have an average of 0.93 million USD but show considerable variability, with a standard deviation of 0.96 million USD. The range from 0.0242 million USD to 3.2124 million USD suggests significant differences in market liquidity and trading costs, which are indicative of varying levels of market

efficiency. Collectively, these statistics reveal diverse conditions in the East African securities markets, shaped by differences in market size, and efficiency, providing insights into the trading environment and its evolution over the study period.

Examining whether market efficiency affects the connection between trade automation and market performance in the EAC was the particular goal. The null hypothesis (H0), according to which market efficiency does not significantly intervene the relationship between trade automation and market performance, was tested in order to achieve this goal. A four-step process developed by Baron and Kenny (1986) for evaluating mediating or intervening effects was used in order to investigate this. The underlying presumptions of this approach must be fulfilled in order for mediation to be validated.

Step 1: Evaluate how trade automation (TA) affects market performance (PERF) directly. Similar to the methodology employed in the preceding hypothesis (H0), this first stage tests the direct relationship. For this stage, the regression model is defined as follows:

$$PERF_{it} = \alpha + \beta_1 TA_{it} + \epsilon_{it}$$

where the dependent variable is market performance (PERF), and trade automation (TA) serves as the independent variable.

Step 2: Evaluate the impact of market efficiency on trade automation. This step examines whether market efficiency (X2) is significantly influenced by trade automation (TA). The model for this step is:

$$X2_{it} = \alpha + \beta_1 TA_{it} + \epsilon_{it}$$

Here, market efficiency is the dependent variable, and trade automation is the explanatory variable.

Step 3: Determine the effect of market efficiency on market performance. This step tests whether market efficiency (X₂) has a direct impact on market performance (PERF). The model is:

$$PERF_{it} = \alpha + \beta_1 X_{2it} + \epsilon_{it}$$

In this model, market efficiency is the independent variable, and market performance is the dependent variable.

Step 4: Examine the combined effect of trade automation and market efficiency on market performance. This final step assesses whether the inclusion of market efficiency as a mediator changes the connection between trade automation and market performance. The model is specified as:

$$PERF_{it} = \alpha + \beta_1 TA_{it} + \beta_2 X_{2it} + \epsilon_{it}$$

In this model, both trade automation and market efficiency are explanatory variables, and market performance is the explanatory variable (Table 3).

Table 3: Effect of Market Efficiency on the Relationship
Between Trade Automation and Performance

Variable	Step 1 (REM)		Step 2 (REM)		Step 3 (REM)		Step 4 (REM)	
	Model 1 (DV: TA)		Model 2 (DV: ME)		Model 3 (DV: TA)		Model 4 (DV: TA)	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Trade automation	-27.7183 (-2.25)	0.025	1264.091 (2.51)	0.012	-	-	-19.008 (-2.31)	0.021
Market Efficiency	-	-	-	-	.9748 (2.82)	0.005	.1135 (1.60)	0.110
Constant	-.5088	0.028	-3.2000	0.877	1.00098	0.446	.0116	0.983
Model Selection Statistics (Hausman tests)								
	Step 1: 0.9888			0.7284		0.7065		0.9888
	Step 2: 0.6835			0.6185		0.8895		0.9983
	Step 3: 0.1729			0.3485		0.3412		0.5179
	Step 4: 0.7037			0.7776		0.8754		0.9889
Model Fitness Statistics								
		Number of Observations		R²	Wald Chi²		Prob > Chi²	
Step 1: Random-effects GLS regression		34		0.1209	5.04		0.0247	
Step 2: Random-effects GLS regression		36		0.1369	6.31		0.0120	
Step 3: Random-effects GLS regression		36		0.0478	7.93		0.0049	
Step 4: Random-effects GLS regression		38		0.1975	6.15		0.0461	

According to the results, the model selection statistics across all steps of the analysis reveal that random-effects models are suitable for this study, as evidenced by the Hausman test p-values of 0.9888, 0.9983, 0.8179, and 0.9889. The use of random-effects models to evaluate the connections between trade automation, market efficiency, and market performance is validated by these strong p-values, which show no discernible difference between the random-effects and fixed-effects models.

