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Impact of Automation on Stock Market Performance: Evidence from the Stock Market Performance

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Abstract

The study assesses the impact of automation on Stock Market performance. The study relies wholly on secondary data from the Ghana Stock Exchange website (GSE), Ghana statistical service (GSS) and the Bank of Ghana (BOG) online database. The data include Volume of stock traded before and after automation as well as monthly time series data spanning from 2005-2018 which is analyzed with multivariate regression technique. The study concludes that automation has an impact on market efficiency; it further concludes that there is a positive impact of automation, exchange rate and interest rate on the volume of stock traded. Again, the study concludes that the macroeconomic policies of the economy are characterized by volatile and generally high inflation, high interest rates and large exchange rate swings. The study recommends that the trading instructions of the exchange must be change to assist stockholders with the skill to make their own trading verdicts, independent of the services of a certified stockbroker. This has the benefit of accelerating transactions, minimizing commission charges, and improving market volumes and capitalization whiles improving rivalry in the market. This will also allow the exchange to respond quickly to varying trends in market basics in real time. Also, since efficiency thrives immensely on information flow, data on the exchange should be made easily accessible to the public especially potential investors so as to enhance the efficiency of the market. Again, continuous education and training should be conducted for stake-holders and industry players on the Automation Trading System of the GSE.

Keywords: Stock Market Performance, Stock Market Performance, Ghana Stock Exchange, Ghana statistical service (GSS)

1.0 INTRODUCTION

1.1 Background to the Study

As a growing capital market in a developing economy, automation of the stock market stays regarded as a key step towards integrating the financial market as a channel for economic growth. Due to the incessant rise in globalization and the rapid advancement in technology, in tandem per the prerequisite to safeguard proficiency, the Ghana stock exchange was progressively automated from 2008 to 2009. This will substitute the open outcry system, where traders will have to make their demands during trading periods for ration to be completed. According to Jain (2005), doing away with the human system, stockbrokers will no longer make their demands from the manual transaction. With this in the main, automation and trading speed are becoming rapidly vital. Amid monetary aspect of competition this diminishes operation cost and allows the extra proficient distribution of securities by varied stockholders, enhance risk allotment and consumption smoothing, as well as ensuring precision in routine pricing. Where the policy is discharge it allows transaction to be done online on real time basis by the hint of a knob. The automated trading system draws the Exchange's undertakings closer to a global standards and place Ghana in a position to strive to achieve its objective as an investment destination, and surveillance of trading related activities as well as minimized risks allied with the market.

Outline on automated trading have completely change trade volumes in most exchanges. Brokers can gladly procure as well as vend securities from an isolated place with the help of worldwide- based order submission protocols. Recent program to automate the trading platform decades ago was cancelled because the funding agency realized that the recession in the economy was not going to make the project

viable. However, proof emanating from the stock exchange reveals that stock market stimulates economic growth in Africa (Yartey and Adjasi, 2007). The operation of the automated trading scheme is vital to attaining greater effective proficiency, clearness, minimized cost of undertaking commercial, and improved marketplace transparency as well as stockholder confidence. Introduction of automation on the Exchange was on the belief that it would as part of its purposes provide the facilities as well as the agenda to the community for procurement and trade of securities. Accordingly, periods of enactment of automation on the stock market, the question that beckons is whether automation on the trading market has enhance the efficacy of the Ghana Stock market. In contemporary years, market systems of trading gained rapid attention particularly for developing exchange whereby a requisite occurs to develop a monetary arrangement. The rapid advancement in skill has resulted in the improvement of extremely refined automated trading systems, which can together increase cash flow and minimize transaction charges.

1.2 Statement of the Problem

The problems facing the manual scheme of trading which the automated trading system (ATS) seeks to solve includes; having effortless access about the latest news. Again, with the open outcry system, there is a challenge in the operational and informational efficiency of the market. Automated trading system is needed to address the short comings of the manual system of trading. The inefficiencies of the manual trading such as low liquidity will increase cost of trading and the capability to purchase and vend securities. However, automation enables more shares to be traded to improve liquidity on the marketplace as well as position the exchange to compete favourably on the international market by boosting investor confidence to attract extraneous stockholders to the market. The stock markets low income routine is due to the presence of the open outcry systems. Automation is advertised to be part of the procedures on exactly how to stimulate the growth of the Ghana stock market. Automation estimates to minimize the charges and inadequacies allied with the open outcry system of trading in this manner increasing trade action, refining market transparency, liquidity and income in the stock markets by accelerating processes.

Sound empirical studies using data from automated exchange across the world including Wuyt (2007) Chordia and ball (2001) "investigate the relevance of automation to stock performance and efficiency." Automated exchange is more liquid than the manual trading exchanges. Pirrong (2018) "investigates that automated exchanges can be deeper and produce more liquid than the open outcry exchanges." In contrast, some authors find that automated trading can have a negative impact on liquidity when transactions are based on human interactions. Biais et al. (2007) suggest that automation decreases liquidity because for important transactions, traders cannot negotiate directly and so have no control on trading conditions. The authors further argue that automation can cause cash flow to decline since it disallows a direct intervention among traders and does not permit them therefore to reserve a specific switch on trading situations.

Pagano and Roe¨ ll (2013) compare liquidity and the price-formation processes in several trading systems with different degrees of transparency. They suggest that a greater transparency in the trading process improves market liquidity by increasing opportunities for less-informed traders to participate in a system with reduced spreads, volatility and pricing errors. Furthermore, Sato (2009) suggests that, under automation, volatility rises due to overshooting or undershooting because traders using screens do not understand the reasons for price movements. In fact, on a trading floor, traders can observe one another's body language and behavior to obtain additional trading information. This information can include the urgency of trading and the identity of the transacting party.

Naidu & Rozeff (1994) note an increase in volatility and liquidity as well as an improvement in efficiency following the automation of the Singapore stock exchange. They advance that automation speeds up the dissemination of prices, making it likely that volatility will increase, especially when information is hitting the market. The speed with which prices and trading volume are available incites investors to trade to exploit the published information, which is likely to improve market efficiency.

Chordia et al (2000) moved away from focusing on the liquidity of individual stocks and looked at common determinant of liquidity.

According to Derrabi (2005) the automated trading produces a significant and permanent increase of prices. The fixing system also permits efficiency improvement and lower volatility but no significant impact has been noted for stocks traded in continuously. Based on these conflicting findings, there is a knowledge gap in literature on the subject matter to warrant a research in this area. It is against this backdrop that this study seeks to assess the impact of automation on stock market performance.

1.3 Objectives of the Study

The Overall objective of the research is to assess the impact of automation on Stock Market performance. The specific objectives include the following:

1. To examine the impact of Automation on Stock Market Efficiency.
2. To assess the impact of automation and macroeconomic indicators on volumes of Stock traded.
3. To determine the challenges of automation on the Ghana stock exchange market.

1.4 Research Question

1) What is the impact of automation on Stock Market Efficiency?
2) What is the impact of automation and macroeconomic indicators on Volume of stocks traded?
3) What are the challenges of automation on the Ghana Stock Exchange Market?

1.5 Significance of the Research

The significance of this research will function as a source of facts, literature and reference to academia. Furtherance to this it will serve as a source of assessment for further research into issues of system automation of the stock exchange and assist other countries to be more responsive to system automation. If the development of stock market in Ghana can be an engine for growth, then policy makers will focus attention on and direct resources towards establishing and sustaining a dynamic market in the country in order to foster sound and continuous economic growth. In view of this, it is necessary to know whether the stock market in Ghana plays a part in the growth of the Ghanaian economy so as to give it the necessary boost and support. Thus, the study will offer some depths of insight to guide policy, economic planners, portfolio managers and even non listed firms planning to float shares or initial public offers (IPOs) in the market. Finally, Policy makers such as legislators, government agencies among others, will benefit from the recommendation which will be made from the findings to improve trading on the stock market by providing the appropriate services to suit the changes in contemporary stock market's needs.

