KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

KUMASI, GHANA

SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF MATHEMATICS

STRUCTURAL ANALYSIS OF STOCK PRICES AND SOME MACROECONOMIC INDICATORS IN GHANA

BY

OWUSU, LEVINA ANSONG

PG6323911

A THESIS SUBMITTED TO THE DEPARTMENT OF MATHEMATICS OF THE KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY IN PARTIAL FUFILMENT OF THE REQUIREMENT FOR THE AWARD

OF

MASTER OF SCIENCE DEGREE IN INDUSTRIAL MATHEMATICS

MAY, 2014

DECLARATION

I hereby declare that, this submission is my own work towards the Master of Science in Industrial Mathematics and that to the best of my knowledge, it contains no material previously published by another person or material which has been accepted for the award of my degree by this or any other university except where due to acknowledgement has been made in the text.

Owusu, Levina Ansong (PG6323911) …………….. ……………..

(Name of Student and ID) **Signature** **Date**

Certified By:

Dr. Gabriel A. Okyere ……………… ………………

(Supervisor) **Signature** **Date**

Certified By:

Prof. S.K. Amposah …………… …………..

(Head of Department) **Signature** **Date**

ACKNOWLEDGMENT

I sincerely thank the Almighty God for the gift of life. It is always a lovely but risky exercise thanking people. There is the possibility that someone who deserves thanks may be overlooked. First, I am most grateful to my supervisor, Dr. Gabriel Okyere whose suggestions and advice contributed greatly to the writing of this research work.

To my lecturers at K.N.U.ST especially Prof. S.K. Amponsah, Dr. Osei Frimpong, Dr. Coffie, I say thank you for the knowledge you imparted into me. Not forgetting my parents Mr. George Owusu Ansong, Miss Lucy B. Asamani and Miss Vida Tiwaa for their motivation and support in diverse ways.

Next, I am grateful to the Assistant Headmistress of Aburi Girls' Senior High School, Mrs. Akko –Addo and the entire staff for their support. I also acknowledge with thanks the relentless efforts of Mr. Matthew Ali Cheffa, for the various help, prayers and guidance he provided me.

To my friends, loved ones and my cherished siblings, I say thank you. Finally, to Dr. Yaw Okraku – Yirenkyi, Pastor Francis McCarthy and wife, I say God bless you for your prayers, guidance and support.

DEDICATION

I dedicate this research of mine to the Almighty God who has been my source of strength and shield throughout this stressful moment of my life. I also dedicate this piece in honour of my parents, siblings, Mr. Matthew Ali Cheffa and friends who have been there for me throughout my course of study.

ABSTRACT

Capital markets play a significant role in the financial sector of every economy. Through stabilization of the financial sector and the provision of important investment channels that contribute to attract domestic and foreign capital, an efficient market can promote economic growth and prosperity. This study investigates the relationship between stock prices and macroeconomic factors in Ghana using monthly data covering the period November, 1990 to June, 2011. The study employed the celebrated multivariate Vector Auto regression (VAR) models to establish the linkage between stock prices and macroeconomic factors. Additionally, the Granger causality analysis was used to examine the direction of causality between stock prices and the various macroeconomic factors. It was found that interest rate and inflation are the key macroeconomic factors that determine stock prices in Ghana within the period. Furthermore, it was found that with the exception of inflation and interest rate, no other macroeconomic variable specified in the model Granger causes stock prices. Indeed, causality does not also run from stock prices to these variables. Additionally, forecasting GSE index using macroeconomic variables was somewhat difficult since they are affected considerably by economic policies. . The immediate corollary of the results therefore is that, perhaps the Ghana Stock market might be sensitive to global macroeconomic factors other than the internal ones. Thus the economic policies of Ghana need to be properly and utterly synchronized thus brought to line with global macroeconomic and financial conditions. Incidentally, this policy direction would mean that, controlling domestic policies alone is not enough for the determination of stock prices in Ghana.

TABLE OF CONTENTS

CONTENTS **PAGES**

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Capital markets which are markets for buying and selling at long term debts or equity backed securities, play a significant role in the financial sector of every economy. Through stabilization of the financial sector and the provision of important investment channels that contribute to attract domestic and foreign capital, an efficient market can promote economic growth and prosperity. Indeed, capital market efficiency means the unanticipated portion of the return on security is unpredictable, and over a sufficient number of observations does not differ systematically from zero. The unanticipated portion is the actual return less what was expected based on some fundamental analysis.

According to Fama (1990), a market is efficient if prices rationally, fully, and instantaneously reflect all relevant available information and no profit opportunities are left unexplained. In an efficient market, past information is of no use in predicting future prices and the market should react only to new information. However, since this is unpredictable by definition, price changes or returns in an efficient market cannot be predicted. Fama (1990) also defined market efficiency in the forms of weak, semi-strong, or strong. The weak-form of market efficiency means the unanticipated return is not correlated with previous unanticipated returns, thus the market has no memory and knowledge of past returns, and they have no bearing on determining future returns. Semi-strong market efficiency means market returns are not correlated with any publicly available information. And lastly, with the strong-form of market efficiency, the unanticipated return is not correlated with any information be it public or insider since all available information is already being reflected in present returns.

The stock market significantly plays principal role to the financial sector or intermediation in both developing and developed countries by channeling idle funds thus, monies not being used to yield financial returns, from surplus to deficit units in an economy. A developing economy requires more resources to sustain the rapid expansion. As a result, the stock market serves as an important tool in the mobilization and allocation of savings among competing users which are critical to the growth and efficiency of the economy (Alile, 1984). Through mobilization of resources the stock market promotes economic growth by providing avenue to pull large and long term capital through issuing of shares and stocks and other equities for industries in desperate need of finance to expand their business. Thus, the overall development of the economy is a function of how well the stock market performs and empirical evidences have proved that development of the capital market is an essential condition for economic growth. While developed economies have fully explored the mobilization of resources through the capital market, the developing countries are yet to fully enjoy the benefits of raising capital via the capital market.

A number of macroeconomic variables have been identified to influence share prices in the stock market. Consequently, the relationship between macroeconomic variables and shares prices has been comprehensively explored by both economists and financial analysts. In Ghana, just as in many other contemporary scenarios, the increasing integration of the financial markets and implementation of various stock market reforms has incidentally placed substantial significance on the activities of the stock market. Thus, in line with the theoretical exposition, a country's financial market is efficient when prices reflect the fundamentals and risks of that country, rather than the fundamental risks of other countries. Consequently, the informational efficiency of national stock markets has been extensively examined through the study of the causal relationship between stock price indices and macroeconomic aggregates. It can therefore, be argued that, if real economic activity affects stock prices, then an efficient stock market instantaneously reacts and incorporates all available information about economic variables. The rational behavior of market participants ensures that past and current information is fully reflected in current stock prices. As such, investors are not able to develop trading rules and, thus may not consistently earn higher than normal returns. Therefore, it can be concluded that, in an informationally efficient market, past (current) levels of economic activity are not useful in predicting current (future) stock prices.

1.2 Problem Statement

Ghana embarked on economic reforms (Economic Recovery Programme) in 1983, having found herself on the brink of collapse with inflation hovering around 123 percent and other worse economic conditions. The Ghana Stock Exchange which was established as part of the reforms and practically started operations in 1990 was to enable corporate institutions and government to raise quick capital to accelerate development in order to reduce undue reliance on donors. It is becoming increasingly curious to examine the performance of the Ghana Stock Exchange (GSE) since its establishment. In the quest to perform well, several factors come to play in determining the stock prices of the GSE. However, studies have been done to determine the performance and relationship between the stock prices using different approaches. Thus Kyereboah-Coleman and Agyire- Tetteh, (2008) and Frimpong (2009) established the relationship using the cointegration approach without taking into accounts the possibility of external shocks.

The present study therefore seeks to utilize monthly data to determine the relationship between macroeconomic variables and stock prices in Ghana with implications on the efficiency of the Ghana Stock Market, using the most celebrated Vector Auto regression method. Furthermore the study seeks to account for the effects of possible external shocks (oil prices) for which other studies have failed to do. In addition, the long term behavior of the variables will be looked at. Lastly, the study seeks to perform a causality analysis of the stock prices and the indicators taking into account the contribution of the real economic activity in determining the stock prices in Ghana for which other studies have not done.

1.3 Objectives of the Study

The primordial objective of this study is to investigate the correlation and causal relationship between stock market and real macroeconomic variables. The specific sets of objectives of the study are:

1. To determine the relationship between stock market index (GSE all share index) and macroeconomic variables using the Multivariate Vector Auto regression model.
2. To analyze the trends in GSE all share index over the period under consideration.

3. To examine the direction of causality between stock market index and macroeconomic economic variables, that is, is it unidirectional or bidirectional.
4. To analyse the long term behavior of the variables.
5. To suggest appropriate policy measures arising from the empirical findings to aid in the efficient operation of the Ghana Stock Market.

1.4 Research Questions

The study seeks to find answers to the following questions:

1. What is the causal impact of the key macroeconomic variables on stock prices in Ghana?
2. Do the macroeconomic variables significantly affect stock prices jointly or individually?
3. Do stock prices Granger-cause macroeconomic variables or the reverse?

1.5 Significance of the Study

The study of the relationship between stock prices and macroeconomic factors in Ghana will provide investors and potential investors a guide to understanding the changes and how macroeconomic variables affect the stock market. Thus, it will guide them to make correct investment decisions as they observe variations in the macroeconomic factors. Moreover the findings of the study would serve as a documentary guide which consequently would assist policymakers in their decision as to which particular sector of the economy should be concentrated. Mention can also be made to the fact that, though a large body of the literature has examined the same relationship, this study provides new evidence with the inclusion of oil prices to capture the effect of possible external shocks as well as real output. Consequently, this study having filled in this lacuna or gap, may also evoke the interest for further studies in a more micro-oriented fashion where the same relationship can be examined on a case study basis.

1.6 Method of Study

1.6.1 Data Type

The study of the relationship between stock prices and macroeconomic variables is tracked mainly in a time series framework. Thus, secondary macroeconomic time series data as well as data on GSE all share index are used in the analysis. All data used in the study are taken from International Financial Statistics of the IMF, Bank of Ghana and other augmenting sources.

1.6.2 Data Analysis

The data obtained will be analyzed both descriptively and quantitatively. Trend analysis of the key variables of interest will basically be used in the descriptive analysis. Furthermore, a multivariate Vector Auto regression (VAR) as well as Granger Causality Test will be used to establish the relationship mentioned therefore. Specifically, the multivariate cointegration approach which is done in the framework of VAR is employed, and subsequently tests for possible feedback effects. All estimations are carried out using Stata Data Analysis and Statistical software.

1.7 Scope of Study

The study will utilize time series monthly data spanning from the period 1990:11 through to 2011:06, thus making use of 248 data points enough for effective time series regression analysis. Also, other macroeconomic variables were not included because data are not readily available in monthly units. The monthly dataset is perhaps good in time series since its frequency is high and thus provides enough data points to capture much variability in the variables used.

1.8 Organization of the Study

The study is organised in five chapters. Chapter one comprises of the background of the study, problem statement, objectives of the study, research questions, significance of the study, method of study, scope of the study and the organisation of the study; chapter two presents a review of the relevant literature on stock prices and macroeconomic variables both theoretically and empirically. Chapter three concentrates on the appropriate methodology to be used in the study. It essentially provides the basic means upon which all the estimations could be carried out. It also details the description of the variables and the empirical strategy. Chapter four presents the data type and sources. It also analyses and discusses the empirical results. The last chapter presents the findings from the data analysis, offers some policy recommendations and concludes.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter theoretically reviews the relationship between macroeconomic variables and stock prices; as well as the empirical studies that have been done on the same relationship. Thus, the theoretical relationship between each macroeconomic variable and stock prices; as well as the empirical evidence on each pair have been carefully reviewed in this chapter.

2.1 The Relationship between Macroeconomic Factors and Stock Returns

As for instance, psychologists suggest that the success or failure of an individual can be caused by his or her social, economic, and family environment, the same idea can be extended to the valuation of securities of a firm. Thus, economic and industry environment as well as the analysis of individual companies or stock should be a matter of concern on the valuation process (Reilly and Brown, 2006 p. 361). Therefore, the top-down (the three-step) approach discerns the importance of the economic and industry environment on the valuation process contrast to the bottom-up approach. Whiles the top-down approach is of the belief that, both the economy and industry significantly affect the total returns for individual stocks, regardless of the qualities of a firm; the bottom-up approach argues that, it is possible to find stocks to provide superior returns regardless of the economy and industry outlook. Empirically, however, most academic studies investigating the effects of economic factors on stock returns have supported the top-down investment approach. Aside the individual quality and profit potential of firms, economic environment and performance of a firm influence the value of a security and its rate of return.

The theoretical stock valuation models such as Dividend Discount Model (DDM), Free Cash Flow Valuation, and Residual Income Valuation are essentially used to explain the nexus or relationship between stock prices and macroeconomic variables. According to the models, the current prices of an equity share is approximately equal to the present value of all future cash flows; thus any economic variable affecting cash flows and required rate of return in turn influences the share value as well.

Furthermore, theory postulates that the volatility of stock returns increase during economic recessions and decrease during recoveries. Schwert (1989) reports that, stock market volatility is higher during recessions. Moreover, the study reveals that, there is weak evidence that macroeconomic volatility can help predict stock volatility, whereas there is strong evidence that financial asset volatility helps predict future macroeconomic volatility. Moore (1983) also shows that in most cases, the general level of stock prices has been much higher at the top of an economic boom than at the bottom of an economic recession in the USA. The study further argues that, the turn in stock prices occur prior to the turn in business activity. Consequently, stock prices are stated to lead the swing in the business cycle, and stock price indices are "leading indicators."

2.2 Relationship between Stock Prices and Interest Rate

Theoretically, the literature has espoused a negative correlation between interest rates and stock prices. Several reasons account for such indirect relationship between these two variables. In an equity valuation process, a discount rate is first determined. A chosen discount rate reflects both the time value of money and the riskiness of the stock. The risk free rate represents the time value of money. A risk premium represents compensation for risk, measured relative to the risk free rate. A decided discount rate is perceived by an investor as a required rate of return (Stowe et al., 2007, p. 47). The Capital Asset Pricing Model (CAPM) is one of the methods to determine the required rate of return (which might be made of two parts: the risk-free rate and the risk premium).

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] \quad (1)$$

where $E(R_i)$ is the expected return on asset *i* given its beta; R_f is the risk-free rate of return; $E(R_m)$ is the expected return of the market portfolio and β_i is the asset's sensitivity to returns of the market portfolio.

Equation (1) describes the relationship between risk and expected return, and the calculated required rate of return is applied to the pricing of risky securities. That is, it is very crucial to determine the required rate of return in the process of stock value. This is because changes in interest rates affect the theoretical value of shares through affecting the investor's required rate of return. Dividend Discount Model can be applied to determine the value of shares.

$$V_0 = \sum_{t=1}^{\infty} \frac{D_t}{(1+r)^t} \quad (2)$$

where V_0 is the present value of dividends, and r is the required rate of return.

The risk-free rate will change, consequent upon the government adjusting the key interest rates. There is thus a positive link between interest rate and the risk-free rate, that is, an increase in interest rate increases the risk-free rate as well which would invariably result in the higher market rate. If nothing else changes, the stock's target price should drop due to the higher required rate of return; and the opposite holds. If the interest rates fall and everything else is held constant, the stock's target price should rise because the required rate of return has dropped. Moreover the required rate of return will rise if the risk premium increases.

Again, a company's operation can be affected by interest rates. Any increase in the interest rate, all things being equal, will raise the cost of capital. Thus, it daunts on the company to work harder in order to generate higher returns in a higher interest environment. This action by the company is required to offset the effect of the inflated interest rate expenses which can potentially consume all its profits. Furthermore, if interest rate costs shoot up to such a level that the company is having problems paying off its debt, then its survival may be threatened. In that case, investors will demand an even higher risk premium. As a result, the fair value will fall even further.

The relationship between interest rates and market returns is anticipated to be a negative one either through the inflationary or discount factor effect. Empirically, a plethora of studies have tested this relationship. Humpe and Macmillan (2007) found a negative correlation between stock prices and long term interest rate in the United States and Japan. The same relationship has been tested over emerging markets as well. Al-Sharkas (2004) and Adam and Tweneboah (2008) indicate a negative and significant relationship between stock prices and interest rates for Jordan and Ghana respectively. Maysami et al. (2004) also found that, short and long-term interest rates respectively have significant positive and negative relationships with the Singapore's stock market. Ozturk (2008) also reports that only the lagged overnight interest rate does Granger cause stock returns while stock returns do Granger causes treasury interest rate and overnight interest rate. The empirical results of Muradoglu and Metin (1996) indicate that growth rates of interest rates negatively affect stock returns with a significant lag in short run dynamic model in the case of Turkey. Also, Yildirtan (2007) indicates the real interest rate on deposits and interest rate differential variables have an extremely weak, negative relation with stock returns in Turkey. The studies for both developed and emerging markets report negative relationship between stock returns and interest rate, which is consistent with the theory.

2.3 Relationship between Stock Price and Money Supply

Monetary policy influences the general economy through a transmission mechanism. Both a contractionary and an expansionary monetary policy might have bilateral effects. In the case of the latter, the government creates excess liquidity by engaging in open market operation, which results in an increase in bond price and lower interest rates. The lower interest rate would lead to the lower required rate of return and thus, the higher stock price. Moreover, an increase in monetary growth indicates excess liquidity available for buying stocks, eventually resulting in higher stock prices due to an increase of demand to both common stocks and the real good markets. However, monetary growth might result in higher inflation and hence, higher nominal interest rate according to Fisher equation. The higher interest rate leads to the higher required rate of return, which will result in the lower stock price.

Considering the contractionary monetary policy, to reduce the growth rate of money supply would result in a decrease in the supply of funds for working capital and expansion for all business. Additionally, a contractionary monetary policy would raise market interest rate and hence firm's cost of capital. Furthermore, an increase in interest rate would make it more expensive for individuals to finance mortgages and the purchase of other durable goods. However, a decrease in money supply might result in the lower inflation, hence the lower required rate of return via the lower nominal interest rate. Thus, this would lead to the higher stock prices.

In literature, the initial studies generally imply that changes in the growth rate of the money supply could serve as a leading indicator of stock price changes, while subsequent studies questioned these findings (Reilly and Brown 2006, p. 362). Beltratia and Morana (2006) indicate a twofold linkage between stock market (S&P 500) and macroeconomic volatility. They suggest that discrete changes in monetary policy, affecting the volatilities of interest rates and money growth, seem to be the best candidate to account for breaks in the volatility of stock returns and therefore to explain the level and discrete jumps in volatility. Furthermore, while stock market volatility also affects macroeconomic volatility, the causality direction is strong from macroeconomic to stock market volatility. Flannery and Protopapadakis (2001) studying NYSE-AMEX-NASD point out that money supply is a strong risk factor candidate. A monetary aggregate (generally M1) affects both returns and conditional volatility. Fama (1981), Geske and Roll (1983) point out that stock returns are negatively related to money supply. Errunza and Hogan (1998) indicate money supply volatility does Granger cause return volatility for German and France but not for Italy, Netherlands, UK, Switzerland and Belgium. Humpe and Macmillan (2007) report that Japan stock prices are influenced negatively by the money supply, while there is an insignificant (although positive) relationship between US stock prices and the money supply.