In Step 1, the random-effects model reveals an R-squared value of 0.1209, indicating that approximately 12.09% of the variability in market performance is explained by the trade automation in the model. This relatively modest R-squared suggests that while the model provides some insight into the factors affecting market performance, a significant portion of the variability remains unexplained, pointing to the presence of other influential factors not included in the model.

With a p-value of 0.0247 and a Wald Chi2 statistic of 5.04, the model is statistically significant. The null hypothesis, which states that none of the independent variables have a significant effect on the dependent variable and that all regression coefficients in the model are zero, is tested by the Wald Chi2 statistic. The result indicates that at least one of the factors in the model has a substantial impact on market performance, with a p-value below the traditional cutoff of 0.05. This demonstrates the overall relevance of the model and the significant contribution of the included variables to the explanation of the fluctuations in market performance.

The coefficient for percentage volume traded is -27.71834, with a p-value of 0.025. This coefficient indicates that for every one-percentage-point increase in trade automation, the market performance decreases by approximately 27.72 million USD. The negative sign of the coefficient reflects a detrimental impact of trade automation on market performance. Furthermore, the p-value associated with this coefficient is below the 0.05 significance level, highlighting that this negative effect is statistically significant and not due to random chance.

The null hypothesis, according to which trade automation has no discernible impact on market performance, is rejected due to the significance of the trade automation coefficient. This result, which particularly demonstrates a negative link, supports the idea that trade automation has a quantifiable impact on market performance. The results from Step 1 underscore the direct impact of trade automation on market performance, suggesting that increased automation correlates with decreased market performance.

In Step 2, the analysis focuses on the relationship between percentage volume traded and annual bid-ask spreads, a measure of market efficiency. The coefficient for trade automation is 1264.091, accompanied by a p-value of 0.012. This positive coefficient suggests that an increase in trade automation, as reflected by a higher percentage of volume traded, is associated with an increase in annual bid-ask spreads. This result implies that higher trade automation contributes to greater market efficiency by widening the bid-ask spread, which can be indicative of improved liquidity and more accurate pricing of securities.

This association is statistically significant, as indicated by the coefficient's p-value of 0.012, which is less than the traditional cutoff of 0.05. This importance highlights the robustness of the relationship and demonstrates that the observed beneficial impact of trade automation on market efficiency is unlikely to be the result of chance fluctuation. The significant positive coefficient supports the notion that increased trade automation enhances market efficiency by improving the ability to reflect information in security prices, as evidenced by the increased bid-ask spreads.

The model fitness statistics for Step 2 further reinforce the validity of these findings. The R-squared value of 0.1369 shows that roughly 13.69% of the variability in annual bid-ask spreads is explained by the trade automation in the model. While this R-squared value reflects a moderate explanatory power, it suggests that the model captures a meaningful portion of the variance in market efficiency, although other factors may also play a role.

Furthermore, Step 2's Wald Chi2 statistic of 6.31 and p-value of 0.0120 support the model's overall significance. The Wald Chi2 test tests the null hypothesis that all regression coefficients are equal to zero in order to determine whether the model as a whole is statistically significant. A statistically significant model and a substantial correlation between trade automation and market efficiency (annual bid-ask spreads) are indicated by a p-value below the 0.05 cutoff.

In Step 3, the analysis examines the effect of annual bid-ask spreads (market efficiency) on average total market capitalization, a key measure of market performance. The coefficient for market efficiency is 0.974834, accompanied by a p-value of 0.005. This positive coefficient suggests that as the annual bid-ask spreads increase, indicating enhanced market efficiency, the market performance also rises. This relationship implies that improvements in market efficiency, as measured by tighter bid-ask spreads, are associated with better market performance, reflecting a positive impact on overall market capitalization.

The correlation between market efficiency and market success is statistically significant, as evidenced by the p-value of 0.005, which is significantly lower than the traditional significance level of 0.05. This result confirms that the observed positive effect of market efficiency on market performance is not likely due to random chance but is a robust finding. The significance of this coefficient highlights the crucial role of market efficiency in enhancing market performance, underscoring that efficient markets tend to exhibit higher total market capitalization.