This study is useful to the investment community, system developers, organizations that are already trading and those intending to raise their capital through GSE, share brokers and investment analysts in planning, analyzing and making capital and other related decisions. The study would also leave further inroads for future researchers in other disciplines of finance, economics and management regarding the progressive growth of Stock Market in Ghana.

1.6 Scope of the Study

The treatise covers activities on the Exchange i.e. Volumes of stock traded before and after automations and Macroeconomic Indicators (Exchange Rate, Inflation and Inter-Bank Interest Rates). The study further covers automation's impact on the Stock exchange activities relation to efficacy and the associated challenges of the Automated Trading System.

1.7 Organization of the Study

The treatise is structured into five Chapters. The first section provides overview to the background of the study and the key aims of the research. The second section also examines pertinent literature from

mutually an appreciative enquiry and acute analysis points and provides some perspectives on some empirical works. This provides significant evidence about effort put in similar field of study. The third section provides a description on the methodology. The gathering and organization of facts suggested and the fourth section include the examination of the data as well as the interpretation of findings whereas the last Chapter gives the conclusion as well as recommendation of the study.

2.0 LITERATURE REVIEW

This Chapter reviews imperative literature relating to automated trading system in Ghana. It further deliberates on issues in theoretical and empirical literature of stock trading and its related elements.

2.1 Theoretical Literature

2.1.1 Stock Markets

Stock market promotes economic development by ensuring an enhancement to national savings and improving the magnitude and superiority of investment. Performance of the market facilitate economic growth through investments amid individual, providing avenue for corporate financing and well-organized distribution of wealth in the economy. According to (Yartey and Adjasi, 2007). Stock markets contribute to financing corporate investments and growth of listed firms in Africa i.e. stock markets impact aggregate economic performance through corporate financing. The implementation of the Automated Trading System (ATS) was a key to achieving enhanced operational efficiency, transparency, reduced cost of doing business, and enhanced market integrity and investor confidence (Capital Markets Authority, 2007). Performance of stock provides an indication to stockholders concerning their upcoming moves. Stock prices and its indexes provide an awareness of the immediate upcoming trend of the stock sector. Stock Market Indexes as one indicator of stock performance naturally, provides the overall efficiency of the market or specific sector in its fullness (Sigh 2005).

Stock Prices are another indicator of performance of the stock. If the price of a particular stock is rising, then it is perceived that it has certain positive signals which reflect in the stock performance and consequently the stock market is most likely to underperform and might see a downward trend. Thus, Stock Market Performance acts as the barometer of the economy as a whole (Stock Performance and Measurements, 2010). According to Fama (2009), stock prices reflect macro-economic variables such as exchange rate, interest rate, industrial production, real GNP, money supply and capital expenditures. Due to that an investigation was conducted by Maysani and Koh (2000) and Choi *et al* (2014) to find the impacts of the interest rate and exchange rate on the stock returns and concludes that the exchange rate and interest rate are the determinants in the stock prices. On the other hand, a study conducted by Tabak (2006) to analyze the dynamic relationship between stock prices and exchange rate in the Brazilian economy reveals that there is no long-term relationship between these variables whiles Hardouvelis (2002) points out that there exists an inverse relationship between stock prices and changes of interest rate and this can be rationalized in terms of money supply surprises.

The value of a stock is another variable of stock market performance. Rises in values of stock encourage investors to trade extra, thus increasing trading volume. Equally, growth in trading can lead to growth in prices Suominen (2001). If the value of a specific stock is increasing at that point it is apparent it requires firm encouraging signals which reflect in the stock performance and thus the stock arcade is prospective to underperform and perceive a descending trend. Volume of stock traded on the other hand is another measure of stock market performance. According to Oranika (2010), volume of stock traded refers to the quantity of stocks of a given institution traded at specified period of time. Volumes of stock traded show the transaction happenings of community purchasers and venders therefore it gives facts concerning the actions of the stock brokers (Harris, 2003).

Increase in the volume of stocks traded propels a positive indication to the stock exchange and a decrease in the volume traded sends out a negative signal to the performance. In line with that, the effect of stock prices on volume traded concludes whether stock performance is affected negatively or

positively. Suominen (2001) "explains the progressive co-relational impact amid trading volume and price variability based on secluded facts." He proves that price variations are not adequate basis in predicting instability but the data content on trading volume is also base on the available evidence concerning the firm. A number of studies also examine information asymmetry on the purchase or sale of securities. "(Ogunkola, Bankole, & Adewuyi, 2006) "investigate stock price actions when the trader may be in ownership of non- public information". Mendelson and Pedersen (2005) "reveal the liquidity results in price reductions." Thus cost of capital for firms with illiquid securities is higher than for firms with regularly-traded securities.

2.1.2 Automation Trading System

For the purposes of this study, automated trading involves a subsection of microelectronic trading that focus on computer algorithms for policymaking and implementation of order submissions. The core objective of a stock market is to make available conveniences for line of work of firm securities and other financial instruments. Naidu and Rozeff (1994) advanced that automated trading system speeds up the dissemination of prices, especially when information is hitting the market. Otherwise, the faster availability of prices and trading volume incites investors to trade or exploit the published information, and this is likely to improve market efficiency.

Stock market has continuously remained noted in dominant sites for coziness record of trades. Currently, modem exchanges are automated per the progression of worldwide infrastructures, which ensures quick and fewer transactions (Jain, 2005) The stock exchanges have extraordinarily changed over the years as a result of active role that worldwide web platforms execute. Developing arcades upgrade their microstructures by embracing automated transaction to take benefit of present skill. Overview of completely automated trading is one of the allied improvements amid the stock implementation of insider trading laws and established transformation (de la Torre, Gozzi, and Schmukler, 2006). For the purposes of this study, automated trading involves a subsection of microelectronic trading that focus on computer algorithms for policymaking and implementation of order submissions. The core objective of a stock market is to make available conveniences for line of work of firm securities and other financial instruments. Determinants of Volume have been acknowledging in theory of determining volume of stocks traded on exchanges and these discuss below; Automation involves the procurement and vending of securities by a stock investor. This is frequent through a trading floor of the exchange.

Nonetheless, the World Wide Web creates the opportunity of trading online. As a result of rapid advancement in technology, trading online has become probable and also desirable for the reason that businesses do not require to employ stock dealers and offer them commissions because of their bids. Trading of shares online involves the procurement and vending of merchandises with the assistance of computer and accessing the "trading floor" through Arpanet. Enhance automation and straight-through processing within securities and fund distribution lifecycle is the key to resolving the quandary in which investment management institutions find themselves today. Automation eliminates the manual re-keying of data, improves timeless of information delivery, reduces the potential for misinterpretation of messages and enhance exception processing. Automation also reduces volume sensitive, allowing investment managers to manage peaks and troughs in their business with little impact on staffing. This results in a reduction in errors and failed trades, hence, a reduction in both costs and risks, thereby resulting in higher returns and performance increase.

2.1.3 Challenges of the Ghana Stock Exchange

The remarkable routine of the GSE since its commencement does not mean that the exchange is innovative similar to the London Stock Exchange. From linked literature, two categories of limitations have laden the growth of the exchange. The primary one relays to the administrative and macro-economic set up and the second one relays to the market precisely (Ahaidu, 2015). The macroeconomic policies of the economy over the periods are branded by unstable and usually high inflation, high interest rates and huge exchange rate swing. These indicators stop stockholders from having a transparent visibility of the

macro environs. According to Benimadhu (2003), "The precise problems upsetting stock markets in Africa are poor liquidity level, limited listed firms and the small size of the exchange." The treatise accepts that the stock exchanges in Africa are imposed with related repercussions. Factors distressing the growth of the exchange relays to the absence of a national stockholder base, steered by official stockholders such as retirement fund and insurance firms. Payment and trade schemes as well as trading arrangement are similarly covering the world's stock market.