The results of studies for emerging markets are contradictory. For Amman Stock Exchange, Maghayereh (2002) indicates the coefficient of money supply (M1) is negative but not statistically significant at the 10 % level, whereas Al-Sharkas (2004) shows that money supply (M2) has a positive effect on stock returns. Maysami *et a*l. (2004) reveal the positive correlation between changes in money supply (M2) and Singapore’s stock returns. Abugri (2008) reports that the responses of returns to money supply are negative and significant in Brazil and Argentina, while the responses of returns in Mexico and Chile to money supply appear to be insignificant in explaining the movement of returns. Nishat and Shaheen (2004) indicate that Karachi Stock Exchange Index and money supply (M1) are cointegrated and two long-term equilibrium relationships exist between these variables. Additionally, the results of the study indicate money supply does Granger-causes stock price movements.

The empirical results of Muradoglu and Metin (1996) indicate that money supply is positively related to stock returns in short run dynamic model. Yildirtan (2007) reveals that an increase in money multiplier positively and strongly affects ISE 100 Index. However, Karamustafa and Kucukkale (2003), Kandir (2008), and Tursoy *et* *al*. (2008) indicate that there is no significant pricing relationship between the stock return and money supply. Additionally, the results of Muradoglu *et al*. (2001) display no cointegrating relationship between stock prices and any of monetary variables or groups of variables of concern for whole research period (1988- 1995).

Furthermore, Karamustafa and Kucukkale (2003) point out the stock price is neither the result variable nor the cause variable of money supply, while the results of Ozturk (2008) indicate that money supply does not Granger cause the stock returns but the stock returns do Granger causes Central Bank Money. Since the results of the empirical studies are conflicting, the actual relationship between money supply and stock prices is thus an empirical question and the effect varies over countries and time.

2.4 Relationship between Inflation and Stock Price

At the process of stock valuation, it is important to consider the effects of inflation on stock prices because inflation rates vary around the world and over time. In theory, stocks should be inflation neutral, and rising inflation should have no impact on stock valuations. Fisher (1930) noted that the nominal interest rate *r* can be expressed as the sum of expected real return ρ and expected inflation rate *E*(*I*).

Linear approximation: $r \approx \rho + E(I)$

Exact methodology: $(1+r) = (1+\rho)*(1+(E(I))$

The nominal interest rate is observed in the marketplace and is usually referred to as the interest rate, while the real interest rate is calculated from the observed interest rate and the forecasted inflation. It is argued that real interest rates are stable over time. Therefore, fluctuations in interest rates are caused by revision in inflationary expectations, not by movements in real interest rates. As Irving Fisher (1930) noted, nominal interest rate is decomposed into an expected real rate and an expected inflation component. Fisher argued that the expected real return is determined by real factors, and is unrelated to expected inflation. That is, real rates of return on common stocks and expected inflation rates are independent and that nominal stock returns vary in a one-to-one correspondence with expected inflation. Gultekin (1983) testing the generalized Fisher hypothesis for 26 countries for the period of 1947-1979, could not find a reliable positive relation between nominal stock returns and inflation rates. Moreover, the findings of the study reveal that regression coefficients are predominantly negative.

A negative relationship between inflation and stock prices is contended in literature because an increase in the rate of inflation is accompanied by both lower expected earnings growth and higher required real returns. In the US, there is substantial empirical evidence that high inflation is associated with a high equity risk premium and declining stock prices (Hoguet, 2008). Rising inflation is apt to restrictive economic policies, which in turn increases the nominal risk-free rate and hence raises the required rate of return in valuation models.

Mention can also be made to the fact that, inflation has a distorting effect on reporting earnings when historical costs are used in accounting. Reported earnings based on depreciation recorded at historical cost as an estimate of replacement costs gives an overstatement of earnings. Similarly, a first in first out (FIFO) inventory system leads to understatement on inventory costs and an overstatement of reported earnings. So, a company operating in a high-inflation environment will be penalized if it cannot pass through inflation (Solnik and McLeavey 2009, pp. 242-244). Sharpe (1999) argued that “A one percentage point increase in expected inflation is estimated to raise required real returns about one percentage point, which amounts to about a 20% decrease in stock prices.” Fama and Schwert (1977) show that the USA common stock returns are negatively correlated to the expected component of the inflation rate, and probably also to the unexpected component. Fama (1981) hypothesize that the negative relations between real stock returns and inflation observed during the post-1953 period were the consequence of proxy effects. Stock returns are determined by forecasts of more relevant real variables, and negative stock return-inflation relations are induced by negative relations between inflation and real activity. Saunders and Tress (1981) indicate that Australian nominal stock returns and inflation are related in a significantly negative fashion, implying that stocks are extremely poor inflationary hedges for the investor. In addition, the study indicates a mainly unidirectional relationship between inflation and stock returns, with price level charges leading the equity index in time.

Similar to developed markets, Naka, Mukherjee and Tufte (1998) for India and Nishat and Shaheen (2004) for Pakistan indicate that inflation is the largest negative determinant of stock prices. Additionally, Nishat and Shaheen (2004) indicate inflation does Granger-cause stock price movements in Pakistan. Maghayereh (2002) and Al-Sharkas (2004) also show reliable negative relationship between Jordanian stock prices and inflation. However, Firth (1979) for UK, Maysami *et al.* (2004) for Singapore, and Adam and Tweneboah (2008) for Ghana report a significant positive relationship between inflation (CPI) and stock returns. These results provides a sharp contrast to empirical works that have found a significant negative relationship between stock returns and expected inflation.

The long-run steady state results of Muradoglu and Metin (1996) indicate that the negative relation between Turkish stock prices and inflation persists when other monetary variables are included in the model. Ozturk (2008) reveals that there is no causal relationship between inflation and stock returns in Turkey. Analysis of Kandir (2008) points out that inflation rate is significant for only three of the twelve portfolios, while the regression results of Tursoy *et al.* (2008) indicate that there is no significant pricing relationship between the stock return and inflation. Rjoub *et al*. (2009) indicate the unanticipated inflation has a positive effect on the returns of the constructed portfolios. As Gultekin (1983) indicates, the relationship between stock returns and inflation is not stable over time and that there are differences among countries regardless of either developed or emerging markets.

2.5 Relationship between Stock Price and Exchange Rate

There is no theoretical consensus on the existence of relationship between stock prices and exchange rates nor on the direction of the relationship. However, in the literature, two approaches have been asserted to establish a relationship between exchange rate and stock prices: The goods market model (known typically as 'flow-oriented' model) and the portfolio balance model (known as 'stock-oriented' model).

First approach is referred to Dornbusch and Fisher (1980) focusing on the association between the current account and the exchange rate. Dornbusch and Fisher (1980) developed a model of exchange rate determination that integrates the roles of relative prices, expectations, and the assets markets, and emphasis the relationship between the behaviour of the exchange rate and the current account. Dornbusch and Fisher (1980) argue that there is an association between the current account and the behaviour of the exchange rate. It is assumed that the exchange rate is determined largely by a country's current account or trade balance performance. These models posit that changes in exchange rates affect international competitiveness and trade balance, thereby influencing real economic variables such as real income and output. That is, goods market model suggests that changes in exchange rates affect the competitiveness of a firm, which in turn influence the firm's earnings or its cost of funds and hence its stock price. On a macro level, then, the impact of exchange rate fluctuations on stock market would depend on both the degree of openness of domestic economy and the degree of the trade imbalance. Thus, goods market models represent a positive relationship between stock prices and exchanges rates with direction of causation running from exchange rates to stock prices. The conclusion of a positive relationship stems from the assumption of using direct exchange rate quotation (Stavarek, 2004). Direct quotation defines exchange rate as the price of one unit of foreign currency in domestic currency terms. Thus domestic currency depreciation means an increase in exchange rate.

On the other hand, portfolio balance models put much more stress on the role of capital account transactions (Tahir and Ghani, 2004). Portfolio balance model assumes a negative relationship between stock prices and exchange rates. A rise in domestic stocks prices would attract capital flows, which increase the demand for domestic currency and cause exchange rate to appreciate. A rising stock market leads to the appreciation of domestic currency through direct and indirect channels. A rise in prices encourages investors to buy more domestic assets simultaneously selling foreign assets to obtain domestic currency indispensable for buying new domestic stocks. The described shifts in demand and supply of currencies cause domestic currency appreciation. The indirect channel grounds in the following causality chain. An increase in domestic assets prices results in growth of wealth that leads investors to increase their demand for money, which in turn raises domestic interest rates. Higher interest rates attract foreign capital and initiate an increase in foreign demand for domestic currency and its subsequent appreciation (Stavarek, 2004).

Actually, changes in exchange rate affect exporter and importer firms conversely. In case of a depreciation of the domestic currency, imported products suddenly become more expensive in terms of the home currency. If this price increase can be passed through to customers, earnings will not suffer from the currency adjustment. But this is often not the case. First, the price increase will tend to reduce demand for these imported products. Second, locally produced goods will become more attractive than important goods, and some substitution will take place (Solnik and McLeavey 2009, p. 244). Therefore, the shares of importer firms will decrease, whereas the shares of exporter become more valuable.

Stavarek (2004) reports that neither the intensity nor direction of causal relationship is the same in the developed economies and the new EU-member countries. Obben *et al*. (2006) imply that there is bidirectional causality in the foreign exchange and New Zealand stock markets both in the short run and in the long run.

As to emerging markets, the results of Abugri (2008) reveal that the response of Brazilian and Mexican stock returns to an exchange rate shock are negative and significant, while neither in Argentina nor Chile stock returns responds significantly to exchange rates. Adam and Tweneboah (2008) show that there is negative relationship between Ghana stock market and exchange rate, while the results of Maysami *et al*. (2004) for Singapore support the hypothesis of a positive relationship between exchange rate and stock returns.

Tabak (2006) indicates that there is no long-run relationship, but there is linear Granger causality from stock prices to exchange rates, in line with the portfolio approach Brazilian stock prices to exchange rates with a negative correlation. Furthermore, the study shows evidence of nonlinear Granger causality from exchange rates to stock prices. The study of Horobet and Ilie (2007) offer contradictory results for Romania. While the application of the Engle-Granger methodology indicates no cointegration between the exchange rates and the stock prices, the use of the Johansen-Juselius procedure suggests the presence of cointegration between the two stock market indices and the exchange rates, either nominal bilateral, nominal effective or real effective rates.

In the case of Turkey, the empirical results of Muradoglu and Metin (1996) indicate stock returns are expected to increase as exchange rates increase. The findings of the Yucel and Kurt (2003) reveal that export companies' mean exposure coefficient is higher than non-export companies' mean exposure, indicating that exposure pattern of export and non-export companies are different. Furthermore a depreciation of domestic currency leads to an increase in the value of export firms. The results of Kasman (2003) provide evidences that a log-run stable relationship between stock indices and exchange rates exists. Furthermore, the study reports inconclusive evidence where causality relationship exists for both ways between the composite index and exchange rates, financial sector index and exchange rates, and service sector index and exchange rate. Moreover, causality relationship exists from the exchange rate to the industry index in a unique direction. Karamustafa and Kucukkale (2003) point out that the relations between stock returns and exchange rate is uncertain, indicating that the Istanbul Stock Exchange (ISE) is neither the result variable nor the cause variable of exchange rate variable. Likewise, the findings of Ozturk (2008) point out that, there is no causal relationship between stock retuns and exchange rate. The empirical results of Aydemir and Demirhan (2009) indicate that there is bidirectional causal relationship between exchange rate and all stock market indices. While the negative causality exists from the ISE-100, services, financial and industrial indices to exchange rate, there is a positive causal relationship from technology indices to exchange rate. On the other hand, negative causal relationship from exchange rate to all stock market indices is showed. Yildirtan (2007) shows that there is no relation between the deviations of real exchange rate from trend, average deviation of real exchange rate variables and the ISE-100. The real exchange rate also point out an extremely weak, negative relation. Analysis of Kandir (2008) points out that exchange rate seems to affect all of the portfolio returns, while the regression results of Tursoy *et al*. (2008) indicate that there is no significant pricing relation between the stock return and exchange rate.

Adjasi *et al* (2008) analysed the effect of exchange rate volatility on stock market in Ghana as well as the effect of other macroeconomic variables on stock market volatility. The authors attempted to find the nature of volatility in both the stock market and the exchange rate from 1995 to 2005 and the results showed that there is an inverse relationship between exchange rate volatility and stock market returns. The study of Adjasi *et al* (2008) indicated that there is the presence of volatility shocks of the exchange rate on stock returns on the Ghana Stock Exchange, thus given an indication that changes in the tradeoff between risk and return is predictable thus serving as a useful guide for risk management.

Likewise money supply and inflation, the relationship between stock returns and exchange rate is not stable over time and that there are differences among countries regardless of either developed or emerging markets.

2.6 Relationship between Stock Prices and Real Economy

The industrial production index is typically used as a proxy for the level of real economic activity. It is theoretically shown that the industrial production increases during economic expansion and decreases during a recession, and thus a change in industrial production would signal a change in economy. The productive capacity of an economy indeed rises during economic growth, which in turn contributes to the ability of firms to generate cash flows. That is why the industrial production would be expected to act beneficially on expected future cash flows, hence a positive relationship between real economy and stock prices exist. Furthermore, the volatility of stock returns increases during economic contractions and decreases during recoveries. Fama (1981) indicates that the growth rate of industrial production had a strong contemporaneous relation with stock returns. Many studies show that large fractions (often more than 50%) of annual stock-return variances can be traced to forecasts of variables such as real GNP, industrial production, and investment that are important determinants of the cash flows to firms (Fama, 1990).

Foresti (2007) indicates that stock market prices can be used in order to predict growth, but the opposite is not true. Fama (1990) reports that a large fraction of the variation of stock returns (the NYSE) can be explained primarily by time-varying expected returns and forecasts of real activity. Nardari and Scruggs (2005) report that stock market (CRSP NYSE) volatility changes over time primarily because of changes in the volatility of "news about future returns". Errunza and Hogan (1998) show that industrial growth rate volatility does Granger cause return volatility for Italy and the Netherlands but not for Germany, France, UK, Switzerland and Belgium.

The findings of Flannery and Protopapadakis (2001) indicate that three real factor variables (Balance of Trade, Employment/Unemployment, and Housing Starts) are strong risk factor candidates, and these real factor candidates affect only the returns conditional volatility for NYSE-AMEX-NASD. Furthermore, it is reported that remarkably, two popular measures of aggregate economic activity (Real GNP and Industrial Production) do not appear as risk factors, as well as that Real GNP announcements are associated with lower rather than higher return volatility. Humpe and Macmillan (2007) indicate both US and Japan stock prices are positively related to industrial production. As to emerging markets, Nishat and Shaheen (2004) infer that industrial production is the largest positive determinant of stock prices in Pakistan, as well as bilateral Granger cause between industrial production and stock prices. Naka, Mukherjee and Tufte (1998) indicate that industrial production is the largest positive determinant of Indian stock prices. Additionally, domestic output growth is its predominant driving force to Indian stock market performance. Maghayereh (2002) and Al-Sharkas (2004) for Jordan and Maysami et al. (2004) for Singapore indicate that industrial production is positively and significantly related to the stock returns. Abugri (2008) reports that the response of stock returns to industrial production are positive and significant in Brazil and Chile, while industrial productions do not appear to exert a significant impact on the expected stock returns in Argentina and Mexico. Adam and Tweneboah (2008) indicate the positive relationship between foreign direct investments and Ghana stock index. In the case of Turkey, Karamustafa and Kucukkale (2003) show that the relation between stock returns and industrial production is positive and the relation between stock returns and trade balance is negative. Furthermore, the findings of the study indicate that the ISE is neither the result variable nor the cause variable of any macroeconomic variable. The results of Yildirtan (2007) evidence that there is a linear relation between imports, exports and the stock returns. According to the results of Ozturk (2008), the stock returns do Granger causes foreign investor transactions, current account deficit/GNP and industrial production index. Kandir (2008) and Tursoy *et al.* (2008) indicate that industrial production does not appear to have any significant affect on stock returns. According to the result of Kaplan (2008), the stock prices have a positive and statistically significant long-run effect on out level implying that stock prices lead real economic activity in Turkey. Furthermore, the direction of the causality between variables is only from stock market price to real economic activity. Erbaykal *et al.* (2008) reveal a positive and statistically significant long term relationship between stock prices and independent variables which are industrial price index, employment level and fixed investments under “Proxy hypothesis” developed by Fama (1981). The study concludes that under the light of this evidence, Proxy hypothesis developed by Fama (1981) is valid for Turkey and that the variables which are the indicators of real economic activity such as industrial production index, employment level and fixed investments are effective on stock prices via inflation.

The results of studies for both development and emerging markets generally indicate positive relationship between real economy and stock returns, as hypothesized.

2.7 Conclusion

It is evident that macroeconomic variables such as interest rate, exchange rate, money supply, inflation (Consumer Price Index), real economic production etc. have some impact on share price on Stock Exchange Markets in both developed and developing countries where studies have been conducted. It is expected that these findings would also be applicable in Ghana and would be tested accordingly. Studies on Ghana have concluded that there exists either a positive or a negative relationship between exchange rate and share prices. Also cointegration exists between share prices and other macroeconomic variables. The present study seeks to contribute to the above studies by determining long-run and short-run relationship in the modern stocks and macroeconomic variables using monthly data. Thus, the present study fills in the lacuna by including a number of macroeconomic factors and using a more recent data to test the relationship in Ghana.

CHAPTER THREE

RESEARCH METHODOLOGY

3.0 Introduction

This chapter seeks to describe the data to be used in the empirical model. Further, we specify the model to be used in the estimations as well as outlining the various estimations methods within the framework of time series which is supposed to aid in unveiling the dynamism that exists between stock prices and macroeconomic factors. The chapter is organized as follows: the first part deals with difference equations, vector difference equations, eigenvalues and eigenvectors, stability analysis of vector difference equation. The second part also describes the data sources and types as well as the a priori expectations for each independent variable. The third part concentrates on the empirical strategy which comprises the specification, estimation and inferences in VAR models. Also, we describe types of structural analysis performed using VAR models, in particular Granger-Causality tests, and the computation of impulse response functions.