To further support the validity of this finding, the model fitness statistics for Step 3 are examined. The R-squared value is 0.0478, which indicates that approximately 4.78% of the variability in market performance is explained by market efficiency. Although this R-squared value suggests a relatively modest explanatory power, it still indicates that the model captures a meaningful portion of the variability in market performance, demonstrating the relevance of market efficiency in influencing market capitalization. Furthermore, the p-value for this step is 0.0049 and the Wald Chi2 statistic is 7.93. By determining whether the regression coefficients are jointly substantially different from zero, this statistic evaluates the model's overall significance. The model's statistical significance is confirmed by the p-value of 0.0049, which supports the finding that annual bid-ask spreads significantly affect market performance.

In Step 4, the analysis investigates whether market efficiency influences the relationship between trade automation and market performance, addressing the specific objective of the study. The findings indicate that the coefficient for trade automation is -19.0083 with a p-value of 0.021. This coefficient indicates that when market efficiency is considered, the negative impact of trade automation on market performance is moderated. The coefficient's negative value indicates that the existence of market efficiency partially mediates the relationship, reducing the severity of the adverse effect of trade automation on market performance. The p-value of 0.021 is below the standard significance level of 0.05, confirming that this mediation effect is statistically significant.

The model fitness statistics further support these findings. The R-squared value of 0.1975 indicates that approximately 19.75% of the variability in market performance is explained by the model, which includes trade automation and market efficiency. This is a substantial improvement from previous steps, reflecting that the model better captures the relationship between trade automation and market performance when accounting for market efficiency. Additionally, the Wald Chi2 statistic for this step is 6.15 with a p-value of 0.0461. By evaluating the model's overall significance, this statistic verifies that the entire model is statistically significant at the 0.05 level. The significance of market efficiency in mediating the relationship between trade automation and market performance is confirmed by this conclusion, which emphasizes its mediating role.

The null hypothesis (H0) is disproved in light of these findings. The results show that the link between trade automation and market performance is considerably impacted by market efficiency. According to Baron and Kenny (1986), partial mediation happens when the independent variable's influence on the dependent variable diminishes after the mediator has been controlled, whereas complete mediation happens when the independent variable no longer influences the dependent variable after the mediator has been controlled and all other conditions (confirmations of significance) in the previous steps have been met. Therefore, market efficiency plays a critical role in this relationship and offers a more knowledge of how trade automation affects market performance within the East African Community. In this instance, market efficiency partially mediates the negative impact of trade automation.

The study's findings confirm that trade automation positively influences market efficiency, which in turn enhances the performance of securities markets in the EAC. Automated trading systems improve the speed of information processing and trade execution, leading to more efficient markets characterized by accurate pricing. This aligns with Olanrewaju (2025), who argue that improved market efficiency fosters better market performance by minimizing information asymmetry and enhancing price discovery. Similarly, Kang, Lee and Park (2022)

suggest that efficient markets facilitate smoother transactions and create conditions that encourage higher investment levels and market stability. The study's findings support this view, highlighting that as market efficiency improves, key performance indicators such as liquidity and investor confidence also rise, reinforcing the positive role of automation in financial markets.

However, while enhanced market efficiency generally benefits securities markets, Aldridge and Krawciw (2022) caution that the relationship between efficiency and performance is not always straightforward. The introduction of automation-related frictions such as algorithmic trading anomalies, technical inefficiencies, and regulatory mismatches may create new challenges that impact performance in unpredictable ways. Despite automation's potential to optimize market operations, it also necessitates continuous monitoring and regulatory adjustments to mitigate unintended consequences such as excessive volatility or market manipulation risks. Therefore, while the findings validate the positive role of market efficiency in improving securities market performance, they also underscore the need for careful implementation and oversight to ensure that automation delivers sustainable and long-term benefits to the EAC financial markets.

Furthermore, these outcomes are consistent with the recent analysis by Addy et al. (2024), who established that artificial intelligence-driven algorithmic trading improves speed, adaptability, and price discovery, the core components of market efficiency. The authors pointed out that as algorithms evolve to process and react to market signals in real time, they reduce latency and enhance order matching accuracy, particularly in high-frequency trading environments. However, they also warned that these benefits are contingent on the robustness of surrounding market infrastructure and the presence of well-regulated environments. In the EAC context, the positive influence of automation on efficiency suggests that despite infrastructural limitations, automation tools are increasingly being adopted to enhance informational transparency and execution precision.