2.1.4 Efficiency of the Ghana Stock Exchange

According to Ahaidu (2015) "numerous scholars have issue alarms concerning the efficiency of the Ghana Stock Exchange". Frimpong (2008) "studies the weak-form EMH in the circumstance of the exchange". The weak-form EMH was prohibited for the GSE and he concludes that the GSE is faintly unproductive." Osei (2002) "also studies the reaction to annual remunerations announcements of the exchange". The treatise establishes that the arcade is unpredictable with the EMH. The assumption is that; the exchange is unproductive per regard to yearly remunerations evidence issues by the firms registered on the exchange. Hence, it is conditional for a considerable amount of stock values on the GSE to also be underestimated or overestimated as the arcade is mostly unproductive. There is a chance for a diligent forecaster to regularly outstrip the marketplace norms. The inefficiency of the exchange has relevant repercussions for stockholders, mutually local and international. Information on profitable arbitrage projection functions to entice stockholders to expand from extra effectual markets to capitalize on the GSE arcade to improve their remunerations.

2.1.5 History of the Ghana Stock Exchange

According to Ahiadu (2015) "the GSE is recognized in 1989 as a reserved firm limited by guarantee under Ghana's Companies Code, 1963. The Exchange is granted acknowledgment as an authorize Stock Exchange under the Exchange Act of 1971 (Act 348) in October 1990. It conversely, transformed its standing to a public company limited by guarantee in April 1994. Trading on the floor of the Exchange started in November 1990". The exchange presently has about thirty-five (35) listed companies and two (2) corporate bonds. Trading is approved on the Floor of the Exchange under the Continuous Auction Trading System (CAT). Securities traded on the floor of the exchange comprise Common Stock, Corporate and Government bonds. Nonresident Ghanaians and aliens are granted authorization through the Exchange Mechanism to advance through the Exchange without any prior consent. Conversely, a unique external Portfolio investor have access to only up to 10% of any security accepted for listing on the Exchange. Furtherance to this, the entire assets of all inhabitants in a listed security shall not outstrip 74%. There is unrestricted and complete foreign exchange remit ability for the unique capital plus all capital gains, returns and linked incomes. In addition, a 10% withholding tax on bonus revenue for all stockholders, both resident and non-resident. Capital gains on registered securities are, conversely, tax exempt till the period 2015.

Since its commencement, the exchange's enactment has mottled significantly. All listings are involved in the main index which is recognized as the GSE All-Share Index. In 1993, the GSE was the 6th finest index performing developing stock market, with a capital increase of 116%. In 1994 it was the finest index performing stock market amid all the developing arcades, attaining 124.3% in its index level. 1995"s index development was a disappointing 6.3%, as a result of high inflation and interest rate. Development of the Index for 1997 was 42% and at the end of 1998 it was 868.35 (1998 Review: Ghana Stock Exchange). "The Exchange pursues to strengthen its exertions in expanding listings and stimulate fund mobilization and embolden privatization of State Owned Enterprises on the Exchange. Capacity building will be improved by advancing the awareness of its staff and market operatives to improve professionalism in the industry. However, "there will be arrangement in place for the automation of trading, clearing, settlement and depository system to elevate the efficacy of the security market for all users" (Ahiadu, 2015)"

2.1.6 Performance of the Ghana Stock Exchange

"The GSE All-Share Index, a measure of the overall routine of the stock exchange, has improved from 77.25 points in 1990 to around 5,572.34 points at the end of December 2009. In 2008, the index verified an all-time extraordinary level of 10,431.64 points in spite of the global financial crisis (Ahiadu, 2015)". "The Exchange has been presence for two years. It is one of the finest performing stock market amid all developing market and the biosphere. The GSE appears the 6th finest performing developing arcade stationing a remarkable return of 114% in 1993. In 1994, the GSE was voted the finest performing market amid all developing arcades (Ahiadu, 2015)." The year 2008 recognize a rise in the value of trade on the exchange. Regardless of the worldwide economic predicament, the GSE gained 58%. In 2009, GSE became one of the foulest in performance in the world trailing 47% and posed 32% in 2010 (Ahiadu, 2015)".

2.2 Empirical Literature

2.2.1 Automation

According to Yartey and Adjasi (2008), "automation decreases the inadequacies in African markets and increases trading action and liquidity". Automated trading scheme also expedite processes as well as actions of exchanges and minimizes cost allied with the open outcry scheme. Automation eradicates the necessity for trade intermediation as stockholder's log onto systems to observe as well as trade on the markets. This supports a subsequent research conducted by Black (2005); Amihud (2002); Mendelson & Lauterbach (2006); Derrabi (2005); Naidu and Rozeff (1994). A key aspect in evaluating the performance of a particular trading system is its liquidity. The trading environment and liquidity have an impact that can be found in a recent study by Harris, Panchapagesan and Werner (2006). They investigate delisting from NASDAQ to the pink sheets. These accompany a large decline in liquidity since spreads almost triples, as did volatility.

A vibrant aspect in assessing the routine of a specific trading scheme is its liquidity. Venkataman (2001) "relates the NYSE (which has a trading floor) with Euro next Paris (fully screen based) for a section of related securities and finds that spreads are lower on a floor base exchange than on an electronic exchange". Theissen (2002) "offers direct proof by linking the floor and the screen-based trading scheme of the Frankfurt Stock Exchange, which functions in parallel." He realises that automated trading scheme gives little spreads for liquid stocks. From above literature, it is clear that automation have an impact on stock volatility and liquidity. This therefore, justifies the need for scholars to scrutinize the role and impact of automation on stock volatility and liquidity by providing empirical evidence into how automated trading system positively or negatively affects the volumes of stocks traded at GSE.

2.2.2 Interest Rate

"Some studies in Africa look at interest rate as a vital economic indicator which stimulates the growth of the stock exchange. For example, a treatise on the impact on real interest rate as a vital aspect on stock market performance, in terms of liquidity and activity (Jaine, 2013)." The co-integration study through Error Correction Mechanism (ECM) indicates important long run and short run connection amid the variables, suggesting that interest rate had an impact on stock exchange performance. Ehrmann and Fratscher (2004) "analyse the response of equity markets to U.S. fiscal procedure with an exceptional emphasis on comparative contributions of credit and interest rate channel for the period 1994 to 2003." Their outcomes show that fiscal policy influence individual stocks in intensely expanded means. Nwokoma (2002) tries to create an association amid some macroeconomic indicators." The outcome reveals that only manufacturing production and level of interest rates, as characterized by the 3 – month commercial bank deposit rate have a long-run connection with the market." Prashanta and Bishnu (2008) "reveal that the rationale for the connection amid interest rate and stock market reoccurrence is that prices of stock and rate of interest inversely correlate." Advanced interest rate decreases the value of equity as postulated by the dividend discount model, makes fixed earning securities more attractive as a substitute to holding stocks and may diminish the propensity of stockholders to borrow and advance in securities, and increase the cost of holding commercial and hence influence turnover.

Consequently, demand of stocks increases and stock markets go up as a result of interest rate cut. Mishkin (2007) also proves that lower interest rates increase stock prices which in turn reduce the probability of financial distress. Despite the fact that Modigliani and Chon (2008) consider interest rate as one of the most significant determinants of the stock prices, it cannot be said with confidence that changes in interest rate will directly affect the stock market. This is because the risk of a particular investment increases as interest rates increases. As risk increases the cost of stocks fall and investors lose money. However, the converse is actually beneficial. An increase in interest rates increases the cost of capital. An increase in interest rate is usually a good indicator of a slowing economy. The higher interest rate deters people from purchasing things and it stops companies from investing in stock options that will help them grow. This cause sales, profits, and stock prices to dwindle. The role of interest rates in investing is complicated and can be hard to understand. In general, increasing interest rates are bad for investors because it is bad for the companies they are investing in. Impact of interest rate on volumes traded (Retrieved on 10 June, 2010).