3.1 Difference Equation

The difference equation is a formula for computing an output sample at time t based on past and present input samples and past output samples in the time domain. It can also be described as a rule or a function which instructs how to compute the value of the variable of interest given past values of that variable and time. The system may be initialized at some point t_0 which in most cases is taken to be $t_0 = 0$ where t runs over all natural numbers. Thus $t \in \mathbb{N}$ .We may write the general form of a difference equation as

$$F(X_t, X_{t-1}, X_{t-2}, \ldots, X_{t-p}, t) = 0$$

where F is a given function. The variable X_t is called the endogenous dependent variable and is an *n –vector*. Thus, $X_t \in R^n, n \geq 1$ is called the dimension of the system. The difference between the largest and the smallest time index of the dependent variable explicitly involved is called the order of the difference equation.

3.1.1 Homogeneous Equations

Equations of the form $X_t = \alpha X_{t-1}$, where α is a constant are called homogeneous equations. They involve the terms X_t and X_{t-1}.

3.1.2 Non-homogeneous Equations

Non-homogeneous are of the form $X_t = \alpha X_{t-1} + c$, where α and c are constants. They are called non-homogeneous due to the extra term c, but α and c are still constants.

3.1.3 Solutions to Difference Equations

A solution of a difference equation is an expression (or formula) that makes the difference equation true for all values of the integer variable t. The nature of a difference equation allows the solution to be calculated recursively. It is easier to see the solution of the difference equation through algebraic equation. For example, if we have a difference equation

$$X_t = AX_{t-1} + b$$

with initial value $X_0 = c$, then we can determine the:

$t=0; \; X_0 = c$

$t = 1; X_1 = AX_0 + b = Ac + b$

$t = 2; X_2 = AX_1 + b$

$X_2 = A(Ac + b) + b$

$X_2 = A^2c + b(1 + A)$

$t = 3; X_3 = AX_2 + b$

$X_3 = A(A^2c + b(1 + A) + b)$

$X_3 = A^3c + Ab + A^2b + b \; X_3$

$= A^3c + b(1 + A + A^2)$

$t = 4; X_4 = AX_3 + b$

$X_4 = A(A^3c + b(1 + A + A^2) + b$

$X_4 = A^4c + Ab + A^2b + A^3b + b$

$X_4 = A^4c + b(1 + A + A^2 + A^3)$

$t = n; X_n = A^nc + b\,(1 + A + A^2 + \ldots + A^{n-1})$

There is an exponential sequence $1 + A + A^2 + A^3 + \ldots + A^{n-1}$ to be summed.

This sequence has first term of1, $n - 1$ terms and a common ratio of A. However,

the series

$$\sum_{i=0}^{n-1} A^i 1 + A + A^2 + A^3 + \cdots + A^{n-1}$$

Has a closed form

$$\sum_{i=0}^{n-1} A^i = \frac{1 - A^n}{1 - A}$$

For A = 1.Thus, the solution of the difference equation

$$X_t = AX_{t-1} + b, X_{0=}c$$

Is

$$X_n = A^n c + b\left(\frac{1-A^n}{1-A}\right), A = 1$$

3.2 Vector Difference Equation

A vector difference equation is a difference equation in which the value of a vector (or matrix) of variables at one point in time is related to its own value at one or more previous points in time using matrices. Sometimes, the time-varying object may itself be a matrix. The order of the equation is the maximum time gap between any two indicated values of the variable vector. For example, $Y_t = P\,Y_{t-1}$ is an example of first-order matrix equation, in which Y is an $(n \times 1)$ vector of variables and P is $(n \times n)$ matrix. The equation $Y_t = P\,Y_{t-1} + QY_{t-2}$ is also an example of a second-order matrix equation in which Y is an$(n \times 1)$ vector of variables, and P and Q are $(n \times n)$ matrices.

3.2.1 Homogeneous Vector Difference Equation

The equations $Y_t = P\,Y_{t-1}$ and $Y_t = P\,Y_{t-1} + QY_{t-2}$ are homogeneous vector (or matrix) equations because there are no constant terms added to the end of the equations.

3.2.2 Non-Homogeneous Vector Difference Equation

The equations $Y_t = P\,Y_{t-1} + b$ and $Y_t = P\,Y_{t-1} + QY_{t-2} + b$ with additive constant vector b are examples of non-homogeneous vector equations.

3.2.3 Solutions of Vector Difference Equation

Let us assume that we have a homogeneous vector difference equation of the form $Y_t = P\,Y_{t-1}$, then we can iterate and substitute recursively from the initial condition, say $Y_0 = a$, which is the initial value of the vector Y and which must be known in order to find the solution:

$$t=1;\quad Y_1 = P\,Y_0 = P\,a$$

$$t=2;\quad Y_2 = P\,Y_1 = P\,P\,a = P^2 a$$

$t=3$; $Y_3 = P\,Y_3 = P\,P\,P\,a = P^3 a$, and so forth. By induction, we obtain in terms of t:

$$Y_t = P^t a = DQ^t D^{-1} a,$$

where D is an $(n \times n)$ matrix whose columns are the eigenvalues of P(assuming the eigenvalues are all distinct) and Q is an $(n \times n)$ diagonal matrix whose diagonal elements are the eigenvalues of P . P t shrinks to zero matrix over time

if and only if the eigenvalues of P are less than unity in absolute value.

3.3 Eigenvalues and Eigenvectors

3.3.1 Definition of Eigenvalues

The number λ is an eigenvalue of a square matrix A if and only if $A - \lambda I$ is singular, that is, $\det(A - \lambda I) = 0$ where det is determinant. A singular matrix is an $(n \times n)$ matrix whose determinant is equal to zero.

3.3.2 Determination of the Eigenvalues of a Matrix

To find the eigenvalues of a singular matrix *A*, the determinant, $det\ (A - \lambda I) = 0$. This is called the characteristic equation. For an $(n\ x\ n)$ matrix with $n \geq 4$, the process of computing the eigen values is too long and cumbersome to complete by hand. Hence the implementation of a computer programing would help. For this study, the Stata Data Analysis and Statistical software will be used to compute the eigenvalues. It turns out that the eigenvalues of some matrices are complex numbers, even when the matrix only contains real numbers. When this happens the complex eigenvalues must occur in conjugate pairs, thus $\lambda = \alpha \pm \beta i$.

3.3.3 Definition of Eigenvectors

An eigenvector of A corresponding to λ is a non-zero vector v which satisfies the equation $(A - \lambda I)v = 0$.

3.3.4 Determination of the Eigenvectors of a Matrix

To calculate the eigenvectors of a matrix, you must first determine the eigenvalues. Substitute one eigenvalue λ into the equation $(A - \lambda I)v = 0$ and solve for v; the resulting non-zero solutions form a set of eigenvectors of A corresponding to the selected eigenvalue. This process is then repeated for each of the remaining eigenvalues.

3.4 Stability Analysis of Vector Difference Equations of order one (1)

The stability of a vector difference equation depends on the nature of the eigenvalues. For example, the difference equation $X_t = AX_{t-1}$ is;

1. Stable if all eigenvalues of A satisfy $|\lambda_i| < 1, i = 1, 2, ...$
2. Neutrally Stable if some $|\lambda_i| = 1$ and other $|\lambda_i| < 1, i = 1, 2, ...$
3. Unstable if at least one eigenvalue has $|\lambda_i| > 1, i = 1, 2, ...$

For a stable equation, the powers A^t approaches zero and so does the solution $X_t = A^t X_0$.

3.5 Variable Description

The overall measure of stock market performance is captured by the variable GSE All-Share-Index which is the dependent variable in this study. This is a composite index which reflects the average price movements in all the equities listed on the stock market. The use of this composite index is justified since it captures all other performance measures such as market capitalization, liquidity and turnover ratio. Nominal exchange rate is the nominal monthly average Ghana Cedi[1]

(GH¢) to US dollar (US$) rate. Inflation is proxied by the average monthly inflation while 91-day Treasury bill rate is used as a proxy for interest rates. We use M2+ (broad money supply including foreign currency deposits) as a proxy for money supply while external supply shocks are proxied using monthly crude oil prices. Lastly, since GDP figures are unavailable on a monthly basis, we use a composite index for economic activity (CIEA) from the Bank of Ghana as a surrogate variable for the real economy.

3.6 Specification of the Operational Model

This study specifies the following augmented functional model of the stock market performance for Ghana which is based on the theoretical and empirical literature on asset valuation:

$$GSE_t = \delta_0 + \delta_1 INFL_t + \delta_2 INTR_t + \delta_3 EXR_t + \delta_4 M2_t + \delta_5 OILP_t + \delta_6 RGDP + \varepsilon_t \quad (1)$$

where *GSE* is GSE All-Share index which serves as a proxy for stock market performance; *INFL* is the rate of inflation; *EXR* is the exchange rate; *INTR* is the interest rate; *M*2 is a measure of money supply; *OILP* is oil prices to proxy external supply shocks which is also treated as an exogenous variable since Ghana is a small oil importing country and hence cannot influence the world market price of oil, *RGDP* is a measure of economic activity *t* is time and *ε* is the usual white noise error term.

[1] Cedi (¢) is Ghana's official unit of currency generally denoted as GH¢. On 3rd July 2007, the Ghanaian cedi (GHC) was redenominated. The new Ghana cedi (GHS) is equal to 10,000 old Ghanaian Cedis (1 GHS = 10,000 GHC). The old currency remained in circulation alongside the new until December 2007. One Ghana cedi is divided into one hundred Ghana pesewas (Gp).

A log-linear specification of the relationship between variables in Equation (1) would be an innocuous assumption. First, there could be non-linear relationship between the variables and also taking the natural logarithms of variables reduces their scale from a ten-fold to a two-fold which has the potential of reducing heteroscedasticity (Gujarati, 1995). Second, estimating the log-linear relationship will aid the interpretation of the estimated coefficients as partial elasticities (i.e., the independent variables would measure the relative changes in the dependent variables).Thus, the stochastic relationship between the variables in its estimable form is specified as follows:

$$\ln GSE_t = \delta_0 + \delta_1 \ln INFL_t + \delta_2 \ln INTR_t + \delta_3 \ln EXR_t + \delta_4 \ln M2_t + \delta_5 \ln OILP_t + \delta_6 \ln RGDP + \varepsilon_t \quad (2)$$

where all the variables have been defined already except *ln* which is the natural logarithm.

3.6.1 Expectations about Explanatory Variables

Inflation rate indicates the overall ability of governments to manage an economy. Ultimately, inflation is translated into nominal interest rate and an increase in nominal interest rates increase discount rate which results in reduction of present value of cash flows so it is said that an increase in inflation is negatively related to equity prices. An empirical studies by Chen, Roll and Ross (1986), Barrows and Naka (1994), Mukherjee and Naka (1995) and Wongbangpo and Sharma (2002) conclude that inflation has negative effects on the stock market. Thus, this study expects the coefficient on inflation to be negative (i.e., $\delta_1 < 0$).

Restrictive monetary policies in the form of high interest rates would make cash flows worth less. This would reduce the attractiveness of an investment; hence shrink the value of stock returns. This can also be looked at from the view of 'substitution effect' hypothesis. A rise in interest rate would increase the opportunity cost of holding cash-in-hand, which leads to substitution effect between stocks and other interest-bearing securities. Further, a negative relationship between the two can be hypothesized as interest rates can influence the level of corporate profits which further influence the investors' willingness to invest. Since most companies finance their capital through borrowings, a reduction in interest rates reduces the costs of borrowing and serves as an enticement for growth, which will have positive effects on the returns. Furthermore, as a significant amount of stocks are purchased with borrowed money, an increase in interest rates would make transactions more expensive and hence lead to reduced demand and price depreciation. Thus, the study expects a negative correlation between interest rate and stock prices (i.e., $\delta_2 < 0$).

As indicated earlier on, this study uses end of month US Dollars/Ghana cedi exchange rate. Since Ghana is an import dominated country, currency depreciation will have an unfavourable impact on the domestic stock market. As the Ghana cedi depreciates against the U.S. dollar, products imported become more expensive. Consequently, if the demand for these goods is elastic, the volume of imports would increase, which in turn causes lower cash flows, profits and the stock price of the domestic companies. Thus, a negative relationship is anticipated between the exchange rate and stock prices (i.e., $\delta_3 < 0$).

Broad money (M2) is used as a proxy for money supply. An increase in money supply leads to an increase in liquidity which ultimately results in upward movement of nominal equity prices. Thus, the study anticipates a positive correlation between money supply and stock prices (i.e., $\delta_4 > 0$).

Crude oil price is used as proxy for oil price. Ghana is a net importer of crude oil; therefore, oil price play an important role in Ghanaian economy. For oil importer countries, an increase in oil price will lead to an increase in production costs and hence to decreased future cash flow, leading to a negative impact on the stock market. Consequently the study anticipates a negative coefficient on the oil price variable ($\delta_5 < 0$).

Composite index for economic activities is used as a proxy to measure the growth rate in the real sector. Thus, it presents a measure of the overall economic activity in the economy and affects stock prices through its influence on expected future cash flows. It is anticipated that an increase in economic activity is positively related to stock returns (i.e., $\delta_6 > 0$).

3.7 Empirical Strategy: Multivariate VAR Modeling

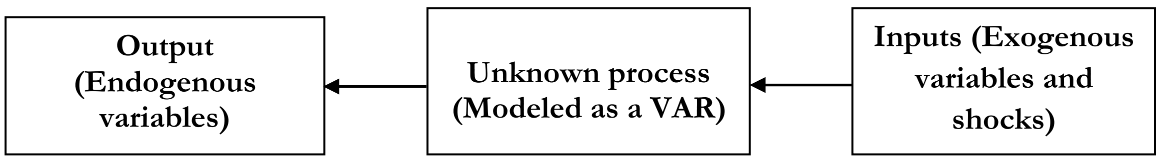
3.7.1 Vector Auto regression (VAR)

One of the most successful, flexible and easy to use models for the analysis of multivariate time series is the vector autoregression (VAR) model is. It is a natural extension of the univariate autoregressive model to dynamic multivariate time series. The VAR model has proven to be especially useful for describing the dynamic behavior of economic and financial time series and for forecasting. Oftentimes, VAR provides superior forecasts to those from univariate time series models and elaborate theory-based simultaneous equations models. Consequently, forecasts from VAR models are quite flexible because they can be made conditional on the potential future paths of specified variables in the model.

Additionally, the VAR model is also used for structural inference and policy analysis. In structural analysis, certain assumptions about the causal structure of the data under investigation are imposed, and the resulting causal impacts of unexpected shocks or innovations to specified variables on the variables in the model are summarized. These causal impacts are usually summarized with impulse response functions and forecast error variance decompositions.

3.7.2 The Idea behind Vector Autoregressive Model

Until the 1970s macroeconometrics had used simultaneous equation systems which require that one precisely determine the relationship among variables, and also required that at least the key equations to be identified so that one can estimate the coefficients precisely. This approach has been criticized following the Lucas critique that raised the problem that even the coefficients of such equation (behavioral parameters) may change over time, so policy recommendations and forecasting from such systems may be misleading and invalid. During the 1980s, Sims suggested the VAR as an alternative solution. This theoretically treated the economic system we are to estimate as a black box:



The main idea was that you do not precisely specify a system of equations but rather you use a very general VAR system to draw conclusions based on the reaction of the endogenous variables on changes in exogenous factors. These are the impulse response functions.

VAR is actually a set of reduced form equations form a system of simultaneous equations. Assume that we have two macroeconomic variables, say, real aggregate income (y_t) and rate of inflation (π_t). We believe that these are in simultaneous relationship but have a degree of hysteresis (so they can partly be explained by their past values)

$$y_t = \beta_{10} + \beta_{11}\pi_t + \beta_{12}y_{t-1} + u_t;\ u_t \sim iid\left(0, \sigma_u^2\right) \tag{3.1}$$

$$\pi_t = \beta_{20} + \beta_{21}y_t + \beta_{22}\pi_{t-1} + v_t;\ v_t \sim iid\left(0, \sigma_v^2\right) \tag{3.2}$$

Equations (3.1) and (3.2) are exactly identified and hence the reduced form equations are as follows:

$$y_t = \delta_1 + \theta_{11}y_{t-1} + \theta_{12}\pi_{t-1} + \eta_{1t} \tag{3.3}$$

$$\pi_t = \delta_2 + \theta_{21}y_{t-1} + \theta_{22}\pi_{t-1} + \eta_{2t} \tag{3.4}$$

Equations (3.3) and (3.4) are typically a VAR(1) system with:

$$\eta_{1t} = \frac{u_t + \beta_{11}v_t}{1-\beta_{11}\beta_{21}};\ \delta_1 = \frac{\beta_{10} + \beta_{11}\beta_{20}}{1-\beta_{11}\beta_{21}};\ \theta_{11} = \frac{\beta_{12}}{1-\beta_{11}\beta_{21}};\ \theta_{12} = \frac{\beta_{11}\beta_{22}}{1-\beta_{11}\beta_{21}};\ \eta_{2t} = \frac{v_t + \beta_{21}u_t}{1-\beta_{21}\beta_{11}}$$

$$\delta_2 = \frac{\beta_{20} + \beta_{21}\beta_{10}}{1-\beta_{11}\beta_{21}};\ \theta_{21} = \frac{\beta_{21}\beta_{12}}{1-\beta_{11}\beta_{21}};\ \theta_{22} = \frac{\beta_{22}}{1-\beta_{11}\beta_{21}}$$

So all VAR systems are already based on an assumed system of equations, which necessarily involve some theoretical considerations and a set of assumptions. It is worthy of notice that η_{1t} and η_{2t} are correlated, since they both depend on u_t and v_t. The practical application of VAR is like follows: first you choose a proper VAR representation and you draw conclusions on the relationship among the endogenous variables based on Impulse Response Functions (IRFs). The IRFs for y are simply:

$\frac{\partial y_t}{\partial \eta_{1t-i}}, \frac{\partial y_t}{\partial \eta_{2t-i}}$ and for $\pi: \frac{\partial \pi_t}{\partial \eta_{1t-i}}, \frac{\partial \pi_t}{\partial \eta_{2t-i}}$. for i = 0,…,T. In words, the IRF shows how an endogenous variable reacts on innovations in its own value (own error term) or on an innovation in another endogenous variables (error term of another equation).

The problem of simultaneity and IRFs becomes apparent when you look at the values of the η's. IRF is only useful if η_1 and η_2 can be subject to a shock independently. But how is it possible that only η_1 experiences a shock if it is correlated with η_2? Well, the answer is that it is not possible. So, unless the endogenous variables are uncorrelated (so they are not simultaneously correlated…) you need to tell how they are related. When the contemporaneous correlation structure of the shocks is taken into account, then we have Structural Vector Autoregression (SVAR).