Expanding this understanding, Jiang and Wang (2021) empirically confirmed that high-frequency trading generally enhances efficiency by narrowing bid-ask spreads and improving liquidity. Their findings suggest that the net effect of automation on efficiency and performance must be considered alongside accompanying market conditions. The current study's results support their conclusion by demonstrating that while automation can improve efficiency, that improvement is only as impactful as the efficiency gains are stable, scalable, and integrated with market-supporting policies and practices.

Further evidence by Easley and O'Hara (2022) supports this view, highlighting that the relationship between automation and efficiency is not inherently linear. While trade automation tends to improve liquidity and information symmetry, the persistence of regulatory gaps can

dampen the overall effect on market performance. Their study underscored the importance of aligning regulatory oversight with automation technologies to ensure efficiency gains are channeled toward market development. In the EAC context, this study's findings suggest that although automated systems have enhanced efficiency, their full potential remains untapped due to lingering operational and institutional bottlenecks.

Moreover, the findings from Schmidt-Kessen, Eenmaa, and Mitre (2022) provide an institutional economics lens to interpret the mediating role of efficiency. They theorized that automation by standardizing transaction processes can promote cooperative market behavior, reduce ambiguity, and build investor confidence. However, they also warned that overly rigid automated frameworks may reduce adaptability, especially in volatile markets. The current study reflects this trade-off, showing that while market efficiency mediates the link between automation and performance positively, any fragility in the efficiency layer could disrupt the transmission of automation's benefits to performance metrics. Lastly, Courdent and McClelland (2022) examined the South African securities exchange and found that algorithmic trading improved liquidity but also led to higher short-term volatility. They argued that the efficiency gains were real but sometimes uneven across instruments or trading tiers. Their findings parallel the current study's results, where improved efficiency has enhanced market performance, but the overall relationship remains sensitive to how evenly automation benefits are distributed across segments. In emerging exchanges like those in the EAC, the evidence suggests that automation must be accompanied by targeted efficiency reforms such as smart order routing, real-time reporting, and harmonized clearing procedures to unlock its true value for market performance.

CONCLUSIONS AND RECOMMENDATIONS

The findings reveal several important insights into the impact of trade automation, and market efficiency on the performance of securities markets in the EAC. The study highlighted the significant role of market efficiency in determining market performance. Market efficiency, characterized by narrower bid-ask spreads, was positively associated with market performance, suggesting that more efficient markets tend to perform better. However, while market efficiency showed a positive influence, it did not achieve conventional levels of statistical significance. This indicates that while market efficiency is important for market performance, its impact might be inclined by additional aspects, such as the overall market environment or the development of the market. Thus, the benefits of trade automation on market efficiency and performance may be contingent on a more complex interplay of factors.

This study provides an empirical departure from conventional automation literature by examining how trade automation influences securities market performance in the distinct and under-researched context of EAC capital markets. Most prior studies on automation, and efficiency have focused on developed economies with robust market infrastructure and liquidity. This research bridges that gap by applying the same analytical rigor to emerging securities exchanges specifically, the NSE, DSE, USE, and RSE where market fragmentation, infrastructural limitations, and regulatory disparities define trading dynamics. By doing so, it shifts the centre of academic inquiry to include developing markets, generating evidence that is locally grounded and globally relevant.

The findings challenge the widely held notion that trade automation inherently improves market performance. Instead, the study demonstrates that in the EAC context, increased trade automation correlates with a statistically significant decline in market performance. This result offers a critical contribution to knowledge by showing that the success of automation is not universally transferable. It is shaped by the maturity of market systems, the level of digital adoption, and the capacity of institutions to support real-time electronic trading. This challenges earlier assumptions embedded in trade automation theory and calls for a more nuanced understanding of technology's role in fragmented and illiquid markets. A further contribution lies in the study's modeling of interdependencies between trade automation, market and efficiency. Previous research has tended to evaluate these elements in isolation. This study breaks new ground by conceptualizing and empirically testing their mediating and moderating effects within an integrated framework.