2.2.3 Inflation Rate

Studies examine by Nwugi (2013) "looks at the connection amid stock market volatility and the volatility of macroeconomic indicators." He finds that macroeconomic volatility in terms of inflation has a weak analytical influence for ordinary market volatility. Schwertz (2002) also did similar study by looking at association amid stock market and macroeconomic variables. Davis and Kutan (2003) extended Schwert's study by accounting for volatility persistence in an international setting. Their result was in line with the findings in Schwert's paper in the sense that the variability of information and output growth rate has weak predictive power for stock market volatility. According to Jhingan (2010) "when there is inflation most prices rise, though some rise faster than others." Afolabi et al (2003) "explains that there is a connection amid inflation and rising prices of stock." Sogu (2005) "conditions that inflation rate expects to vary all other things being equal, positively in line to variations in stock prices." Consequently, assessing the impact of inflation on stock prices of quoted firms, if there is a connection, one should assume a positive relationship amid inflation and the variation in stock prices.

Wuyts (2007) "indicates other environmental factors which determine or affect stock market liquidity. He states that a market is liquid if traders can quickly purchase or vend a huge number of shares without large price impact". This involves the readiness of a market participant to take the opposed side in a contract by another trader. Impact of inflation on stock market is apparent from the point that it stimulates the rates of interest. If the inflation rate is high, the interest rate is also high. In a situation where inflation and interest rates are high, the creditor will have the propensity to recompense for the increase in interest rates being high. It is believing that inflation is advantageous to common stock. This is major because it is argued that inflation increases the returns to shareholders since price of products rise faster than wages rates. The expected relationship between inflation and returns to owners of equity would be valid if business firms were debtors and if the current interest rates on debt finance failed to reflect the future changes in the price level. Inflation represents one of the nervous in expectation of the potentially negative consequences.

However, the rising prices and the higher interest rates do not lead to positive effects on the investment portfolios of investors. Since the revenues and earnings of companies tend to rise at the same pace as inflation, then stocks provide protection to inflation to a significant degree. Also, inflation has another negative impact, thus prices rise but no additional value is added. This means that money loses its purchasing power and as a result, a person can only buy less than before. However, when the inflation starts to fall to its normal levels, the overstated earnings and revenues will decline as well. These ups and downs lead to blurring the actual state of value.

2.2.4 Exchange Rate

Wongbangpo and Sharma (2002) "Study the connection among stock earnings for 5 Asian nations: Indonesia, Malaysia, Philippines, Singapore, the Thailand and the five macroeconomic variables." By

noticing both short and long run relationship amid relevant stock indexes and macroeconomic indicators of gross national product (GNP), money supply, the interest rate, and exchange rate reveal that in the long run all five stock price indexes relates positively to growth in output and negatively to aggregate price level. Prashanta and Bishnu (2008) "investigate macroeconomic variables that affect stock market in the recent empirical literature, with exchange rate being one of those variables." There are relations amid stock market earnings and exchange rate via changes in foreign investment. Adjasi and Biekpe (2005) also investigate the relationship between stock market returns exchange rate movements in seven African countries. Co- integration tests show that the long run exchange rate depreciation leads to increases in stock market prices in some of the countries, and in short – run, exchange rate depreciations reduce stock market returns.

Mishra (2004) "examines that stock return, exchange rate return, the demand for money and interest rate relates to each other through regular connection occur between them." Further, forecast error variance decomposition indicates that exchange rate return affects the demand for money; interest rate causes exchange rate to change; exchange rate affects the stock return; demand for money affects stock return; interest rate affects the stock return, and demand for money affects the interest rate. In Mao and Kao (2002), exporting firms' stock values were seen to be more sensitive to changes in foreign exchange rates. Their findings also reveal another topical issue of the relationship between stock exchange rate and stock prices, existing evidence indicates a weak link between them at a micro level. On the macro level, they find that a currency appreciation negatively affects the stock market of an export-dominant country and positively affects the stock market of an import of a-dominant country.

2.2.5 Trade Volumes

According to Theissen (2002) trade volume, is the quantity (total number) of a security traded in a given period of time." In a situation of a single stock trading on a stock exchange, the volume usually describes the quantity of stocks that change hands in a period. "The transactions are on stocks, bonds, options contracts, futures contracts and commodities (Theissen, 2002; Venkataman (2001)." Certain results of combined trading action adopt the whole quantity of stock trade as a degree of capacity (Gündüz & Hatemi, 2005). Others base their studies on the overall quantity of stocks operated by the overall quantity of stocks owing by way of a measure of size or capacity. Specific bit capacity is often involving in the examination of price/volume and volatility/volume relations (Maghyereh 2005). Furtherance to this, Studies converging on the impact of evidence on the exchange's activity use specific revenue as a degree of volume. Conversely, some fewer studies of developing markets and their outcomes are mixed. Chang et al. (2001) "finds no modification in the efficiency of the price detection process following the overview of a continuous auction system." However, Green et al. (2002) and Ngugi et al. (2003) "offer information from stock markets in India and Africa, correspondingly, this show that markets with advance trading expertise have bigger productivity.

2.6 Conceptual Framework

A conceptual framework explains either graphically or in narrative form, the main things to be studied, such as, the key factors: constructs or variables of a social research and the presumed relationships among them (Miles and Huberman 1994). Frameworks can be rudimentary or elaborate and theory driven or of ordinary description of any event or causes of any event. A conceptual framework specifies who and what will or will not be studied.

According to Ravitich and Riggan (2012), a conceptual framework is an argument about why the topic one wishes to study matters, and why the means proposed to study it are appropriate and necessary. A conceptual framework is also an analytical tool that expresses various views about issues within particular contexts. To make distinction between issues concerning ideas and how to organize them one may require a conceptual framework to explain the ideas which relates to each other. Often effective conceptual framework would portray real situation and show them in such a way as to make them easy to remember and apply (Ravitch and Riggan 2012). Conceptual framework may be abstract

representations, connected to a research project's goals that direct the corrections and analysis of data. Shields and Rangarajan (2014), define conceptual framework as the way ideas are organize to achieve a research project purpose. A conceptual framework, therefore keeps the researcher focused so as not to wander from the target being investigated. The conceptual framework may be sketched diagrammatically or set up as a flowchart. In this study, issues concerning automation have been the main focus.

Diagrammatic presentation of the conceptual framework

Conceptual framework of the study is presented and explained in Figure 2.1.

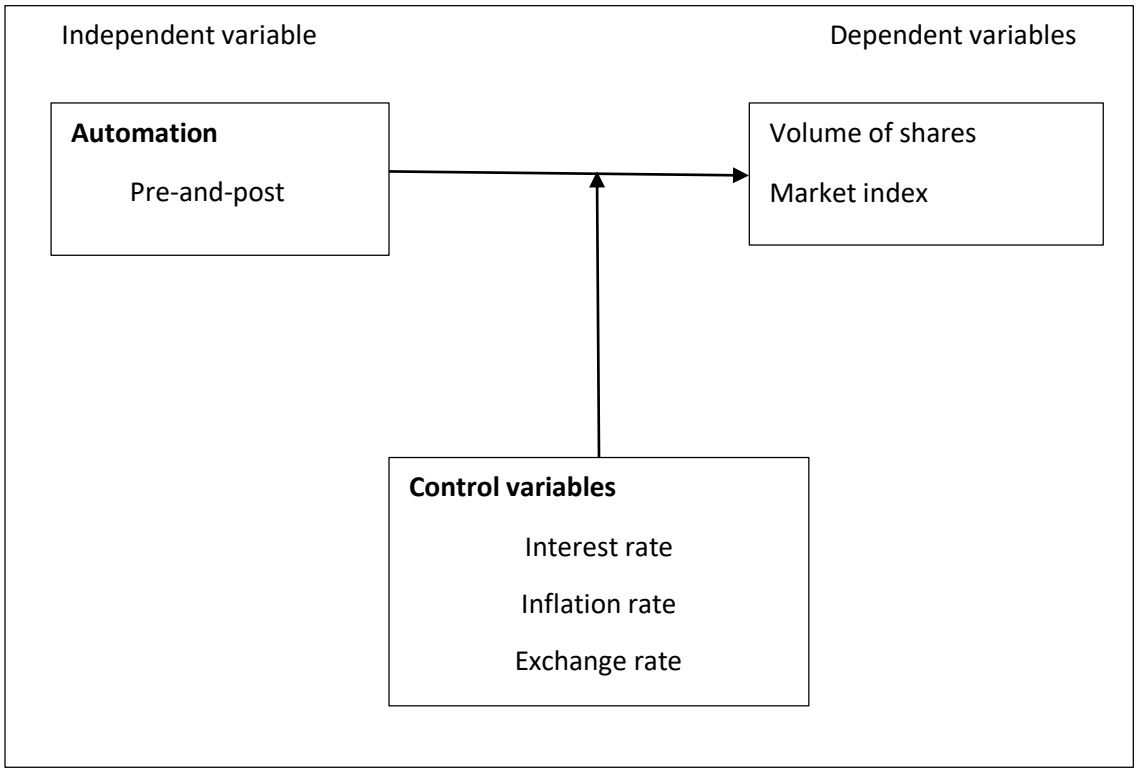

Fig. 2.1 Conceptual framework showing the relationship between automation and stock market performance

3.0 METHODOLOGY

This chapter focuses on the methodology of the study. It outlines the research design. In addition, the sources and type of data used, data analysis as well as statistical methods used are explained.