3.8 The Stationary Vector Autoregression Model

Let $\mathrm{Y_t} = (y_{1t}, y_{2t}, \ldots, y_{nt})'$ denote an $n \times 1$ vector of time series variables. In our case, these time series variables are GSE-All share index, money supply, inflation, exchange rate, interest rate, composite index for real economic activities and oil prices. The basic *p*-lag vector autoregressive (VAR(*p*)) model has the form:

$$\mathrm{Y_t} = c + \Pi_1 \mathrm{Y}_{t\text{-}1} + \Pi_2 \mathrm{Y}_{t\text{-}2} + \cdots + \Pi_p \mathrm{Y}_{t\text{-}p} + \varepsilon_t,\ t = 1, \cdots, T \tag{3.5}$$

where Π_i are $n \times n$ coefficient matrices and ε_t is an $n \times 1$ unobservable white noise vector process with zero mean and serially uncorrelated with time invariant covariance matrix Σ. For example, a bivariate VAR(2) model equation by equation has the form:

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} c_1 \\ c_2 \end{pmatrix} + \begin{pmatrix} \pi_{11}^{(1)} & \pi_{12}^{(1)} \\ \pi_{21}^{(1)} & \pi_{22}^{(1)} \end{pmatrix} \begin{pmatrix} y_{1t-1} \\ y_{2t-1} \end{pmatrix} + \begin{pmatrix} \pi_{11}^{(2)} & \pi_{12}^{(2)} \\ \pi_{21}^{(2)} & \pi_{22}^{(2)} \end{pmatrix} \begin{pmatrix} y_{1t-2} \\ y_{2t-2} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \tag{3.6}$$

where $\operatorname{cov}(\varepsilon_{1t}, \varepsilon_{2s}) = \sigma_{12}$ for t = s; 0 otherwise. Equation (3.6) each has the same number of regressors – lagged values of y_{1t} and y_{2t}. Hence, the VAR(*p*) model is just a seemingly unrelated regression (SUR) model with lagged variables and deterministic terms as common regressors. Note that (2) is not a square but it means the VAR is of order two.

In lag operator notation, the VAR(*p*) is written as:

$$\Pi(L)\mathrm{Y}_t = \mathrm{c} + \varepsilon_t \tag{3.7}$$

Where, $\Pi(L) = I_n - \Pi_1 L - \cdots - \Pi_p L_p$. The VAR (p) is stable if the roots of

$$\det\left(I_n - \Pi_1 z - \cdots - \Pi_p z^p\right) = 0 \tag{3.8}$$

lie outside the complex unit circle (have modulus greater than one), or, equivalently, if the eigenvalues of the companion matrix

$$F = \begin{pmatrix} \Pi_1 & \Pi_2 & \cdots & \Pi_n \\ I_n & 0 & \cdots & 0 \\ 0 & \ddots & 0 & \vdots \\ 0 & 0 & I_n & 0 \end{pmatrix}$$

have modulus less than one. Assuming that the process has been initialized in the infinite past, then a stable VAR (*p*) process is stationary and ergodic with time invariant means, variances, and autocovariances. The basic VAR (*p*) model may be too restrictive to represent sufficiently the main characteristics of the data. Thus considering the nature of the series we are using in this study, it is imperative to include other deterministic terms such as a linear trend or seasonal dummy variables in order to represent the data reasonably well. Additionally, stochastic exogenous variables may be required as well. Incidentally, the general form of the VAR(*p*) model with deterministic terms and exogenous variables is given by

$$Y_t = \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + \cdots + \Pi_p Y_{t-p} + \Phi D_t + \Gamma X_t + \varepsilon_t \quad (3.9)$$

where D_t represents an $(n \times n)$ matrix of deterministic components, X_t represents an $m \times 1$ matrix of exogenous variables, and Φ and Γ are parameter matrices.

3.8.1. Test for Stationarity

For a VAR model, the series used in the model have to be stationary which can be checked using the Augmented Dickney Fuller (ADF) and the Phillips – Perron (PP) tests. The ADF tests the null hypothesis that a time series y_t is *I(1)* against the alternate hypothesis that *I(0)*, assuming that the dynamics in the data have an ARMA structure. The ADF test is based on estimating the test regression

$$y_t = \beta' D_t + \phi y_{t-1} + \sum_{j-i}^{p} \psi_j \Delta y_{t-j} + \varepsilon_t$$

Where D_t is a vector of deterministic terms. The *p* is the lagged difference terms, Δy_{t-j} are used to approximate the structure of the errors, and the value of *p* is set so that the error ε_t is serially uncorrelated. The error term is also homoskedastic thus the errors are drawn from the same distribution for all values of the independent variables. The ADF t – statistic and normalized bias statistic are based on the last squares estimates of the equation and are given by

$$ADF_t = t_{\phi-1} = \frac{\hat{\phi} - 1}{SE(\phi)}$$

$$ADF_n = \frac{T(\hat{\phi} - 1)}{1 - \hat{\psi}_1 - \ldots - \hat{\psi}_p}$$

The test regression for the Phillips – Perron (PP) unit root test is

$$\Delta y_t = \beta^t D_t + \pi y_{t-1} + \mu_t$$

Where μ_t is *I(0)* and may be heteroskedastic, thus the errors are drawn from different distributions for different values of the independent variables. The PP tests correct for any serial correlation and heteroskedasticity in the errors μ_t of the test regression by directly modifying the test statistics $t_{\pi-0}$ and $T\hat{\pi}$. These modified statistics , denoted by Z_t and Z_π are given by

$$Z_t = (\frac{\hat{\sigma}^2}{\hat{\lambda}^2}).t_{\pi-0} - \frac{1}{2}(\frac{\hat{\lambda}^2 - \hat{\sigma}^2}{\lambda^2}).(\frac{T.SE(\hat{\pi})}{\hat{\sigma}^2})$$

$$Z_\pi = T\hat{\pi} - \frac{1}{2}\frac{T^2.SE(\hat{\pi})}{\hat{\sigma}^2}(\hat{\lambda}^2 - \hat{\sigma}^2)$$

The terms $\hat{\sigma}^2$ and $\hat{\lambda}^2$ are consistent estimates of the variance parameters

$$\hat{\sigma}^2 = \lim_{T\to\infty} T^{-1}\sum_{t-1}^{T} E\left[\mu_t^{\ 2}\right]$$

$$\hat{\lambda}^2 = \lim_{T\to\infty} \sum_{t-1}^{T} E\left[T^{-1} S_T^{\ 2}\right]$$

Where $S_T = \sum_{t-1}^{T} \mu_t$. The sample variance of the least squares residual $\hat{\mu}_t$ is a consistent estimate of σ^2, and the Newey-West long-run variance estimate of μ_t using $\hat{\mu}_t$ is a consistent estimate

of λ^2. Under the null hypothesis that π=0, the PP *Zt* and *Zπ* statistics have the same asymptotic distributions as the ADF t-statistic and normalized bias statistics. One advantage of the PP tests over the ADF tests is that the PP tests are robust to general forms of heteroskedasticity in the error term μ_t. Another advantage is that the user does not have to specify a lag length for the test regression.

3.9 Estimation of the Empirical Relationship

Consider the basic VAR(p) model (3.5). Assume that the VAR(p)model is covariance stationary, and there are no restrictions on the parameters of the model. In Seemingly Unrelated Regression (SUR) notation, each equation in the VAR(p)may be written as

$$\mathrm{y}_i = \mathrm{Z}\pi_i + e_i,\ i = 1, \cdots, n \qquad (3.10)$$

where y_i is a $\mathrm{T} \times 1$vector of observations on the i^{th} equation, Z is a $\mathrm{T} \times K$ matrix with t^{th} row given by $\mathrm{Z}'_t = \left(1, \mathrm{Y}'_{t-1}, \cdots, \mathrm{Y}'_{t-p}\right)$, $K = np + 1$, π_i is a $K \times 1$vector of parameters and e_i is a $\mathrm{T} \times 1$ error with covariance matrix $\sigma_i^2 I_T$. Since the VAR(p) is in the form of a SUR model where each equation has the same explanatory variables, each equation may be estimated separately by ordinary least squares without losing efficiency relative to generalized least squares. Let $\hat{\Pi} = \left[\hat{\pi}_1, \cdots, \hat{\pi}_n\right]$denote the $K \times n$ matrix of least squares coefficients for the n equations.

Let $vec\left(\hat{\Pi}\right)$denote the operator that stacks the columns of the $n \times K$ matrix $\hat{\Pi}$into a long $nK \times 1$vector. That is,

$$vec\left(\hat{\Pi}\right) = \begin{pmatrix} \hat{\pi}_1 \\ \vdots \\ \hat{\pi}_n \end{pmatrix} \qquad (3.11)$$

Under standard assumptions regarding the behavior of stationary and ergodic VAR models (see Hamilton (1994) or Lutkepohl (1991)) $vec\left(\hat{\Pi}\right)$is consistent and asymptotically normally distributed with asymptotic covariance matrix

$$avar = \hat{\Sigma} \otimes \left(Z'\mathrm{Z}\right)^{-1} \qquad (3.12)$$

where

$$\hat{\Sigma} = \frac{1}{T-k}\sum_{t=1}^{T}\hat{\varepsilon}_t\hat{\varepsilon}_t' \quad \text{V} \tag{3.13}$$

and $\hat{\varepsilon}_t = Y_t - \hat{\Pi}' Z_t$ is the multivariate least squares residual from (3.5) at time t.

3.9.1 Methods of estimating VAR model

This study will make use of the classical least squares (LS) and maximum likelihood (ML) methods to estimate the reduced VAR(p)model. The method of least square is about estimating parameters by minimizing the squared discrepancies between observed data and their expected values. Consider the levels VAR(p) model (3.5) written in a more compact form

$$y_t = [c_1, \pi_1, \pi_{2,} \ldots, \pi_p] z_{t-1} + \varepsilon_t \tag{3.14}$$

where $z_{t-1} = (1, y_{t-1}, y_{t-2}, \ldots, y_{t-p})'$. The deterministic terms may be adjusted accordingly if there is just a constant in the model or no deterministic component at all. Given a sample of size T, $y_t, \ldots, y_T$, and p presample vectors, $y_{-p+1}, \ldots, y_0$, the parameters can be efficiently estimated by ordinary least square method (OLS) for each equation separately. The estimator is easily seen to be

$$[\hat{c}_1, \hat{\pi}_1, \hat{\pi}_{2,} \ldots, \hat{\pi}_p] = (\sum_{t-1}^{T} y_t z'_{t-1})(\sum_{t-1}^{T} z_t z'_{t-t})^{-1} \tag{3.15}$$

for a normally distributed process y_t,, where $\mu_t \sim N(0, \sum \mu)$, this estimator is also identical to the ML estimator, conditional on the initial sample values, thus the estimator has the usual desirable asympyotic properties of standard estimators. It is asymptotically normally distributed with smallest possible asymptotic covariance matrix and the usual inference procedures are available if the process is stable.

As in the standard case, the MLE of the covariance differs from the OLS estimator for a model with a constant, k variables and p lags. Thus,

$$\text{MLE estimator: } \hat{\Sigma} = \frac{1}{T}\sum_{t-1}^{T}\hat{\varepsilon}_t\hat{\varepsilon}'_t$$

$$\text{OLS estimator: } \hat{\Sigma} = \frac{1}{T-kp-1}\sum_{t-1}^{T}\hat{\varepsilon}_t\hat{\varepsilon}'_t$$

where T is the time, $\hat{\varepsilon}_t$ is an (n x 1) residual matrix at time t and $\hat{\varepsilon}'_t$ is the transpose of the residual matrix at time t . Their product then gives an (n x n) matrix. The MLE selects the set of values of the model that maximizes the likelihood function which is the function of the parameters of the model.

3.9.2 Lag Length Selection

The model selection criteria may be used to determine the lag length for the VAR(p) model. The general approach is to fit VAR(p) models with orders p = 0, ...,$p_{\max}$ and choose the value of p which minimizes some model selection criteria. Model selection criteria for VAR(p) models have the form

$$IC(p) = \ln\left|\bar{\Sigma}(p)\right| + c_T.\varphi(n, p) \tag{3.16}$$

where $\bar{\Sigma}(p) = T^{-1}\sum_{t=1}^{T}\hat{\varepsilon}_t\hat{\varepsilon}'_t$ is the residual covariance matrix without a degrees of freedom correction from a VAR(p) model, c_T is a sequence indexed by the sample size T, and $\varphi(n, p)$ is a penalty function which penalizes large VAR(p) models. In this study, we use the three most common information criteria which are the Akaike (AIC), Schwarz-Bayesian (BIC) and Hannan-Quinn (HQ) given respectively as:

$$AIC(p) = \ln\left|\bar{\Sigma}(p)\right| + \frac{2}{T}pn^2 \tag{3.17}$$

$$BIC(p) = \ln\left|\bar{\Sigma}(p)\right| + \frac{\ln T}{T} pn^2 \quad (3.18)$$

$$HQ(p) = \ln\left|\bar{\Sigma}(p)\right| + \frac{2\ln\ln T}{T} pn^2 \quad (3.19)$$

The *AIC* criterion asymptotically overestimates the order with positive probability, whereas the *BIC* and *HQ* criteria estimate the order consistently under fairly general conditions if the true order p is less than or equal to $p_{\max}$.

3.9.3 Inference on Coefficients

If the purpose of establishing the relationship between stock prices and macroeconomic variables is just to estimate, then our method of using VAR suffices. However, in regression analysis, we are not only interested in estimating parameters of a model, but also to make inferences about the true population parameters. The i^{th} element of $vec\left(\hat{\Pi}\right)$, $\hat{\pi}_i$ is asymptotically normally distributed with standard error given by the square root of i^{th} diagonal element of $\hat{\Sigma} \otimes \left(Z'Z\right)^{-1}$. Hence, asymptotically valid t-tests on individual coefficients may be constructed in the usual way. More general linear hypotheses of the form $\mathrm{R} \cdot vec(\Pi) = \mathrm{r}$ involving coefficients across different equations of the VAR may be tested using the Wald statistic:

$$Wald = \left(\mathrm{R} \cdot vec\left(\hat{\Pi}\right) - \mathrm{r}\right)' \left\{\mathrm{R}\left[avar\left(vec\left(\hat{\Pi}\right)\right)\right]\mathrm{R}'\right\}^{-1} \left(\mathrm{R} \cdot vec\left(\hat{\Pi}\right) - \mathrm{r}\right) \quad (3.20)$$

Under the null, (3.20) has a limiting $\chi^2(q)$ distribution where $q = rank(\mathbf{R})$ gives the number of linear restrictions.

The assumptions for the VAR model includes it; being normally distributed. This means that just like a coin toss, each return is an independent draw from the normal distribution. Another assumption is that the random coefficients $c, \pi_1, \pi_2, ..., \pi_p$ from (3.5) at time $t=0,...,n$ are measurable. Again, stationary of the data, stability of the data are all assumptions that after determining the coefficients of the model, with the aid of the wild test, we find the level of significance and reject or fail to reject the various null hypothesis.

3.10 Forecasting

One of the objectives of this study is to forecast the future values of stock prices, given that all the predictors are known. Since, we estimate our relationship in a VAR framework, the intended forecast will be done according which is quite similar to forecasting from a univariate autoregressive model. As an illustration, consider the problem of forecasting future values of stock prices (Y_t) when the parameters Π of the VAR(*p*) process are assumed to be known and there are no deterministic terms or exogenous variables. This is done within the enclaves of traditional forecasting algorithm. The best linear predictor, in terms of minimum mean squared error (MSE), of Y_{t+1} or 1-step forecast based on information available at time T is

$$\mathrm{Y}_{T+1|T} = c + \Pi_1 \mathrm{Y}_T + \cdots + \Pi_p \mathrm{Y}_{T-p+1} \tag{3.20}$$

Forecasts for longer horizons *h* (*h*-step forecasts) may be obtained using the chain-rule of forecasting as

$$\mathrm{Y}_{T+h|T} = c + \Pi_1 \mathrm{Y}_{T+h-1|T} + \cdots + \Pi_p \mathrm{Y}_{T+h-p|T} \tag{3.21}$$

where $\mathrm{Y}_{T+j|T} = \mathrm{Y}_{T+j}$ for $j \leq 0$. The *h*-step forecast errors may be expressed as

$$\mathrm{Y}_{T+h} - \mathrm{Y}_{T+h|T} = \sum_{s=0}^{h-1} \Psi_s \varepsilon_{T+h-s} \tag{3.22}$$

where the matrices Ψ_s are determined by recursive substitution

$$\Psi_s = \sum_{s=0}^{p-1} \Psi_{s-j} \Pi_j \tag{3.23}$$

with $\Psi_0 = \mathrm{I}_n$ and $\Pi_j = 0$ for j > p. The forecasts are unbiased since all of the forecast errors have expectation zero and the MSE matrix for $\mathrm{Y}_{T+h|T}$ is

$$\Sigma(h) = MSE\left(\mathrm{Y}_{T+h} - \mathrm{Y}_{T+h|T}\right) = \sum_{s=0}^{h-1} \Psi_s \Sigma \Psi_s' \tag{3.24}$$

Now consider forecasting Y_{T+h} when the parameters of the VAR(*p*) process are estimated using multivariate least squares. The best linear predictor of Y_{T+h} is now

$$\hat{\mathrm{Y}}_{T+h|T} = \hat{\Pi}_1 \hat{\mathrm{Y}}_{T+h-1|T} + \cdots + \hat{\Pi}_p \hat{\mathrm{Y}}_{T+h-p|T} \tag{3.25}$$

where $\hat{\Pi}_j$ are the estimated parameter matrices. The h-step forecast error is now

$$\mathrm{Y}_{T+h} - \hat{\mathrm{Y}}_{T+h|T} = \sum_{s=0}^{h-1} \Psi_s \varepsilon_{T+h-s} + \left(\mathrm{Y}_{T+h} - \hat{\mathrm{Y}}_{T+h|T}\right) \tag{3.26}$$

and the term $\left(\mathrm{Y}_{T+h} - \hat{\mathrm{Y}}_{T+h|T}\right)$ captures the part of the forecast error due to estimating the parameters of the VAR. The *MSE* matrix of the *h*-step forecast is then

$$\hat{\Sigma}(h) = \Sigma(h) + MSE\left(\mathrm{Y}_{T+h} - \hat{\mathrm{Y}}_{T+h|T}\right) \tag{3.27}$$

In practice, the second term $MSE\left(\mathrm{Y}_{T+h} - \hat{\mathrm{Y}}_{T+h|T}\right)$ is often ignored and $\hat{\Sigma}(h)$ is computed using (3.24) as

$$\hat{\Sigma}(h) = \sum_{s=0}^{h-1} \hat{\Psi}_s \hat{\Sigma} \hat{\Psi}_s' \tag{3.28}$$

with $\hat{\Psi}_s = \sum_{j=1}^{s} \hat{\Psi}_{s-j} \hat{\Pi}_j$.

Asymptotic $(1-\alpha)\cdot 100\%$ confidence intervals for the individual elements of $\hat{\mathrm{Y}}_{T+h|T}$ are then computed as

$$\left[\hat{y}_{k,T+h|T} - c_{1-\alpha/2}\hat{\sigma}_k(h), \hat{y}_{k,T+h|T} + c_{1-\alpha/2}\hat{\sigma}_k(h)\right]$$

where $c_{1-\alpha/2}$ is the $(1-\alpha/2)$ quantile of the standard normal distribution and $\hat{\sigma}_k(h)$ denotes the square root of the diagonal element of $\hat{\Sigma}(h)$.