The findings offer significant insights for policymakers and regulatory bodies within the East African Community, providing a clear direction for improving market dynamics. The results emphasize that while trade automation has the prospective to improve market efficiency, its benefits can be significantly compromised by other aspects. For policymakers, this implies a pressing need to address by implementing policies aimed at enhancing efficiency, such as streamlining procedures and reducing fees, policymakers can help ensure that the advantages of automation are fully realized. This approach would not only enhance market efficiency but also contribute to more competitive and effective financial markets within the EAC.

For market regulators, the research highlights the importance of adopting a holistic regulatory approach that encompasses more than just the promotion of trade automation. It suggests that effective regulation should address various interconnected factors such as market efficiency. Integrating these elements into regulatory frameworks, regulators can create a more balanced trading environment that fosters both innovation and fairness.

This study makes important theoretical contributions by applying trade automation theory to the context of securities markets within the EAC. The study further extends the efficient market hypothesis by demonstrating that market efficiency can be improved through automation, yet this does not automatically translate into better market performance. The findings show that although bid-ask spreads narrowed indicating more efficient pricing the overall performance of the markets did not consistently improve. This suggests that efficiency and performance are not always directly aligned and that other factors, such as liquidity constraints, can dilute the benefits of increased efficiency. These insights offer a more realistic view of how efficiency operates in fragmented and evolving markets like those in the EAC.

The methodology that was employed make several significant contributions to the field by integrating multiple variables into a comprehensive analysis of market performance. Simultaneously examining the effects of trade automation, and market efficiency, the study provides a comprehensive understanding of the elements influencing market performance. In employing both fixed-effects and random-effects models (where necessary), the study enhances the robustness and reliability of its findings. The fixed-effects model accounts for within-market variations, while the random-effects model addresses between-market differences. This dual-model approach helps mitigate potential biases and provides a clearer, more accurate depiction of how trade automation impact market performance. The methodological rigor of using these models ensures that the results are reliable and credible.

LIMITATIONS AND FURTHER RESEARCH

This study examined the relationship between trade automation, market efficiency, and the performance of securities markets within the East African Community (EAC), focusing on four active exchanges—NSE, DSE, USE, and RSE—over the period 2015 to 2024. A primary limitation is the regional specificity of the findings, which may not be generalizable beyond the EAC due to variations in economic conditions, regulatory structures, and technological capacities in other markets. Additionally, differences in infrastructure maturity and regulatory enforcement across the four exchanges may have introduced inconsistencies in data comparability, potentially affecting the uniformity of the findings. The exclusive reliance on historical secondary data may also overlook recent developments, limiting the study's ability to reflect the current dynamics of evolving financial markets. Furthermore, the study did not include important contextual variables such as macroeconomic indicators, political stability, and investor sentiment, factors that significantly shape market behavior and may influence the effects of trade automation and efficiency. Excluding these dimensions may limit the explanatory depth and leave out critical dynamics that affect market performance in real-world settings.

Furthermore, the focus on trade automation in its current form did not explore the broader technological landscape, including the rise of artificial intelligence, machine learning, or other fintech innovations that are rapidly redefining market processes.

Future research should consider a broader set of explanatory variables, including macroeconomic and behavioral factors, to better understand the contextual conditions under which automation and efficiency affect market performance. Expanding the study to other African or global markets would also offer comparative insights and improve the generalizability of findings. Moreover, longitudinal research designs could track changes over time, revealing how relationships between automation, efficiency, and performance evolve in response to policy shifts, market integration efforts, and technological advancements. A deeper exploration of how regulatory frameworks and infrastructure readiness influence the effectiveness of automation would provide further practical value for policymakers and market actors in emerging economies.

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Conflict of Interest

The authors affirm that there are no conflicts of interest related to this study, financial or otherwise.

Data Availability Statement

The data used in this study were obtained from secondary sources, including annual financial statements and trading records of the NSE, USE, DSE, and RSE. Data supporting the findings may be made available upon reasonable request to the corresponding author.

Ethics Statement

This research involved analysis of publicly available secondary data and did not include human or animal subjects. As such, it did not require ethical approval.

Informed Consent Statement

No primary data were collected directly from individuals in this study. However, the study maintained full compliance with privacy and data protection standards where applicable.

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