3.1 Research Design

This study adopts the exploratory design. It seeks to explore whether automation of the Ghana Stock Exchange carries any performance implications for the performance of the exchange. To this end, the study develops a multiple regression model and employs monthly time series data for analysis. Pearson correlation analysis and Variance Inflation Factor are used to diagnose the data for reliability of the results.

3.2 Sources and Type of Data Use

The study focuses wholly on secondary data from the Ghana Stock Exchange website (GSE), Ghana statistical service (GSS) and the Bank of Ghana (BOG) online database. The data include volume of stock traded before and after automation as well as monthly time series data spanning from the period

2005-2018: 1st January 2005 to 30th June 2007 (pre-automation period) and 1st July 2008 to 31st December 2018 (post-automation period). The data is considered reliable since the data is collected by them and are institutions charged with the responsibility.

To differentiate between the performance in the pre and post automation periods, estimations were done for the pre-automation and post automation periods. Since the automation process took some time before it was finally implemented as a result of some institutional and implementation challenges at the exchange, the periods of implementation was excluded. Therefore, the pre-automation period was taken as 54 months from 1st January 2005 to 30th June 2007, while the post automation period was taken as 54 months from 31st July 2008 to 31st December, 2018. In addition to the comparative analysis of the efficiency analysis, The researcher presents analysis of the overall efficiency of the exchange over the entire period from 1st January 2005 to 31st January December, 2018. The essence of this is to compare analysis of stock market efficiency that does not consider the impact of technology with stock market efficiency Analysis that considers the impact of technological change.

3.3 Data Analysis

Descriptive statistics such as percentages and charts are used in the analysis. Inferential statistics, mainly regression analysis, are used to analysis the impact of automation on trading volume and macroeconomic indicators (exchange, inflation and interest rate). The software use for analysis is Stata version 15.1 Correlational and Multiple Regression model are used for the analysis.

Table 3.1 Variables

Variables	Description	Notations
Dependent Variable Volume of Shares traded	Measures the monthly volume of shares traded at the GSE	VOL
GSE Stock market index	Measures the performances of the market.	GSE SMI
Independent Variable Automation	Measured by the dummy variable =1 when GSE was automated, =0 before GSE was automated.	D
Control Variables		
Inflation	Measured using the consumer price index.	INF
Interest rate	Interest rate measures the amount of interest due per period, as a proportion of the amount lent deposited or borrowed.	INT

Exchange rate	It measures the rate at which one currency can be traded for alternative currency. This rate changes frequently on global foreign exchange market where all types of currencies are traded	EXCH

3.4 Models and Estimation Techniques

The estimation technique used in this study is the multivariate regression technique. To measure the impact of automation on volume of stock traded, the following model is estimated

$$vol_e = a_0 + a_1 Int_t + a_2 Inf_t + a_3 Exch_e + a_4 D + \varepsilon$$

Where;

vol_e= Volume of shares traded

a_0= constant;

a_1 = coefficient

Int = Interest rate

INF= Inflation

Exch = Exchange rate

D = Dummy Variable

ε = error term

4.0 DATA ANALYSIS

In this chapter, the data collected for the study are analyzed. Before estimating the model developed for the study, some examination of the properties of the data is done. Some trend analysis of the volume of trade of the GSE is done to gauge the behavior of the exchange. After this, the model developed for the study is estimated.

4.1 Descriptive Statistics

The descriptive statistics of the data used for the study are presented in Table 4.1. The mean monthly volume of trade is GH¢20,074,745. However, the median of GH¢8,397,958 indicates that the exchange has recorded GH¢8,397,958 in most of the months under investigation. The median score of 1 for automation suggests that the data for the months after the automation of the GSE are more than the data before the automation of the exchange used in this study.

Table 4.1 Descriptive Statistics

	Volume	Exchange	Inflation	Interest	Automation
Mean	20074745	2.06	14.94	17.31	0.77
Median	8397958.	1.52	14.05	16.00	1.00
Maximum	1.29E+09	4.48	25.66	26.00	1.00
Minimum	23520.00	0.90	8.39	12.50	0.00
Observations	156	156	156	156	156

4.2 Correlation Analysis

Table 4.2 is the Pearson Correlation Matrix. It displays the correlation between pairs of variables chosen for the study. It is evident that automation and the control variables (inflation, exchange rate and

interest rate) positively load on volume of trade. In the case of automation, the interpretation is that some evidence has been establish to the effect that automation has improves the volume trade of the exchange. The positive correlations between volume of trade and the control variables (inflation, exchange rate and interest rate) suggest that variations in them are likely to positively drive the volume of trade on the GSE. The standard threshold common in the literature is that correlation between two right-hand side variables of a regression model should not be more than 0.80. Evidence in Table 4.2 indicates that the correlations between pairs of the right-hand side variables are within this acceptable threshold. However, it can be observed that the correlation between inflation and interest rate as well as exchange rate and interest rate exceeds this threshold which raises multicollinearity concerns. To address the possible bias of the results emanating from this problem two regression models are estimated. First, the impact of automation on the efficiency of GSE measured by the volume of trade is assessed by estimating a model in which inflation and exchange rate serve as the only control variables. In the second model, interest rate is used as the only control variable. This helps to gain a better insight into the impact of automation of the GSE on its efficiency.

Table 4.2 Pearson Correlation Matrix

	Volume	Automation	Inflation	Exchange	Interest
VOLUME	1				
AUTOMATION	0.10	1			
INFLATION	0.05	0.28	1		
EXCHANGE	0.20	0.52	0.58	1	
INTEREST	0.16	0.36	0.81	0.84	1

4.3 Trend Analysis of Volume of Trade

The volume of trade of Ghana Stock Exchange (GSE) trend is shown in Figure 4.1. There is a fluctuation in the volume of stocks trade over the last twelve years (2005-2017). A decline in volume traded was observed from 2005 to 2010. However, there was a slight rise in volumes traded in 2010, after which volumes traded recorded a downward trend in 2011 until 2012. After 2012, volumes traded have exhibited an inconsistent movement, increasing and dropping, however marginally up until 2016 where a sharp rise in volumes was observed. The observed fluctuating trend has the tendency of dampening investor confidence since there is an unceasing certainty in volumes traded and its gains. By implication of the unstable trend, volume of trade on the GSE will dwindle in the years.