3.11 Structural Analysis

The interpretation of the parameters in a general VAR(*p*) model is generally difficult because it contains many parameters and the underlying complex interactions and feedback between the variables in the model. Consequently, it is important to specify the dynamic properties of a VAR(*p*) using alternative structural analysis. This study relies on two main types of structural analysis thus (1) Granger causality tests and (2) impulse response functions.

3.11.1 Granger Causality

One of the objectives of the study is to ascertain the direction of causality between stock prices and its determinants in the model. Consequently, we conduct Granger causality tests in order to find the direction of causality and possible feedback between stock prices and the regressors in the model. One of the main uses of VAR is forecasting. The structure of the VAR model provides information about a variable's or a group of variables' forecasting ability for other variables. The following intuitive notion of a variable's forecasting ability is due to Granger (1969). Granger causality tests whether lagged values of one variable predict changes in another, or whether one variable in the system explains the time path of the other variables. Hence, a variable x is said to Granger-cause another variable y ($x \rightarrow y$) if past values of x can predict present values of y. Stated differently, if a variable, or group of variables, x is found to be helpful in predicting another variable, or group of variables, y then x is said to Granger-cause y; otherwise it is said to fail to Granger-cause y. Granger (1988) posits two cardinal principles namely the cause precedes the effect and; 'the causal series contains special information about the series being caused that is not available in the other available series' (Granger, 1988). Similarly, there is an instantaneous causality from *x* to *y* ($x \Rightarrow y$) if present and past values of *x* predict present value of *y*. If causality is in one direction e.g. from *x* to *y*, we have uni-directional causality while if *x* Granger causes *y* and *y* Granger causes ***x*,** we have bi-directional or feedback causality ($y \leftrightarrow x$). There are two commonly used causality tests: one due to Granger (1969) and the other due to Sims (1972). The former is, however, more widely used in applied econometrics, partly because of its simplicity and also because it is less costly in terms of degrees of freedom (Charemza and Deadman, 1997). The Granger-causality test is based on the assumption of stationary variables. Thus, if the variables are non-stationary then, Granger-causality tests are applied on the first differences of the variables that have unit root. Thus, formally, *x* fails to Granger-cause *y* if for all s > 0 the mean squared error (MSE) of a forecast of *y*, t+s based on $\left(y_t, y_{t-1,\cdots}\right)$ is the same as the MSE of a forecast of *y*,t+s based on $\left(y_t, y_{t-1,\cdots}\right)$ and $\left(x_t, x_{t-1,\cdots}\right)$. Clearly, the notion of Granger causality does not imply true causality. It only implies forecasting ability. The test for Granger causality is performed by estimating equations of the following form:

$$\Delta x_t = \alpha + \sum_{i=1}^{n} \beta_i \Delta x_{t-i} + \sum_{i=1}^{m} \lambda_j \Delta y_{t-j} + \mu_t$$

$$\Delta y_t = \alpha + \sum_{i=1}^{n} \beta_i \Delta y_{t-i} + \sum_{i=1}^{m} \lambda_j \Delta x_{t-j} + \nu_t$$

(3.29)

The F-test is applied to test the null hypothesis of Granger-non-causality against the alternative of Granger-causality. If the F-statistic is significant at any of the conventional levels, the null hypothesis that '*y* does not Granger-cause *x*' is rejected, otherwise it is accepted.

3.11.2 Impulse Response Functions

The impulse response functions (IRFs) generated from the VAR model trace out the time paths of the effect of a shock in a nominated variable on each of the other variables in the system. From them we can determine the extent to which an exogenous shock causes short-run and long-run changes in the respective variables. The Wold representation of $\mathrm{Y_t}$ based on the orthogonal errors η_t is given by

$$\mathrm{Y_t} = \mu + \Theta_0\eta_t + \Theta_1\eta_{t-1} + \Theta_2\eta_{t-2} + \cdots \qquad (3.30)$$

where $\Theta_0 = B^{-1}$ is a lower triangular matrix. The impulse responses to the orthogonal shocks η_{jt} are

$$\frac{\partial y_{i,t+s}}{\partial \eta_{j,t}} = \frac{\partial y_{i,t}}{\partial \eta_{j,t-s}} = \theta_{ij}^{s},\ i, j = 1, \cdots, n; s > 0 \qquad (3.31)$$

where θ_{ij}^{s} is the $(i, j)^{\text{th}}$ element of Θ_s. A plot of θ_{ij}^{s} against *s* is called the orthogonal impulse response function (IRF) of y_i with respect to η_j. With *n* variables there are n^2 possible impulse response functions.

CHAPTER FOUR

EMPIRICAL RESULTS, ANALYSIS AND DISCUSSIONS

4.0 Introduction

This chapter presents the data type and sources, empirical results, analysis and discussion of the relationship between stock prices and macroeconomic variables in Ghana. The chapter is divided into three main parts. The first part presents the summary statistics of the data used in the estimation as well as their time series properties. The second part presents the empirical estimation results of the VAR model, the inferences as well as the forecast. The last part of the chapter concentrates on the structural analysis of the VAR model: Granger-causality analysis, impulse response functions and forecast error variance decomposition.

4.1 Data Type and Sources

This study chiefly depends on secondary time series monthly data covering the period November, 1990 through to June, 2011, thus making use of 248 data points enough for effective regression analysis. We could have extended our sample period beyond June, 2011 but we believe that the implementation of the Single Spine Salary (SSS) could potentially distort the relationship we intent estimating. The data were obtained from sources including the Ghana Stock Exchange, Bank of Ghana and International Financial Statistics (IMF).

4.2 Summary Statistics and Bivariate Correlation of the Variables

The summary statistics and bivariate correlations between the variables are presented in Table 4.1 and Table 4.2 respectively. In Ghana, between November, 1990 and June, 2011, the GSE-All-Share index averaged 2855.6. Within the same period, the exchange rate averaged GH¢1 to $0.61 whiles interest rate (91 Day Treasury Bill rate) averaged 27.5%. Inflation was within the period also averaged 22.12% with a minimum inflation being 8.58%. Crude oil price on average was $38.1 per barrel, recording its highest price of $132.6 per barrel. The descriptive statistics presented in Table 4.1 provides sufficient grounds to carry on with any kind of analysis since the data shows enough variability.

Table 4.1: Summary Statistics

Variable	Observation	Mean	Std. Dev.	Minimum	Maximum
gse	248	2855.6	3207.1	57.7	13356.1
exrt	248	0.606	0.472	0.034	1.519
int	248	27.5	11.947	11.9	47.9
inf	248	22.12	12.672	8.58	66.4
m2	248	2549.9	3601.812	28.4	15202.1
real	248	139.3	42.093	84.6	253.6
oilp	248	38.1	27.491	10.41	132.6

The pairwise correlations of the variables also presented in Table 4.2 to ascertain the degree of collinearity of the variables. This is also to determine potentially which variables can cause multicollinearity in our estimated models to be presented subsequently. The results of the bivariate correlation indicate that the Ghana Stock

Exchange variable gse, is positively correlated with all the other variables except interest rate and inflation which also happens to have its relatively weak correlation. A higher correlation of Ghana Stock Exchange variable (*gse*) with the other variables is not a matter of concern since it is used mainly as the dependent variable in this study, though the other variables are endogenised. Thus, higher correlation amongst the other variables (mainly the independent variables for the purpose of this study) is rather a matter of concern which can cause the variances of the estimated parameters to be unduly large, resulting in the statistical insignificance of most of them. The issue is further addressed when diagnosing the model in subsequent sections.

The results indicate that, money supply and oil price are highly correlated. Again, inflation and interest rate, money supply and exchange rate; money supply and real sector activity are highly correlated. The question that naturally arises is that, should we drop a variable if it is found to be highly correlated with the other variables in the model as in an attempt to solve the problem of multicollinearity? Since all the variables are deemed relevant explanatory variables, dropping a variable might cause serious consequences to the estimates than keeping it. As expressed by Blanchard[2],

> "…When students run their first ordinary least squares (OLS) regression, the first problem that they usually encounter is multicollearity. Many of them conclude that there is something wrong with OLS; some resort to new and often creative techniques to get around the problem. But, we tell them, this is wrong. Multicollinearity is God's will, not a problem with OLS or statistical technique in general".

[2] Blanchard, O.J. (1967), Comment, *Journal of Business and Economic Studies*, vol 5, pp 449-451. The quote is reproduced from Peter Kennedy, *A Guide to Econometrics,* 4th ed., MIT Press, Cambridge, Mass., 1998, p. 190.

Essentially therefore, multicollinearity is a data deficiency problem and since we have no choice over the data we are using in this empirical analysis, nothing is done about the problem of multicollinearity.

Table 4.2: Bivariate Correlation of the Variables

	gse	*exrate*	*int*	*inf*	*m2*	*real*	*oilp*
gse	1.000						
exrate	0.852	1.000					
int	-0.687	-0.605	1.000				
inf	-0.484	-0.465	0.730	1.000			
m2	0.838	0.860	-0.586	-0.441	1.000		
real	0.636	0.553	-0.347	-0.441	0.818	1.000	
oilp	0.877	0.8024	-0.683	-0.483	0.854	0.6688	1.000

4.3 Trends Analysis in GSE-All-Share Index and the other Covariates

This section presents the graphical analysis of the trends in the variables to casually and visually determine the kind of relationship existing between the stock performance variable and the other variables used in the study. The figures presented in this section pair up GSE with the other variables. In all the figures, the GSE variable is plotted on the primary vertical axis (left vertical axis) whiles the others are placed on the secondary vertical axis (right vertical axis). The reason for placing the series on different axes is quite obvious. Since the series are in different units, in particular if one is smaller units, it becomes difficult to observe its trend when pitched against one with larger units. This nonetheless, clearly relates the variables well as it aid visual inspection.

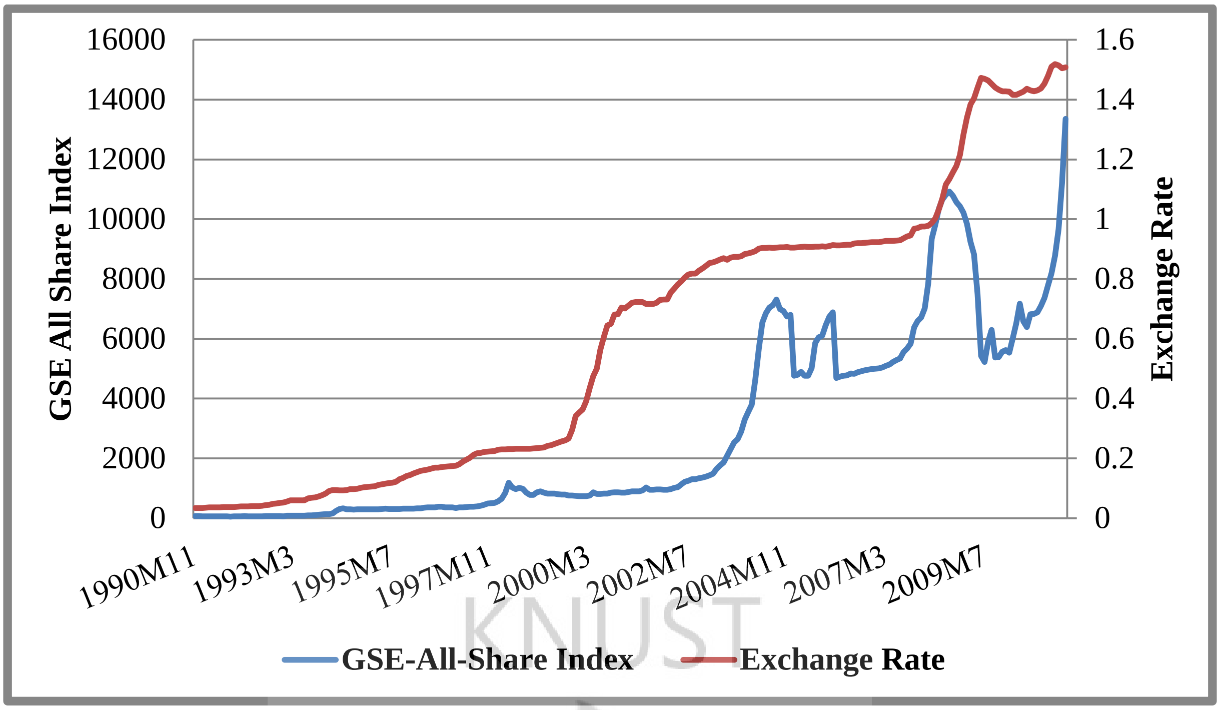


Figure 4.1: Trends in GSE and Exchange Rate in Ghana (1990M11 - 2011M06)

Source: Author's Construct based on data from BOG and Ghana Stock Exchange

Figure 4.1 illustrates GSE Index with exchange rate in Ghana for the period November 1990 and June 2011. There is a clear indication that both series trend upwards, albeit with fluctuations. One interesting observation is that, the exchange rate variable appears to grow quite faster than the GSE variable in relative terms. However, when the trend in the former stalls, the latter fluctuates but in an upward swing. Generally therefore, there seems to be a positive relationship between GSE index and exchange rate.

Figure 4.2 presents the trends in GSE index and interest rate for the period under consideration. Interest rate vacillates more frequently than the GSE index. The figure further illustrates that, periods before December 2003 saw interest rates everywhere above GSE index. After this period, the stock index was found to be above the interest rate. This somewhat suggests that, whiles interest rates are falling, stock indices are growing over the years particularly periods after 2003. Not quite clearly, there seems to be a negative association between these two variables.

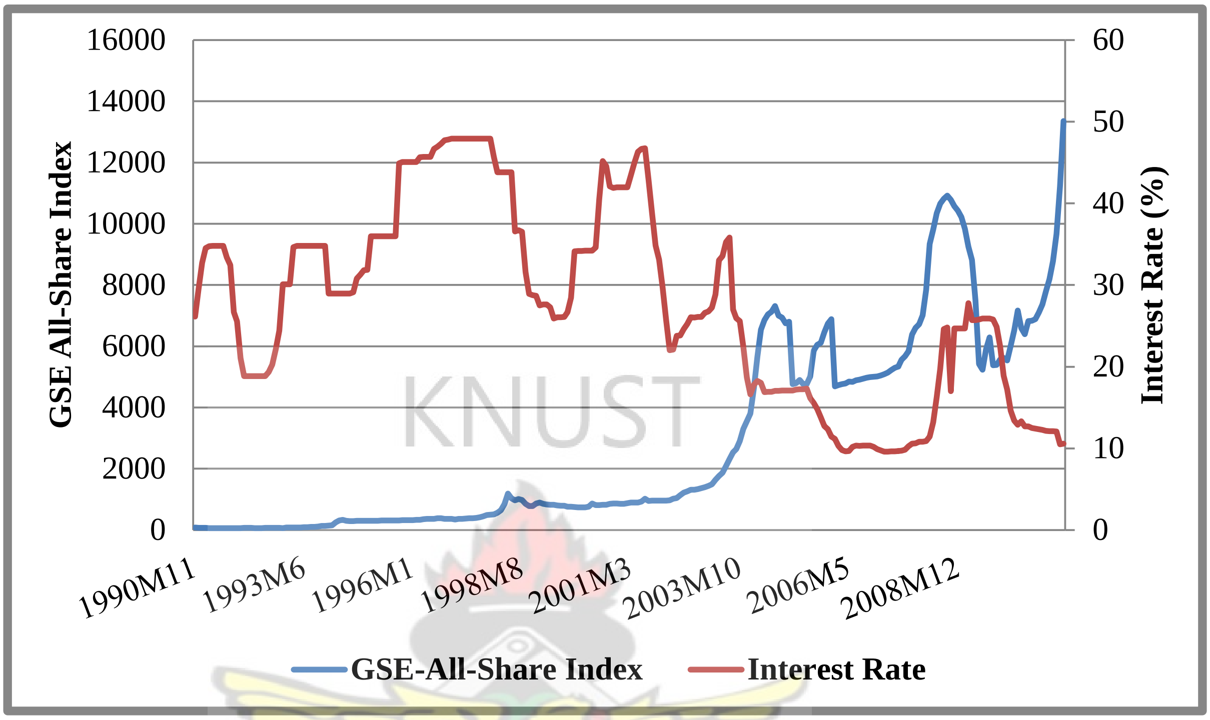


Figure 4.2: Trends in GSE-All-Share Index and Interest Rate in Ghana (1990M11 - 2011M06)

Source: Author's Construct based on data from BOG and Ghana Stock Exchange

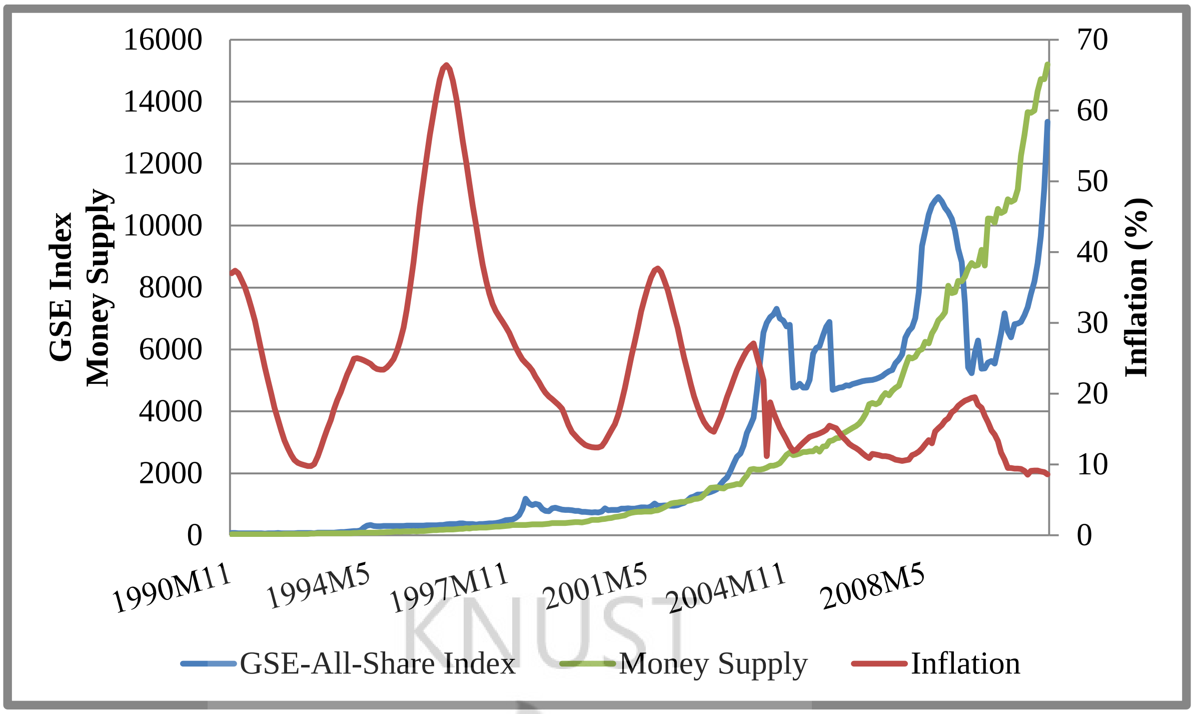


Figure 4.3: Trends in GSE Index, Money Supply and Inflation in Ghana (1990M11 - 2011M06)

Source: Author's Construct based on data from BOG and Ghana Stock Exchange

Figure 4.3 relates GSE index, inflation and money supply trends for the period. The figure indicates that within the period, money supply generally trends upwards with mild fluctuations whiles inflation hovers quite swiftly within the period. There is an indication that, GSE index and money supply are positively associated whiles inflation and GSE are negatively related. Thus, periods that saw generally higher inflation correspond with lower GSE index and money supply. This seemingly suggests a negative relationship between inflation and money supply as well as stock prices.