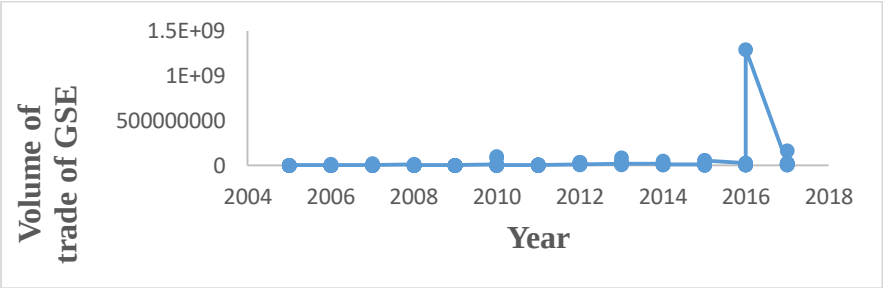

Figure 4.1 Distribution of volume traded on GSE (2005-2017)

4.4 Regression Results

This section is divided into two parts. Part one presents the results without interest rate as a control variable. Part two presents and discusses the results without inflation and exchange rate as control variables. The reason for this has been explained above. Apart from the given above, the results in part two the section will also be used to test the robustness of the results in part one.

4.4.1 Regression Results without Interest Rate

Table 4.3 presents the results when interest rate is excluded from the analysis. The R^2 of the model is 0.52 which suggests that about 52% variations in the volume are accounted for automation and the control variables in the model. The F-statistic of 41.00 at 1% significance level indicates that collectively the predictor variables in the model significantly influence volume of trade. It has been assumed that the current month's volume of trade is influenced by the previous month's volume of trade so a dynamic model has been estimated in which the one-month lag of volume of trade is included in the model as part of the explanatory variables. The positive and statistically significant impact of the one-month lag of volume of trade on the current month's volume of trade suggests persistency of the volume of trade performance of GSE. The results in Table 4.3 show that the coefficient of automation is positive and statistically significant at 1% significance level. The obvious implication is that the automation of the GSE has significantly improved the efficiency of the exchange. This is not surprising because automation comes with benefits such as reduction in transaction costs, easy access to information and speed of transaction.

Exchange rate has also recorded a positive and statistically significant coefficient. Indeed, the significance level of the coefficient is 1%. This is interpreted to mean that variations in exchange are likely to improve the efficiency of GSE. High exchange rate volatility in an economy is likely to attract foreign investors' shares in that economy because the superiority of their currencies over the local currency will mean that they can buy more shares with a small amount of money. The finding is consistent with a study by Prashanta and Bishnu (2008) who reveals that the rationale for the connection amid interest rate and stock market reoccurrence is that prices of stock and rate of interest negatively correlate. This means that advance interest rate decreases the value of equity; makes fixed earning securities more attractive as a substitute to holding stocks and may diminish the tendency of investors to borrow and invest in stocks.

In the case of inflation as a control variable, its coefficient is negative and statistically significant at 1% significance level. This is explained in terms of negative effects of inflation on the portfolio quality of investors. In the midst of high and unpredictable inflation, financial assets may not be attractive because inflation reduces the purchasing power of income earned on such assets unless they are effectively and efficiently priced. So in the midst of inflation volatility investors may invest less in shares. The finding is consistent with a study by Nwugi (2013) who examine the connection amid stock market volatility and the volatility of macroeconomic indicators and finds out that macroeconomic volatility in terms of inflation has a weak analytical influence for ordinary market volatility.

Furthermore, the finding is consistent with a study by Jhingan (2010) who finds that when there is inflation, most prices rise, though some rise faster than others. Similarly, the finding of the current study agrees with a study by Afolabi et al (2003) who establish that there is a connection amid inflation and rising prices of stock. According to Sogu (2005), the conditions that inflation rate expects to vary all other things being equal, positively in line to variations in stock prices; this is consistent with the findings from the present study. The finding is in agreement with a study by Wuyts (2007) who establish that a market is liquid if traders can quickly purchase or vend a huge number of shares without large price impact. This involves the readiness of a market participant to take the opposed side in a contract by another trader. The finding suggests that in evaluating the impact of inflation on stock prices, if there is a connection, one should assume a positive relationship amid inflation and the variation in stock prices. Furthermore, the result implies that the impact of inflation on stock market is also apparent from the point that it stimulates the rates of interest. If the inflation rate is high, the interest rate is also high. In a situation where inflation and interest rates are high, the creditor will have a propensity to recompense for the increase in interest rates being high.

Table 4.3 Regression Results: Dependent Variable- Log Volume of Trade

Variable	Coefficient	Std. Error	t-statistic	Prob.
Log Volume of trade(-1)	0.29	0.08	3.62	0.0004***
AUTOMATION	1.21	0.37	3.30	0.0012***
INFLATION	-0.08	0.03	-2.65	0.0090***
EXCHANGE	0.73	0.16	4.48	0.0000***
CONSTANT	9.42	1.10	8.55	0.0000***

R^2=0.52; F-statistic=41.00(0.0000)

N=155

*** represent 1% significance level

4.4.2 Regression Results with Interest Rate

The model developed for this study is estimated again but this time without inflation and exchange rate as control variables. Instead, interest rate is used as the only control variable. The reason for doing this is given above. Table 4.4 presents the results. The R^2 is 0.47. This suggests that the model is able to account for 47% variation in the volume of trade of GSE. The F-statistic of 44.08 significantly at 1% significance level indicates that the predictors in the model jointly and significantly explain the variations in the volume of trade of GSE. The persistency of the volume of trade performance of GSE is evident in the coefficient of the one-month lag of volume of trade being positive and statistically significant at 1% significance level. The result in Table 4.4 confirms that in Table 4.3 as far as automation is concerned. The coefficient of automation of GSE is positive and statistically significant at 1% significance level. This is indicative of the robustness of the result in Table 4.3 that the automation of the GSE improves its efficiency in terms of volume of trade. Interest rate has a positive coefficient but this is not statistically significant.

The finding is consistent with a study by Jaine, (2013) on the impact on real interest rate as a vital aspect on stock market performance, both in terms of market liquidity and activity and concludes that interest rate had an impact on stock exchange performance. Similarly, the finding was consistent with a study by Ehrmann and Fratscher (2004) on the response of equity markets to U.S. fiscal policy with an exceptional focus on relative contributions of credit and interest rate channel who finds out that fiscal policy affects individual stocks in intensely expanded manner. Again, the findings reecho with a study by Nwokoma (2002) on long- run association between market and some macroeconomic indicators and concludes that only industrial production and level of interest rates, as characterized by the 3-month commercial bank deposit rate have a long-run connection with the arcade. However, the finding is contrary to a study by Prashanta and Bishnu (2008) who finds out that the rationale for the connection amid interest rate and stock market reoccurrence is that prices of stock and rate of interest negatively correlate. The finding implies that advanced interest rate decreases the value of equity as postulated by the dividend discount model, makes fixed earning securities more attractive as a substitute to holding stocks and may diminish the tendency of investors to borrow and invest in stocks, and increases the cost of holding commercial and hence affects turnover.

Table 4.4 Regression Results: Dependent variable- log Volume of trade

Variable	Coefficient	Std. Error	t-statistic	Prob.
Log Volume of trade(-1)	0.44	0.07	6.07	0.0000***
AUTOMATION	1.38	0.38	3.63	0.0000***
INTEREST RATE	0.05	0.03	1.55	0.1229
CONSTANT	6.37	0.99	6.40	0.0000***
R^2=0.47; F-statistic=44.08(0.0000) N=155				

*** represent 1% significance level

4.5 Discussion of results between challenges of automation on Ghana stock exchange market

The third and last objective of the study tries to examine the challenges of automation on the Ghana stock exchange market. The multiple regressions are conducted to assess how the challenges identified influence automation (Table 4.5). There was a statistically significant association between the independent variable (automation) and dependent variables (exchange rate, inflation rate and interest rate) ($Adjuted\ \mathcal{R} - square = 0.723$). The adjusted R-square score of 0.723 indicates that approximately 75% of the total variability in automation is affected by the independent variables. The F statistics was used as a measure of good fit for the regression model. From the F-statistics score of F (3, 68) 62.634, $\rho = 0.000$). The regression model is therefore considered a good fit since the significance level is less than 0.05 (p=0.000). This means that the study accepts the alternate hypothesis that exchange rate, inflation rate and interest rate have a statistically significant impact on Ghana Stock Exchange Market.