Again, as clearly shown in Figure 4.4, crude oil prices and stock index are positively correlated as both series trend upwards generally for the period under investigation.

The period around early 2008 saw an unexpected spike in crude oil price. This was the period when the world market price of crude was increasingly astronomically. This was the same period the world economy was touted as experiencing recession. Unsurprisingly therefore, the stock index dropped significantly within that short period and started appreciating again a year after the world economy began to recover from the economic mishap.

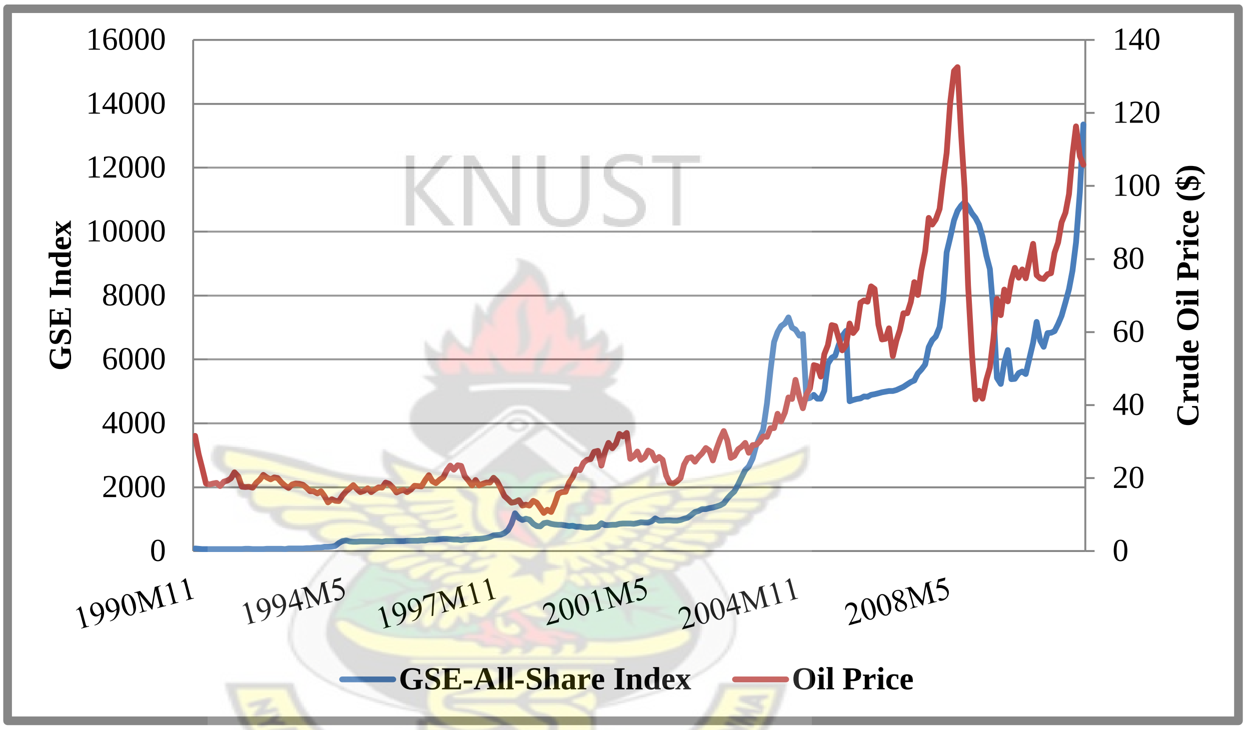


Figure 4.4: Trends in GSE Index and Crude Oil Price in Ghana (1990M11 - 2011M06)

Source: Author's Construct based on data from BOG and Ghana Stock Exchange

Figure 4.5 also relates GSE index with real economic activity index in Ghana for the same period. The trends generally suggest that, real sector activities have grown over the years, albeit the sector recorded its worst performance in August, 1999. Immediately, it picked up the following month where after it maintained a stable but fluctuating trend until November, 2003 when it kept increasing. The period before

November, 2003 saw real sector activity higher in relative terms as per the figure than stock market index. After this period, the latter started increasing quite swiftly though with some pockets of declines. Perhaps, after 2003, a lot of firms saw the need to enlist on the stock market in an attempt to grow their businesses and incorporate a lot more people into their decision making. In sum, the relationship between these two variables is ambiguous.

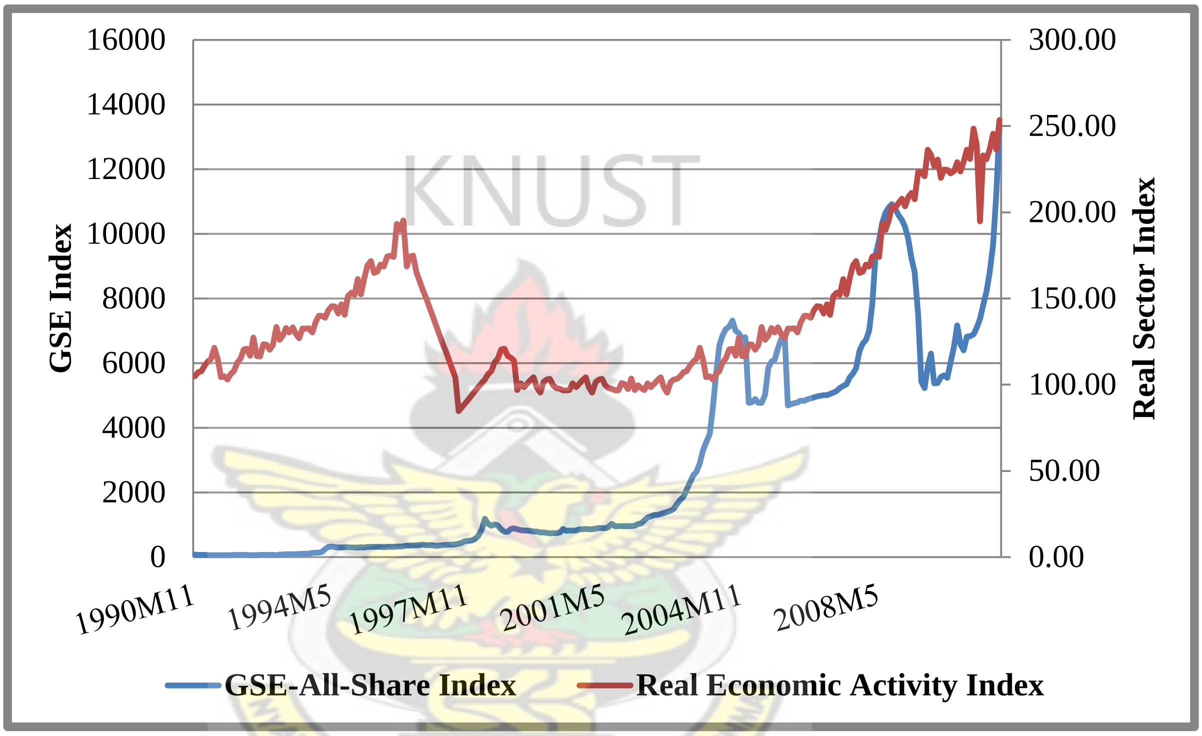


Figure 4.5: Trends in GSE Index and Real Sector Index (1990M11 - 2011M06)

Source: Author's Construct based on data from BOG and Ghana Stock Exchange

4.4 Pre-Analysis Tests

To preclude spurious regression (Granger and Newbold, 1974) and to ascertain that long run relationship exists among the variables, the order of integration of each of the series is checked. Stated differently, for a VAR model, the series used in the model have to be stationary which is checked using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. A graphical inspection of the variables in their levels as shown in the preceding section is suggestive of the non-stationary nature of these series. Thus each of the series presented in the charts exhibits trends in them. However, first differencing them appear to have achieved stationarity since they are mean-reversible.[3]

Table 4.3: Results of the Unit Root Tests

Panel A: Level				
Variable	**ADF**		**PP**	
	Constant No Trend	Constant Trend	Constant No Trend	Constant Trend
Date Period: 1990M11 – 2011M6				
lngse	-1.130	-3.248*	-0.701	-2.481
lnexrate	-2.785*	-1.290	-2.193	-0.897
lnintr	-1.014	-2.746	-1.336	-2.418
lninf	-1.133	-2.293	-2.196	-2.639
lnm2	-1.524	-3.271*	-0.860	-2.031
lnrealsec	-0.389	-0.963	-0.419	-0.996
lnoilp	0.075	-2.373	-0.324	-3.388

Panel B: First Difference				
Variable	**ADF**		**PP**	
	Constant No Trend	Constant Trend	Constant No Trend	Constant Trend
Date Period: 1990M11 – 2011M6				

[3] We present the plots of the first differences of the series in appendix A

$\Delta lngse$	-3.668***	-3.689**	-11.181***	-11.143***
$\Delta lnexrate$	-3.068**	-3.794**	-8.622***	-8.803***
$\Delta lnintr$	-4.411***	-4.568***	-12.630***	-12.616***
$\Delta lninf$	-4.170***	-4.283***	-15.651***	-15.629***
$\Delta lnm2$	-2.867**	-3.090	-14.815***	-14.843***
$\Delta lnrealsec$	-3.405**	-3.616**	-18.233***	-18.276***
$\Delta lnoilp$	-5.036***	-5.164***	-11.692***	-11.715***

The null hypothesis is that the series is non-stationary, or contains a unit root in the case of ADF and PP. The rejection of the null hypothesis for both ADF and PP tests is based on the MacKinnon critical values. *,** and *** indicate the rejection of the null hypothesis at 10% , 5% and 1% significance level, respectively.

It is, however, important to apply formal tests as confirmatory evidence to the casual graphical inspection. Consequently, we apply the unit roots tests of ADF and PP, for which the results are presented in Table 4.3. The results reported in Table 4.3 indicate that each of the series is integrated of order one (i.e., each series is I(1)), and thus contain unit root, which is a necessary precondition for estimating a VAR model. This further confirms the graphical examination of each of the series that they exhibit trends.

4.5 Estimation Results and Analysis of the VAR Model

Since the differenced series are stationary, we estimate our VAR model using the first difference of the variables in the model. Stated alternately, since VAR requires variables to be stationary, using the level form of the variables would not be appropriate because they have been found to be nonstationary. Consequently, we present the results of the estimated VAR model in Table 4.5. Prior to estimating the VAR, we select optimal number of lags to be included in the model using some information criteria as a guide in the selection. The results of the lag selection order criteria are presented in Table 4.4. The results indicate that, the Akaike Information Criterion (AIC) and the Final Prediction Error (FPE) criterion are both selecting lag order of 2 whiles the Hannan-Quinn (HQ) Criterion select a lag order of 1. Adhering to the principle of parsimony in modeling, we settle on the HQ criterion and subsequently use a lag order of 1 in the estimation of the VAR model. Also considering the long series used in the estimation, including two lags in the model is not out of place, all though the AIC penalizes the model quite more in relation to the other information criteria. Again, though the SBIC criterion penalizes the model less, its selection of lag zero is just out of place. Thus, at the 5% level of significance, we use 1 lags in the VAR estimations in conformity with the principle of parsimony.

Table 4.4: VAR Lag Order Selection Criteria

Endogenous variables: $\Delta lngse$, $\Delta lnexrate$, $\Delta lnint$, $\Delta lninf$, $\Delta lnm2$, $\Delta lnreal$, $\Delta lnoilp$

Sample: 1991M2 – 2011M6 Included observations: 245

Lag	LL	LR	FPE	AIC	HQIC	SBIC
0	2649.35		1.0e-18	-21.5702	-21.5299	-21.4702*
1	2765.43	232.17	5.8e-19	-22.1178	-21.7955*	-21.3175
2	2814.83	98.791*	5.8e-19*	-22.1211*	-21.5168	-20.6205

* indicates lag order selected by the criterion (each test at 5% level of significance); LL: Log Likelihood; LR: sequential modified Likelihood Ratio test statistic; FPE: Final prediction error; AIC: Akaike information criterion; SBC: Schwarz information criterion; and HQ: Hannan-Quinn information criterion. Exogenous variables: Constant

Table 4.5: VAR(1) Estimation Results

	$\Delta lngse$	$\Delta lnint$	$\Delta lninf$	$\Delta lnexrate$	$\Delta lnreal$	$\Delta lnm2$	$\Delta lnoilp$
$\Delta lngse_{t-1}$	0.349***	0.018	-0.021	-0.009	0.032	-0.004	0.109
	(0.060)	(0.055)	(0.058)	(0.014)	(0.035)	(0.023)	(0.062)
$\Delta lnintr_{t-1}$	-0.045***	0.207	0.101	0.021	0.002	0.045	-0.014
	(0.001)	(0.063)	(0.066)	(0.016)	(0.039)	(0.026)	(0.070)
$\Delta lninf_{t-1}$	-0.027***	0.041	0.139	0.009	0.034	-0.037	0.032
	(0.006)	(0.061)	(0.064)	(0.016)	(0.038)	(0.025)	(0.068)
$\Delta lnexrate_{t-1}$	-0.064	0.570	0.458	0.592	0.039	0.166	0.046
	(0.217)	(0.199)	(0.208)	(0.052)	(0.125)	(0.082)	(0.223)
$\Delta lnreal_{t-1}$	0.023	-0.023	0.069	-0.013	-0.177	0.042	-0.062
	(0.110)	(0.101)	(0.105)	(0.026)	(0.063)	(0.041)	(0.113)
$\Delta lnm2_{t-1}$	0.035	-0.342	0.092	0.072	-0.095	0.040	-0.160
	(0.168)	(0.154)	(0.161)	(0.040)	(0.097)	(0.063)	(0.173)
$\Delta lnoilp_{t-1}$	0.031	-0.004	0.016	-0.001	-0.017	-0.022	0.274
	(0.060)	(o.055)	(0.057)	(0.014)	(0.035)	(0.023)	(0.062)
Constant	0.016**	-o.003	-0.014	0.005	0.006	0.022	0.006
	(0.007)	(o.007)	(0.007)	(0.002)	(0.004)	(0.003)	(0.008)
RMSE	0.077	0.070	0.074	0.018	0.044	0.029	0.079
R^2	0.1218	0.1153	0.0740	0.4051	0.0417	0.0502	0.0897
χ^2	34.12	32.05	19.67	167.54	10.69	12.99	24.23
	[0.0000]	[0.0000]	[0.0063]	[0.0000]	[0.1524]	[0.0723]	[0.0010]

Notes: Values in ( ) parentheses are standard errors. ** and *** indicate significance at 5% and 1% levels respectively. Values in [ ] parentheses are probability values.

The results of the VAR (1) model are presented in Table 4.5. The results indicate that, the immediate past value of stock price significantly increases its present value. Thus, if the previous month's stock prices increases by 1 percent, the present stock prices increases by approximately 0.35 percent, other things remaining constant.

The results also indicate that, past interest rates have a negative association with current stock prices. This is in accordance with theoretical expectation. Since substantial amount of stocks are purchased with borrowed money, an increase in interest rates would make transactions more costly. Thus, rational investors would tend to invest in less risky assets with high returns. Thus, an increase in past interest rate will have some rippling effects through time to discourage the doing of business and consequently reduces stock performance by approximately 0.05 percent in the current period.

Furthermore, the empirical results indicate that past inflation has a significant negative effect on stock prices in Ghana. The obvious explanation perhaps is that, it takes time for investors to react to changes in the inflationary rates in the economy. The negative coefficient on the inflation variable is consistent with theory. Within the period under investigation, the Ghanaian economy had undergone periods of extreme inflationary trends which consequently led to some swift response from the central bank by increasing the policy rate in an attempt to curtail such escalating prices in the economy. As a consequence, interest rates rise and subsequently result in a reduction in stock prices. Risk-averse investors in periods of escalating prices resort to short term investment mostly in physical assets which means that the stock market loses out since it flourishes on long term investments. Past inflation thus have a negative effect on stock prices. In the literature, a negative relationship between inflation and stock prices is often contended because an increase in the rate of inflation is accompanied by both lower expected earnings growth and higher required real returns. Hoguet (2008) found a similar result in the US as high inflation was associated with a high equity risk premium and declining stock prices.

Moreover, the empirical results indicated that exchange rate has an insignificant negative effect on stock prices. At the aggregate level, the impact of exchange rate fluctuations on stock market would depend on both the degree of openness of domestic economy and the degree of the trade imbalance in an economy. The current findings indicate that exchange rate causes stock prices to fall which apparently indicates that the degree of openness of the Ghanaian economy is low. Adam and Tweneboah (2008) show that there is a negative relationship between Ghana stock market and exchange rate which supports the current findings, albeit not significant.

As anticipated, increases in money supply in the Ghanaian economy increases stock prices, albeit not statistically significant. Thus, increase in M2 growth which indicates excess liquidity available for buying securities lead to higher security prices, though not to any significant extent. Stated alternately, expansionary monetary policy allows government to create excess liquidity (assets that can easily be converted into cash) by engaging in open market operation, which results in an increase in bond prices and lower interest rates. The lower interest rate would lead to the lower required rate of return and thus, the higher stock prices. This may imply that in Ghana, the money supply's positive effect on stock prices through augmented corporate earnings outweighs its negative effect resulting from increased inflation. The results agree with that of Humpe and McMillan (2007) who found an insignificant (although positive) relationship between US stock prices and money supply.

Real activity as expected has a positive effect on stock prices, albeit statistically insignificant. Theoretically, industrial production increases during economic expansion and decreases during a recession, and thus a change in industrial production would signal a change in the economy. However, an expanding economy strengthens the expectation about future stock prices and hence stock returns. The result is however, not surprising considering the comparatively low stock market participations of most Ghanaian households and companies due to the relatively young stock market Ghana possesses. Nonetheless, it is important to highlight the role of real economic activity in the determination of stock prices in the Ghanaian economy as the productive capacity of an economy rises during economic growth, which in turn contributes to the ability of firms to generate cash flows. Naka, Mukherjee and Tufte (1998) indicate that industrial production is the largest positive determinant of Indian stock prices. Additionally, domestic output growth is its predominant driving force to Indian stock market performance which corroborates our findings.