Holding inflation rate and interest rate constant, there was a positive significant association between exchange rate and automation (performance of Ghana Stock Market) ($\beta = 1.826;\ \rho = 0.000$). This means that for every 1.826 increase in the exchange rate, there is 1.826 increases in the performance of Ghana Stock Exchange Market. The finding is consistent with a study by Benimadhu (2003) who finds out that the exchange precise problems upsetting stock markets are poor liquidity level, limited listed firms and the small size of the exchange. There was a positive significant association between inflation and automation holding exchange rate and inflation rate constant ($\beta = 0.044;\ \rho = 0.003$). This suggests that there is a 0.044 increase in the performance of the Ghana Stock Exchange Market for every 0.044-unit increase in inflation rate. The finding corroborate that inflation rate expects to vary all other things being equal, positively in line to variations in stock prices (Sogu, 2005). The finding implies that in a situation where inflation and interest rates are high, there is a propensity to recompense for the increase in interest rates being high.

Interest rate was negative but statistically significant with automation holding exchange rate and inflation rate constant ($\beta = -0.056;\ \rho = 0.044$). This means there is a 0.056 decrease in the performance of Ghana Stock Exchange Market for every unit increase in interest rate and vice versa. The finding is consistent with a study by Prashanta and Bishnu (2008) who reveals that the rationale for the connection amid interest rate and stock market reoccurrence is that prices of stock and rate of interest negatively correlate. This means that advanced interest rate decreases the value of equity; makes fixed earning securities more attractive as a substitute to holding stocks and may diminish the tendency of investors to borrow and invest in stocks.

The findings imply that macroeconomic policies of the economy over the last two decades have been characterized by volatile and generally high inflation, high interest rates and large exchange rate swings. These factors prevent investors from having a clear-cut visibility of the macro environment in the medium to long term investors.

Table 4.5 multiple regression of macroeconomic variables and automation

Automation	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Exchange	1.826	0.154	11.88	0.000	1.519	2.133	***
Inflation	0.044	0.015	3.03	0.003	0.015	0.073	***
Interest	-0.056	0.027	-2.05	0.044	-0.111	-0.001	**
Constant	-1.269	0.276	-4.61	0.000	-1.819	-0.719	***
Mean dependent var		0.500	SD dependent var		0.504		
Adj R-squared		0.723	Number of obs		72.000		
F-test		62.634	Prob > F		0.000		

**** p<0.01, ** p<0.05, * p<0.1*

4.5 Further Check

To further check the robustness of the finding that the automation of the GSE has improved its performance in terms of volume of trade, the model developed for the study is estimated again without the inclusion of any of the control variables. The outcomes are presented in Table 4.6. The outcomes suggest that the impact of automation of the GSE on the performance of the exchange is robust. The finding is consistent with a study by Yartey and Adjasi (2008) who finds out that automation decreases the inefficiencies in African markets and increase trading action and liquidity. Automated trading scheme also expedite processes as well as actions of exchanges and minimizes cost allied with the open outcry scheme (Yartey & Adjasi, 2008). The finding further agrees with a study by Venkataman (2001) who relates the NYSE (which has a trading floor) with Euro next Paris (fully screen based) for a section of related securities and concludes that spreads are lower on a floor base exchange than on an electronic exchange. The finding also agrees with a study by Theissen (2002) who offers direct proof by linking the floor and the screen-based trading scheme of the Frankfurt Stock Exchange, which functions in parallel and concludes that that automated trading scheme gives little spreads for liquid stocks.

Table 4.6 Regression Results: Dependent Variable- Log Volume Of Trade

Variable	Coefficient	Std. Error	t-statistic	Prob.
Log Volume of trade(-1)	0.47	0.07	6.49	0.0000***
AUTOMATION	1.50	0.37	4.04	0.0000***
CONSTANT	6.85	0.95	7.21	0.0000***
R^2=0.46; F-statistic=64.32(0.0000) N=155				

*** represent 1% significance level

5.0 SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

This chapter presents summary of findings, draws conclusion and makes recommendations. The chapter is accordingly divided into three sections. Section one summarizes the main findings of the study. Section two presents the conclusion of the study. In Section three, the recommendations of the study are made

5.1 Summary of Findings

Impact of automation on the Stock Market Efficiency: The study establishes that there is a positive impact of automation on stock market efficiency. Thus, automation helps to minimize the costs and inefficiencies in stock markets and increase trading activities and liquidity. This implies that automation improves on the efficiency of the stock market.

Impact of automation and macroeconomic Indicators on Volume of Stock Traded: Considering the impact of automation and macroeconomic indicators on the volume of stock traded, the study reveals that there is a positive impact of automation and exchange rate on the volume of stock traded. Similarly, interest rates have positive significant impact on the volume of stock traded. However, there is a negative significant impact between inflation rates and volume of stock traded. This implies that there is a significant difference between the volume of stock traded between the period of automation and before automation. The results of the analysis show a significant change in volume of stock traded since the inception of this new system of trading. The results also show that there is positive functional relationship between automation and the volume of stock traded. This implies that the rise or fall of the volume of stock traded is dependent on the functionality (operation) of the automation system. Although, the relationship between the volume of stock traded and automation has a lag function thus the relationship is significant. The study unearths that macroeconomic policies of the economy are characterized by volatile and generally high inflation, high interest rates and large exchange rate swings. These factors prevent investors from having a clear-cut visibility of the macro environment in the medium to long term investors.

Challenges of Automation on the Ghana stock exchange market: The challenges confronting the Ghana Stock Exchange (GSE) and stock market development are: Lack of education on the Automation Trading System and full installation and compliance to the system by industry players. However other challenges on the GSE includes: Outdated method of doing business, lack of efficiency, challenges of liquidity, limited number of securities, interest rate anomaly, small number of floating shares, non-performing companies, high cost of listing on the Stock Exchange, non-existence of credit rating agencies, and inadequate capitalization of Licensed Dealing Members and rigid regulations.

5.2 Conclusion

The study assesses the impact of automation on Stock Market performance. The study relies wholly on secondary data from the Ghana Stock Exchange website (GSE), Ghana statistical service (GSS) and the Bank of Ghana (BOG) online database. The data include Volume of stock traded before and after automation as well as monthly time series data from 2005-2018 which is analyzed with multivariate regression technique. Based on the findings of the study, it concludes that automation has an impact on market efficiency. It further concludes that there is a positive impact of automation, exchange rate and interest rate on the volume of stock traded. Again, the study concludes that the macroeconomic policies of the economy are characterized by volatile and generally high inflation, high interest rates and large exchange rate swings.

5.3 *Recommendations*

The trading instructions of the exchange must be changed to assist stockholders with the skill to make their own trading verdicts, independent of the services of a certified stockbroker. This has the benefit of accelerating transactions, minimizing commission charges, and improves market volumes and capitalization while improving rivalry in the market. This will also allow the exchange to respond quickly to varying trends in market basics in real time. Also, since efficiency thrives immensely on information flow, data on the exchange should be made easily accessible to the public especially potential investors so as to enhance the efficiency of the market. Again, continuous education and training should be conducted for stake-holders and industry players on the Automation Trading System of the GSE.

However, the recommendations inherent in this study can be implemented if the GSE strengthens the trading rules of the exchange. This will decrease the inefficiencies in African markets and increase trading action and liquidity. The recommendations can further be implemented if the GSE allows the automated trading scheme to expedite processes as well as actions of the exchanges and minimizes cost allied with the open outcry system.

5.3.1 Suggested Further Studies

Upon the results from the study, further studies could delve into the issues of automation by: employing adequate economic indicators and consider a wider period to strongly justify automation's impact on the Ghana Stock Exchange.