Oil price also has a positive impact on stock prices, albeit not significant. Thus, the elasticity of stock prices to oil prices in Ghana is less than one and not significant. This result is not surprising, since as noted by Hamilton (2003), the relationship between oil prices and stock markets is not entirely linear and that there are evidence of nonlinearities between the two variables. Also, since Ghana until recently was only a net importer of crude oil had not significant control of oil prices and hence its effects on stock performance has not been that impressive.

It is important to emphasize that a battery of diagnostics was performed on the VAR model and it was found that the model thus estimated is stationary as shown in Table 4.6 and figure 4.6. All the eigenvalues are found in the unit circle which is suggestive of stability of the VAR model estimated. Thus, estimating the VAR model is appropriate.

Table 4.6: Eigenvalue Stability Condition

Eigenvalue	Modulus
0.6488805	0.648881
0.3865694	0.386569
0.2430534	0.243053
0.2152153	0.215215
-0.1623292	0.162329
0.04684242 + 0.1049189i	0.114901
0.04684242 - 0.1049189i	0.114901

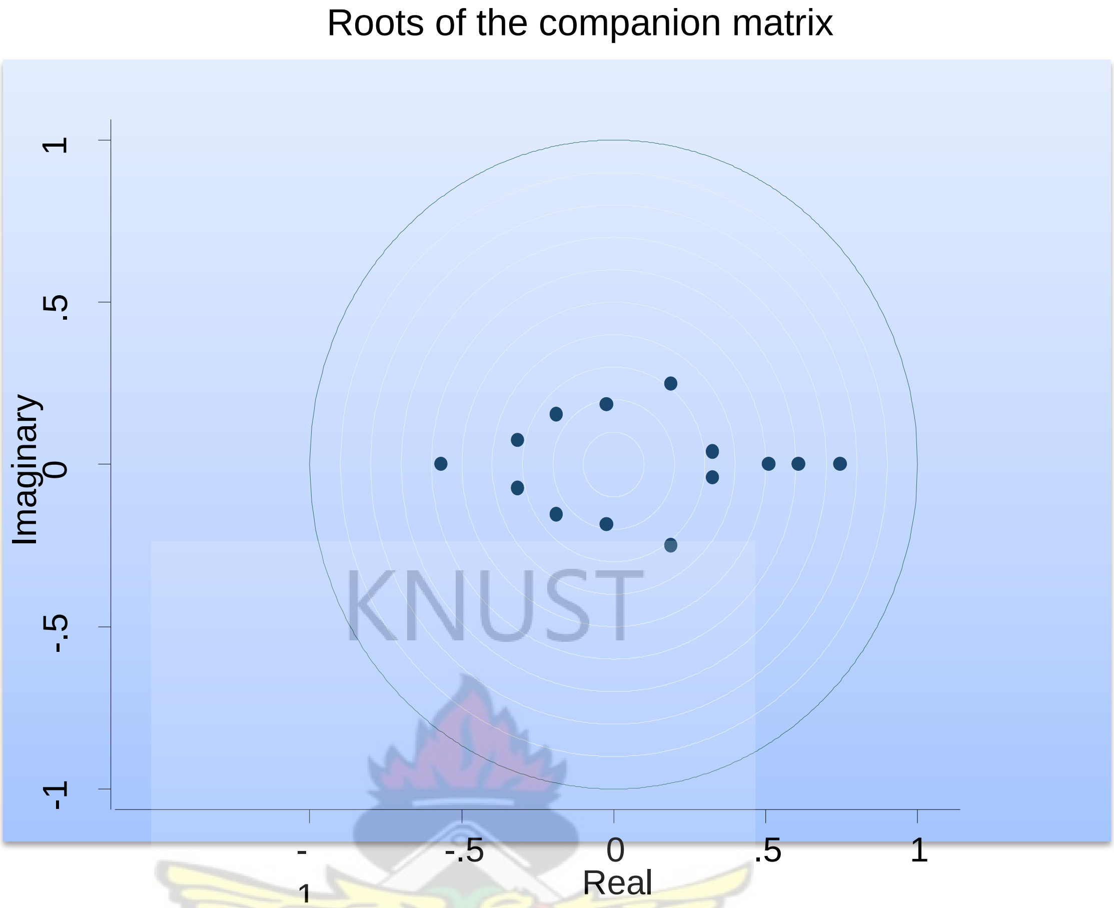


Figure 4.6: Stability Condition of the Estimated VAR Model

4.6 Vector Autogression (VAR) Forecast of GSE Index

Forecasting is the process of estimation in unknown situations. For the purpose of this study, we use the VAR model estimated to forecast the main variable of interest: GSE. We present the results for both in-sample and out-of-sample forecasts. The results are presented in Figures 4.6 and 4.7 respectively. The in-sample forecast shows that, the predicted values are smooth within the forecast period while the true values have obvious fluctuating patterns. Periods after the second half of 2010 witnessed increased growth in the GSE index whiles the forecast values assume a rather stable pattern in GSE. Interestingly, stock prices are easily affected by economic policies and macroeconomic conditions. As a consequence, it is quite difficult to get a reasonable predicted value through by just using the model to forecast a whole year value.

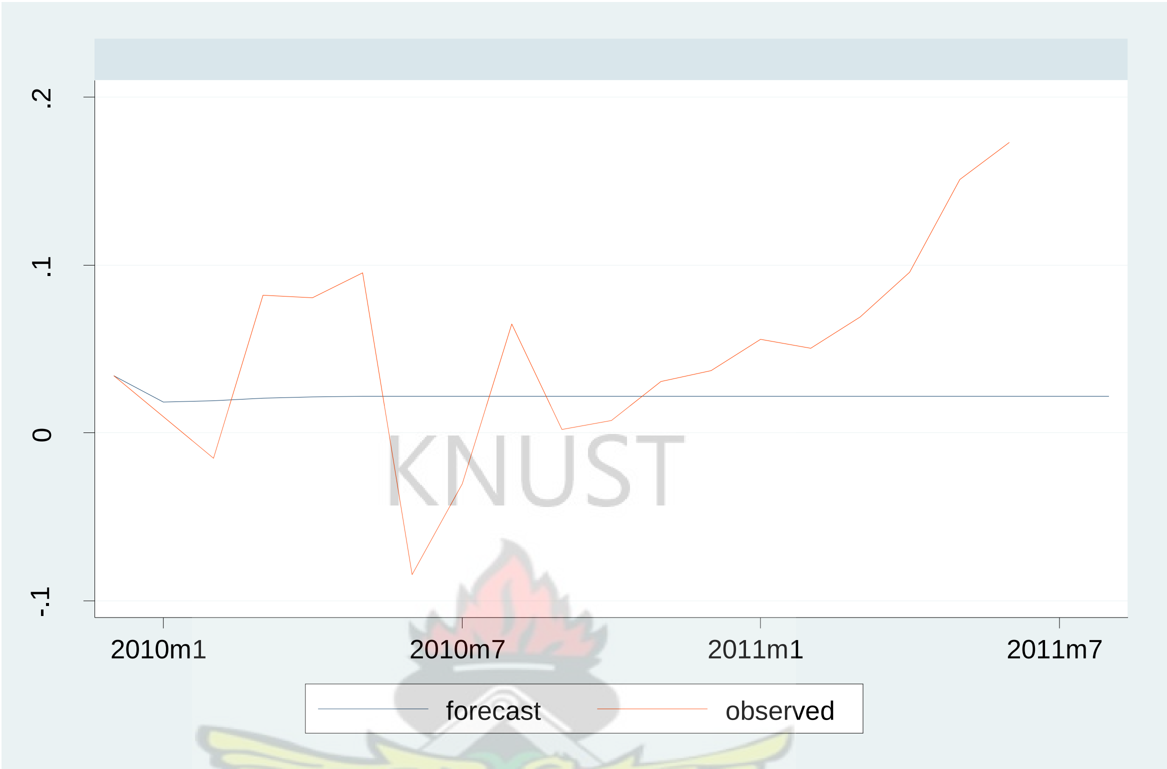


Figure 4.6: In-sample Forecast for GSE Index

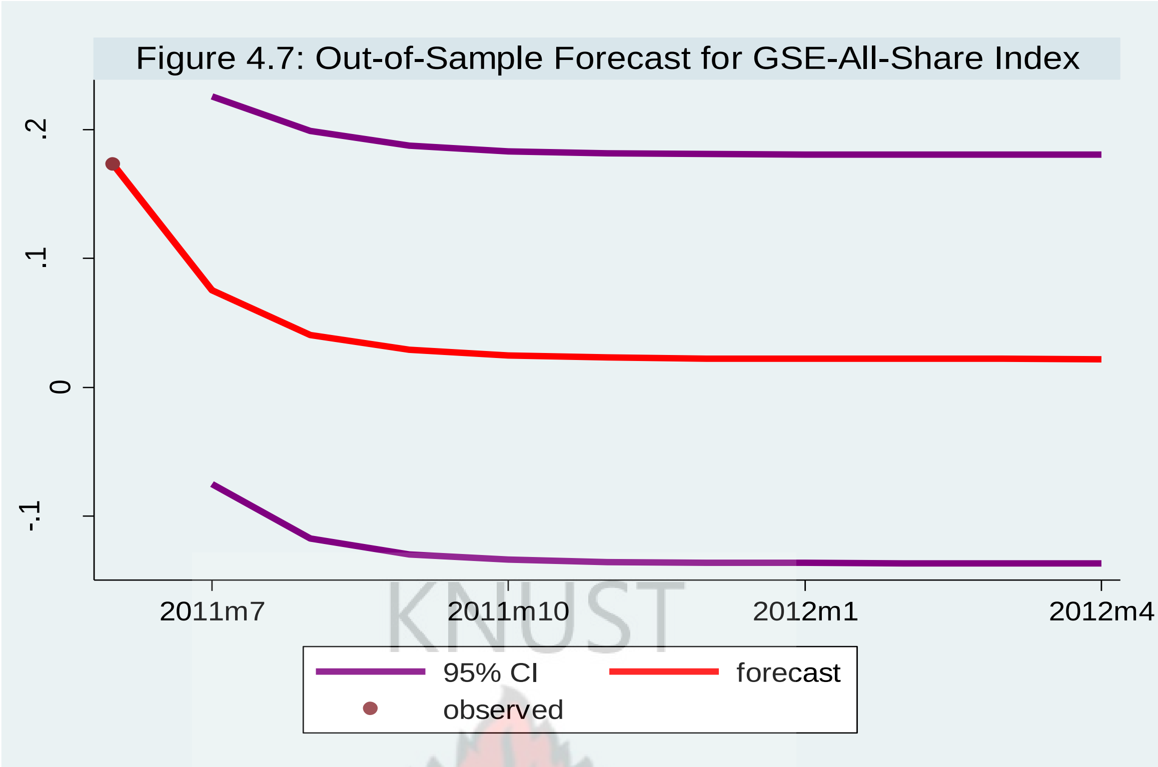


Figure 4.7: Out-of Sample Forecast for GSE-All-Share Index

Figure 4.7 also plots the out-of-sample forecast for 20 periods. The predicted values are smooth as that of the in-sample forecast, thus confirming the assertion that forecasting GSE could be difficult because it is affected by macroeconomic policies which fortuitously can affect GSE.

4.7 Structural Analysis

As noted in the preceding chapter, the interpretation of the VAR model is somewhat difficult and hence it is relevant to analyse the model within the context of structural analysis. Thus, in this section we present the Granger causality analysis in line with one of the objectives of the study in order to ascertain the direction of causality of the variables used in the model. Also we present the impulse response functions of the variable following shocks in others.

4.7.1 Granger Causality Analysis

Granger causality test is a technique for determining whether one time series is useful in forecasting another. The bivariate Granger causality tests were conducted to find out the direction of causality and possible feedback amongst the variables. The results presented in Table 4.7. The results indicate that interest rate causes stock prices. Thus, past values of interest rate can be used to predict the current values of stock prices. However, stock prices do not Granger cause interest rate. There is therefore a unidirectional causality running from interest rate to stock prices. Similarly, causality runs from inflation to stock prices but not the reverse. There is therefore an indication that interest rate and inflation are key determinants and predictors of stock prices in Ghana. Furthermore, the results indicate no causality between stock prices and exchange rate, real sector activity, money supply, and oil prices.

Table 4.7: Granger Causality of the Variables

Equation	Excluded	$\chi^2(2)$	p-value	Inference
$\Delta lngse$	$\Delta lnexrate$	4.364	0.113	Do not reject
$\Delta lngse$	$\Delta lnintr$	5.1677	0.075	Reject
$\Delta lngse$	$\Delta lninf$	4.72637	0.095	Do not reject
$\Delta lngse$	$\Delta lnm2$	0.84302	0.656	Do not reject
$\Delta lngse$	$\Delta lnreal$	1.1377	0.566	Do not reject
$\Delta lngse$	$\Delta lnoilp$	0.60039	0.741	Do not reject
$\Delta lnexrate$	$\Delta lngse$	0.62289	0.732	Do not reject
$\Delta lnexrate$	$\Delta lnintr$	1.9294	0.381	Do not reject
$\Delta lnexrate$	$\Delta lninf$	0.45738	0.796	Do not reject

$\Delta lnexrate$	$\Delta lnm2$	5.0609	0.080	Reject
$\Delta lnexrate$	$\Delta lnreal$	3.3603	0.186	Do not reject
$\Delta lnintr$	$\Delta lngse$	.31635	0.854	Do not reject
$\Delta lnintr$	$\Delta lnexrate$	7.962	0.019	Reject
$\Delta lnintr$	$\Delta lninf$	.32767	0.849	Do not reject
$\Delta lnintr$	$\Delta lnm2$	6.5263	0.038	Reject
$\Delta lnintr$	$\Delta lnreal$	.34613	0.841	Do not reject
$\Delta lnintr$	$\Delta lnoilp$	.56538	0.754	Do not reject
$\Delta lninf$	$\Delta lngse$	.37801	0.828	Do not reject
$\Delta lninf$	$\Delta lnexrate$	2.3873	0.303	Do not reject
$\Delta lninf$	$\Delta lnintr$	3.9614	0.138	Do not reject
$\Delta lninf$	$\Delta lnm2$	.8397	0.657	Do not reject
$\Delta lninf$	$\Delta lnreal$	.67101	0.715	Do not reject
$\Delta lninf$	$\Delta lnoilp$	.06089	0.970	Do not reject
$\Delta lnm2$	$\Delta lngse$	.19165	0.909	Do not reject
$\Delta lnm2$	$\Delta lnexrate$	7.2532	0.027	Do not reject
$\Delta lnm2$	$\Delta lnintr$	16.593	0.000	Reject
$\Delta lnm2$	$\Delta lninf$	3.0009	0.223	Do not reject
$\Delta lnm2$	$\Delta lnreal$	5.363	0.068	Reject
$\Delta lnm2$	$\Delta lnoilp$	6.8185	0.033	Reject
$\Delta lnreal$	$\Delta lngse$	2.2481	0.325	Do not reject
$\Delta lnreal$	$\Delta lnexrate$	1.7027	0.427	Do not reject
$\Delta lnreal$	$\Delta lnintr$	.08029	0.961	Do not reject

$\Delta lnreal$	$\Delta lninf$	1.2343	0.539	Do not reject
$\Delta lnreal$	$\Delta lnm2$	2.2535	0.324	Do not reject
$\Delta lnoilp$	$\Delta lngse$	2.8723	0.238	Do not reject
$\Delta lnoilp$	$\Delta lnexrate$	.07011	0.966	Do not reject

Note: Null hypothesis: Y⇏X (Y does not Granger Cause X); ***, **, * denotes rejection of null hypothesis at 1%, 5% and 10% significance levels respectively. → implies direction of causality.

4.7.2 Impulse Response Functions

Impulse response function (IRF) of a dynamic system is its output when presented with a brief signal, called an impulse. More generally, an impulse response refers to the reaction of any dynamic system in response to some external change. As our VAR model, we have a couple of variables. However, we are interested in the response of GSE Index from the impulses from the other variables. Figures 4.8 and 4.9 illustrate the impulse response functions.

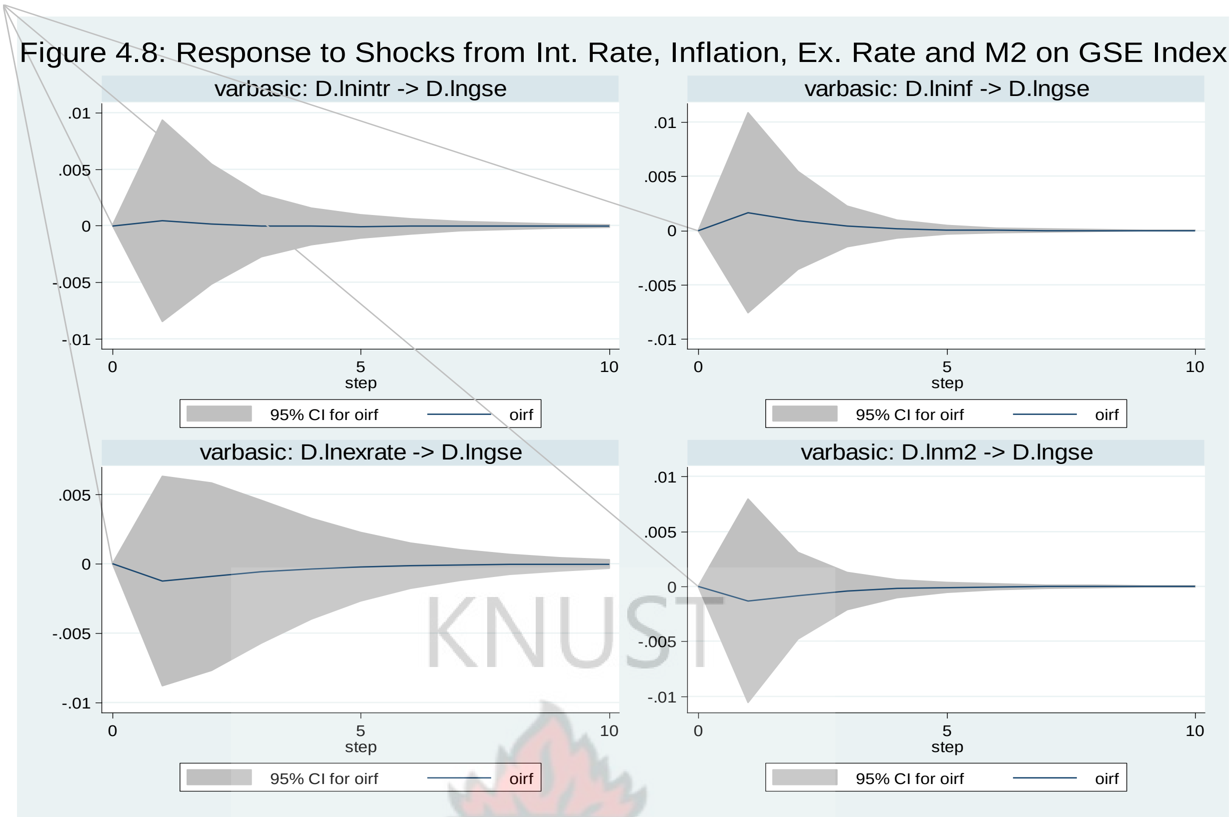


Figure 4.8: Response to Shocks from Int. Rate, Inflation, Ex. Rate and M2 on GSE Index

From Figure 4.8, when the impulse is interest rate, then every response of GSE index is positive at each time responsive period. By the third or fourth period following shocks from interest rate, GSE would have accommodated all the shocks and revert to its equilibrium. However, when the impulse is exchange rate, then GSE first responds negatively immediately after which the response will be positive and all shocks die away by the fifth period. A critical observation of the impulse response functions in a way confirms the Granger causality results as GSE responds positively to shocks from interest rate and inflation.