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APPENDICES

Data use for the analysis

Volume	Exchange	automation	Inflation	Interest	Years
140100	0.9	0	11.6	18.5	2005
101000	0.91	0	14	18.5	2005
42300	0.91	0	16.7	18.5	2005
32000	0.91	0	16.6	18.5	2005
121001	0.91	0	16.3	16.5	2005
52900	0.91	0	15.7	16.5	2005
1013100	0.91	0	14.9	16.5	2005
365001	0.91	0	14.7	16.5	2005
1432400	0.91	0	15	15.5	2005
1003110	0.91	0	15.4	15.5	2005
128300	0.91	0	15.3	15.5	2005
150100	0.91	0	14.8	15.5	2005
160300	0.91	0	14.6	14.5	2006
136100	0.91	0	12.1	14.5	2006
1109100	0.91	0	9.9	14.5	2006
229200	0.91	0	9.5	14.5	2006
52900	0.91	0	10.2	14.5	2006
128300	0.92	0	10.5	14.5	2006
185600	0.92	0	11.4	14.5	2006
36500	0.92	0	11.2	14.5	2006
235100	0.92	0	10.8	14.5	2006
188600	0.92	0	10.5	14.5	2006

14990900	0.92	0	10.3	14.5	2006
299000	0.92	0	10.5	12.5	2006
269700	0.92	0	10.9	12.5	2007
364800	0.93	0	10.4	12.5	2007
796800	0.93	0	10.2	12.5	2007
44900	0.93	0	10.5	12.5	2007
1633800	0.93	0	11	12.5	2007
10031100	0.93	0	10.7	12.5	2007
921500	0.93	0	10.1	12.5	2007
21091600	0.94	0	10.4	12.5	2007
417300	0.94	0	10.2	12.5	2007
129300	0.94	0	10.1	12.5	2007
3185600	0.94	0	11.4	13.5	2007
1424400	0.94	0	12.75	13.5	2007
8647300	0.98	1	12.81	13.5	2008
8396000	0.98	1	13.21	13.5	2008
97400	0.98	1	13.79	14.25	2008
955800	0.99	1	15.3	14.25	2008
15327600	1	1	16.88	16	2008
23520	1.03	1	18.41	16	2008
610900	1.07	1	18.31	17	2008
5956900	1.12	1	18.1	17	2008
2235900	1.13	1	17.89	17	2008
49100	1.16	1	17.3	17	2008
1237300	1.18	1	17.44	17	2008
64300	1.21	1	18.13	17	2008
607900	1.42	1	19.86	17	2009
137600	1.33	1	20.34	17	2009
913200	1.66	1	20.53	18.5	2009
2911600	1.53	1	20.56	18.5	2009
1405400	1.42	1	20.06	18.5	2009
485000	1.41	1	20.74	18.5	2009
1585300	1.4	1	20.5	18.5	2009
206600	1.39	1	19.65	18.5	2009
2362700	1.4	1	18.37	18.5	2009
1242753	1.4	1	18.04	18.5	2009
261779	1.41	1	16.92	18	2009
174533	1.41	1	15.97	18	2009
9358230	1.4	1	14.23	18	2010

3456700	1.41	1	13.32	16	2010
545000	1.38	1	11.66	16	2010
3155000	1.35	1	10.68	15	2010
15054000	1.34	1	9.52	15	2010
10530300	1.38	1	9.46	15	2010
14326700	1.4	1	9.44	13.5	2010
9352600	1.39	1	9.38	13.5	2010
87694300	1.4	1	9.38	13.5	2010
98765000	1.38	1	9.08	13.5	2010
1340544	1.39	1	8.58	13.5	2010
978689	1.4	1	9.08	13.5	2010
3648000	1.4800	1	9.1	13.5	2011
136100	1.4975	1	9.2	13	2011
101000	1.5003	1	9.1	12.5	2011
8396000	1.5008	1	9.0	12.5	2011
137600	1.5014	1	8.9	12.5	2011
545000	1.5031	1	8.6	12.5	2011
140100	1.5062	1	8.4	12.5	2011
8647300	1.5121	1	8.4	12.5	2011
1109100	1.5225	1	8.4	12.5	2011
9358230	1.5306	1	8.6	13	2011
8647300	1.5414	1	8.5	13.5	2011
545000	1.5460	1	8.6	12.5	2011
7626461	1.6144	1	8.7	14.5	2012
13311021	1.6635	1	8.6	15	2012
16253862	1.6791	1	8.8	15	2012
12366077	1.6989	1	9.1	15	2012
12151921	1.7346	1	9.3	14	2012
10905360	1.8762	1	9.4	14.5	2012
12932680	1.8804	1	9.5	14	2012
31207545	1.8843	1	9.5	14	2012
34641865	1.8900	1	9.4	15	2012
33571715	1.8891	1	9.2	14.5	2012
20890825	1.8769	1	9.3	14.5	2012
12275006	1.8785	1	8.8	14.5	2012
18518954	1.8824	1	8.8	15	2013
25577370	1.8848	1	8.8	16	2013
24025601	1.8928	1	8.8	16	2013
16942034	1.9057	1	8.8	16	2013

20227483	1.9203	1	10.9	16	2013
82645882	1.9446	1	11.2	15	2013
21219668	1.9490	1	11.4	15	2013
11812042	1.9528	1	11.2	15	2013
38785794	1.9579	1	11.7	16	2013
24720274	1.9884	1	13.1	16	2013
7489627	2.0604	1	13.1	16	2013
21059583	2.1099	1	13.5	15	2013
18552660	2.3209	1	18.9	18	2014
12521834	2.4463	1	19.0	18	2014
9965874	2.5843	1	19.2	19	2014
21799119	2.7399	1	20.6	21	2014
16619869	2.8600	1	20.0	21	2014
19970197	2.9500	1	20.3	18	2014
13548995	3.0192	1	23.1	18	2014
11074035	3.0650	1	24.0	18	2014
13118593	3.1818	1	24.1	19	2014
9998464	3.1964	1	24.0	21	2014
50215975	3.1973	1	24.1	18	2014
10110518	3.1973	1	23.9	18	2014
10255338	3.2182	1	23.0	21	2015
21289042	3.3609	1	23.0	22	2015
57131804	3.5909	1	23.1	24	2015
11739939	3.8122	1	23.2	26	2015
15614883	3.8932	1	23.4	23	2015
3307895	4.1865	1	23.6	25	2015
10682978	3.5322	1	24.6	26	2015
5465103	3.8588	1	23.4	26	2015
20510193	3.7815	1	23.2	21	2015
10276377	3.7640	1	23.0	22	2015
19121174	3.7898	1	23.2	25	2015
56033636	3.7948	1	23.3	26	2015
21647385	3.8063	1	25.5	26	2016
10836182	3.8714	1	24.5	26	2016
4440804	3.8510	1	25.7	25	2016
8399916	3.8199	1	24.8	25	2016
8941016	3.8665	1	25.0	23	2016
8784632	3.8824	1	24.1	25	2016
9931686	3.9389	1	21.2	25	2016

5074727	3.9449	1	21.5	25	2016
31345950	3.9563	1	21.6	26	2016
5843810	3.9665	1	19.4	26	2016
8530830	3.9718	1	18.7	25	2016
1290566489	4.0969	1	18.2	24	2016
19560794	4.2359	1	16.6	25.5	2017
161506242	4.3728	1	16.4	23.5	2017
31200817	4.4842	1	15.6	22.5	2017
9124698	4.1983	1	16.3	21	2017
18196038	4.2376	1	15.8	21	2017
11267542	4.3322	1	15.1	20	2017
7901264	4.3670	1	14.2	20	2017
17212814	4.3879	1	14.7	20	2017
9392230	4.4036	1	14.1	22.5	2017
12509109	4.3805	1	13.2	21	2017
17841085	4.3946	1	13.6	23.5	2017
7013135	4.4124	1	13.6	21	2017
6901786	4.4204	1	12.0	20	2018
107955790	4.4197	1	12.2	18	2018
18375377	4.4139	1	11.8	17	2018
34228824	4.4053	1	10.6	17	2018
15613093	4.4140	1	10.9	17	2018
24075171	4.4625	1	11.2	17	2018
13727012	4.6476	1	10.7	16	2018
970318	4.7083	1	10.8	16	2018
	4.7570	1	10.3	20	2018
	4.7922	1	9.8	18	2018
	4.7911	1	9.7	18	2018
	4.8147	1	9.8	18	2018