Figure 4.9: Response to Shocks from Real Sector and Oil Prices on GSE Index

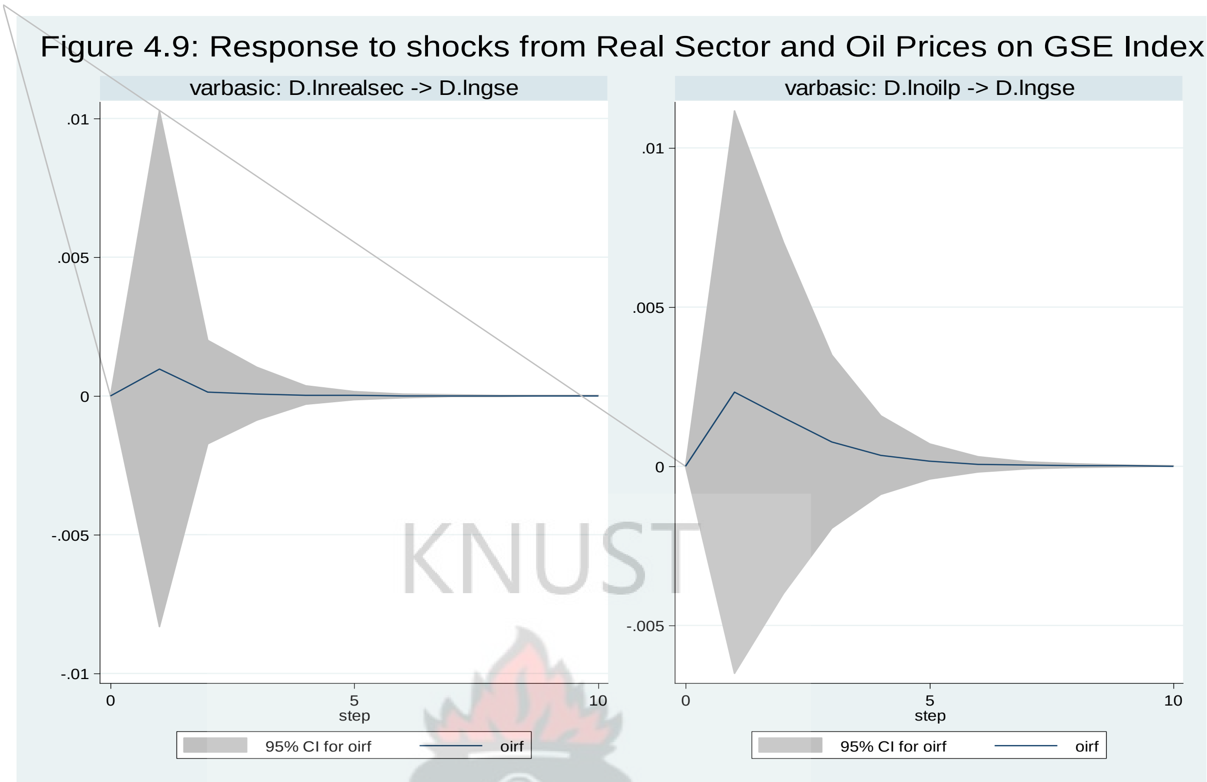


Figure 4.9 illustrates the responses of GSE index from shocks from real sector activity and oil prices. These two shock variables are somewhat sensitive and hence impulses from them results in a positive response on GSE index. In particular, the GSE index responds positively and swiftly to shocks in oil prices since this variable is deemed to affect almost every sector of the economy. However, by the fourth month after the shock, GSE index normalizes (that is, the shocks are all accommodated and the variable GSE reverts back to its original mean level. Shocks from real sector are also positively responded by GSE index and dies away fast after the third month.

CHAPTER FIVE

SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSION

5.0 Introduction

This chapter is structured into three main sections. Section 5.1 summarizes the key empirical findings of the study whiles section 5.2 provides appropriate policy recommendations for the strengthening of the stock market and consequently on the capital market as a tool to promoting economic growth. Finally, section 5.3 concludes the study.

5.1 Summary of Major Findings

The belief that stock market operations as part of the financial liberalization promotes economic growth particularly in developing countries has permeated much thinking throughout the past decades. Thus, drawing on existing literature done for both developing and developed countries, this study seeks to empirically examine the relationship between stock prices and macroeconomic factors for the period November, 1990 and June, 2011 using the multivariate vector autoregressive (VAR) approach. Empirical findings analyzed in the preceding chapter are summarized as follows:

The empirical results indicate that, all the time series variables exhibit trends, and hence non-stationary. Consequently, the differenced series achieved stationarity which were used in the estimation of the VAR model since the technique requires variables to be stationary. The empirical revelation also indicate that, VAR (1) model for the estimation of the relationship between stock prices and macroeconomic factors is appropriate because of the principle of parsimony, though the data was long enough to accommodate higher order lags in the model.

One of the cardinal findings of the study was that inflation and interest rates are crucial in the determination of stock prices in Ghana for the period under consideration. The empirical results further indicate that, though the other factors are also important, within the period, they have not significantly affected stock prices. In particular real economy though has a positive effect in the determination of stock prices but not significant as the Ghanaian economy has not significantly within the period neither declined nor grown.

Furthermore, the empirical results indicate that with the exception of interest rate and inflation which Granger cause stock prices, all the other variables showed no causality with stock prices. Regarding interest rate and inflation, causality does not run from stock prices to these variables but the reverse.

Moreover, the findings reveal that shocks from interest rate and inflation are accommodated shortly by first reacting to them positively. Shocks from oil prices were also found to affect stock prices significantly by positively reacting to them before they die away gradually.

Lastly it was found that, forecasting GSE index (stock prices) in Ghana was somewhat difficult considering how economic policies can affect their determination. Thus, both in-sample and out-of-sample predictions indicated a rather blurry forecast of stock prices within the VAR framework.

5.2 Policy Implications and Recommendations

Concerning the policy implications, the empirical results provide invaluable information for policy formulation and implementation. The results from the estimation indicated that interest rates and inflation are the only instrumental factors in determining stock prices in Ghana. The policy implication is that the Ghana Stock Exchange and hence the entire stock market is not responsive generally to changes in macroeconomic factors in spite of the sizable proportion of stock market capitalization as a share of the country's gross domestic product (GDP). Consequently, predicting stock prices through changes in macroeconomic performance becomes quite doubtful as evident in the forecast of GSE. The immediate effect of the results therefore is that, perhaps the Ghana Stock market might be sensitive to global macroeconomic factors other than the internal ones. Thus the economic policies of Ghana need to be properly and utterly brought into line with global macroeconomic and financial conditions. Incidentally, this policy direction would mean that, controlling domestic policies alone is not enough. Thus, controlling only domestic inflation rate through adjusting interest rate is not enough to provide economic stability since economic policies suffer from other countries economic policies. By so doing, Ghana should coordinate these economic policies that damage economical steadiness.

5.3 Conclusion

The purpose of this study was to investigate the relationship between stock market and a range of macroeconomic variables in Ghana. It went further to examine whether movement in stock prices is determined by macroeconomic variables in Ghana. To capture this, time series macroeconomic data were culled from November, 1990 to

June, 2011 – a period where the capital market gained dominance and where stock market activities boomed. The study employed the multivariate Vector Auto Regression (VAR) technique to establish the relationship between stock prices and macroeconomic variables. Additionally the Granger causality test was applied to ascertain the direction of causality of the variables used in the model. It was found that interest rates and inflation have significant effects in determining stock prices in Ghana. This result was confirmed by the Granger causality test as only interest rates and inflation were found to Grange - cause GSE index in the sample period. This indicates that, perhaps GSE (which is the average share price) is not a leading indicator of stock market performance and hence cannot actually be explained by macroeconomic factors.

REFERENCES

Abugri, B. A. (2008). Empirical Relationship between Macroeconomic Volatility and Stock Returns: Evidence from Latin American Markets, *International Review of Financial Analysis*, Vol.17, Issue 2, pp. 396–410

Adam, A. M. and Tweneboah, G. (2008). Macroeconomic Factors and Stock Market Movement: Evidence from Ghana [Online]. Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1289842

Adjasi, C., Harvey, S.K., and Agyapong, D. (2008). Effect of Exchange Rate Volatility on the Ghana Stock Exchange. *African Journal of Accounting, Economics, Finance and Banking Research* Vol.3.No.3.

Alile, H.I., 1984. The Nigerian Stock Exchange: Historical Perspective, Operations and Contributions to Economic Development. *Central Bank of Nigeria Bullion, Silver Jubilee* Edn, 2: 65-69.

Al-Sharkas, A. (2004). The Dynamic Relationship Between Macroeconomic Factors and the Jordanian Stock Market. *International Journal of Applied Econometrics and Quantitative Studies,* Vol.1-1, pp. 97-114

Aydemir, O. and Demirhan, E. (2009). The Relationship between Stock Prices and Exchange Rates Evidence from Turkey. *International Research Journal of Finance and Economics,* Issue 23, pp. 207-215

Barrows, C. W., & Naka, A. (1994). Use of Macroeconomic Variables to Evaluate Selected Hospitality Stock Returns in the U.S. *International Journal of Hospitality Management*, 13 (2), 119-128

Beltratia, A. and Morana, C. (2006). Breaks and Persistency: Macroeconomic Causes of Stock Market Volatility, *Journal of Econometrics,* Vol. 131, Issue 1-2, pp. 151–177

Charemza, W. C. and Deadman, D. F. (1997) New Directions in Econometric Practice: General to Specific Modelling, Cointegration and Vector Autoregression, 2nd edition, Edward Elgar Publishing Ltd, Cheltenham, UK

Chen, Nai-Fu, Richard Roll and Stephen A. Ross (1986). Economic Forces and the Stock Market. *Journal of Business*, 59, 383-403.

Dornbusch, R. And Fischer, S. (1980). Exchange Rates and the Current Account. *The American Economic Review*, Vol. 70, No. 5, pp. 960-971

Erbaykal, E., Okuyan, H. A., Kadioglu, O. Real (2008). Macro-Economic Variables and Stock Prices: Test of Proxy Hypothesis in Turkey. *Yeditepe International Research Conference on Business Strategies, Istanbul, Turkey, June 13-15, 2008*

Errunza, V. and Hogan, K. (1998). Macroeconomic Determinants of European Stock Market Volatility. *European Financial Management*, Vol. 4, No. 3, pp. 361–377

Fama, E. F. (1981). Stock Returns, Real Activity, Inflation, and Money. *The American Economic Review*, Vol. 71, No. 4, pp. 545-565

Fama, E. F. (1990). Stock Returns, Expected Returns, and Real Activity. *The Journal of Finance,* Vol. 45, No. 4, pp. 1089-1108

Fama, E. F. and Schwert, G. W. (1977). Asset Returns and Inflation. *Journal of Financial Economics*, Vol. 5, Issue 2, pp. 115-146

Firth, M. (1979). The Relationship Between Stock Market Returns and Rates of Inflation. *The Journal of Finance*, Vol. 34, No. 3, pp. 743-749

Fisher, I. (1930). The Theory of Interest [Online] Available at: http://www.econlib.org/library/YPDBooks/Fisher/fshToI.html

Flannery, M. J. and Protopapadakis, A. A. (2001). Macroeconomic Factors Do Influence Aggregate Stock Returns. [Online] Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=314261

Foresti, P. (2006). Testing for Granger Causality Between Stock Prices and Economic Growth MPRA Paper No. 2962. [Online] Available on http://mpra.ub.uni-muenchen.de/2962/1/MPRA_paper_2962.pdf

Frimpong, J. M. (2009). Economic Forces and the Stock Market in a Developing Economy: Cointegration Evidence from Ghana. *European Journal of Economics, Finance and Administrative Sciences,* 16, 1450-2275.

Geske, R and Roll, R. (1983). The Fiscal and Monetary Linkage Between Stock Returns and Inflation. *The Journal of Finance*, Vol. 38, No. 1, pp. 1-33 [Online] Available at: http://www.jstor.org/stable/2327635

Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-Spectral Methods‟, *Econometrics*, Vol. 37, No. 3, pp. 424-438 [Online] Available at: http://www.jstor.org/stable/1912791

Gujarati, D. N. (1995). *Basic Econometrics, 3rd Edition.* McGraw Hill, New York

Gultekin, N. (1983). Stock Market Returns and Inflation: Evidence from other Countries. *Journal of Finance*, 38, 49-65. http://dx.doi.org/10.2307/2327637

Hamilton, J. D. (2003). What is an Oil Shock? *Journal of Econometrics*, 113, pp. 363-98.

Hoguet, G. R. (2008). Inflation and Stock Price, State Street Global Advisors. [Online] Available at: http://www.ssga.com/library/esps/Inflation_and_Stock_Prices_George_Hoguet_8.21.08rev3CCRI1221060800.pdf

Horobet, A and Ilie, L. (2007). On The Dynamic Link Between Stock Prices And Exchange Rates: Evidence From Romania. [Online] Available at: http://mpra.ub.uni-muenchen.de/6429/1/MPRA_paper_6429.pdf

Humpe, A. and Macmillan, P. (2007). Can Macroeconomic Variables Explain Long Term Stock Market Movements? A comparison of the US and Japan. *Centre for Dynamic Macroeconomic Analysis Working Paper Series*. [Online] Available at: http://www.st-andrews.ac.uk/economics/CDMA/papers/wp0720.pdf

Kandir, S. Y. (2008). Macroeconomic Variables, Firm Characteristics and Stock Returns: Evidence from Turkey. *International Research Journal of Finance and Economics*, Issue 16.

Karamustafa, O. and Kucukkale, Y. (2003). Long Run Relationships between Stock Market Returns and Macroeconomic Performance: Evidence from Turkey. [Online] Available at: http://129.3.20.41/eps/fin/papers/0309/0309010.pdf

Kaplan, M. (2008). The Impact of Stock Market on Real Activity: Evidence Turkey. *Journal of Applied Sciences*, 8 (2), pp 374-378

Kasman, S., (2003). The Relationship Between Exchange Rates and Stock Prices: A Causality Analysis. *Dokuz Eylül University Journal of Social Sciences Institute*, Vol. 5, No. 2, pp. 70-79.

Kyereboah-Coleman, A. and Agyire-Tettey K. F. (2008). Impact of Macroeconomic Indicators on Stock Market Performance: The Case of the Ghana Stock Exchange. *The Journal of Risk Finance*, Vol.9 No 4, pg 365-378

Maghayereh, A. (2002). Causal Relations among Stock Prices and Macroeconomic Variables in the Small, Open Economy of Jordan. [Online] Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=317539

Maysami, R. C., Howe, L. C., and Hamzah, M. A. (2004). Relationship between Macroeconomic Variables and Stock Market Indices: Cointegration Evidence from Stock Exchange of Singapore's All-S Sector Indices. *Jurnal Pengurusan* Vol. 24, pp. 47-77

Moore, Geoffrey H. (1983). Business Cycles, Inflation, and Forecasting. *Security Markets and Business Cycles: Chapter 9,* p. 139-160

Mukherjee, T. K. and Naka, A. (1995). Dynamic Relations Between Macroeconomic Variables and the Japanese Stock Market: An Application of a Vector Error Correction Model. *Journal of Financial Research*, 18(2), 223-237.

Muradoglu, G. and Metin, K. (1996). Efficiency of the Turkish Stock Exchange with respect to monetary variables: A Cointegration Analysis. *European Journal of Operational Research*, Vol. 90, Issue 3, pp. 566-576

Muradoglu, G, Metin, K., and Argac, R. (2001). Is There a Long Run Relationship Between Stock Returns and Monetary Variables: Evidence from an Emerging Market. *Applied Financial Economics*, vol. 11, pp. 641-649

Naka, A., Mukherjee, T., and Tufte, D. (1998). Macroeconomic Variables and the Performance of the Indian Stock Market. University of New Orleans, Department of Economics and Finance, Working Papers. [Online] Available at: http://louisdl.louislibraries.org/cgi-bin/showfile.exe?CISOROOT=/EFW&CISOPTR=14

Nardari F. and Scruggs, J. T. (2005). Why Does Stock Market Volatility Change Over Time? A Time-Varying Variance Decomposition for Stock Returns. *EFA 2005 Moscow Meetings* [Online] Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=676673

Nishat, M. And Shaheen, R. (2004). Macroeconomic Factors and Pakistani Equity Market. *The Pakistan Development Review*, Vol. 43, No. 4, pp. 619-637

Obben, J., Pech, A., and Shakur, S. (2006). Analysis of the Relationship between the Share Market Performance and Exchange Rates in New Zealand: A Cointegrating VAR Approach. *New Zealand Economic Papers*, Vol 40, No 2, pp. 147-180

Ozturk, B. (2008). The Effects of Macroeconomic Factors on Istanbul Stock Exchange National 100 Index and Its Volatility (1997-2006), Thesis, Istanbul Technical University (in Turkish)

Reilly, F. K. and Brown, K. C. (2006). Investment Analysis and Portfolio Management. Eigth Edition, Mason – OH, Thomson South-Western.

Rjoub, H., Türsoy, T., and Günsel, N. (2009). The Effects of Macroeconomic Factors on Stock Returns: Istanbul Stock Market. *Studies in Economics and Finance,* Vol. 26, No 1, pp. 36-45.

Saunders, A. and Tress, R. B. (1981). Inflation and Stock Market Returns: Some Australian Evidence. *The Economic Record*, Vol. 57, Issue 156, pp. 58-66.

Schwert, G. W. (1989). Why Does Stock Market Volatility Change Over Time. *The Journal of Finance*, Vol. 44, No. 5, pp. 1115-1153

Sharpe, S. A. (1999). Stock Price, Expected Returns, and Inflation. FEDS Working Paper No. 99-2

Sims, C. (1972). Money Income and Causality. *American Economic Review*, 62 PP540-52.

Solnik, B. and McLeavey, D. (2009). Global Investments. Sixth Edition, Boston, Pearson Prentice Hall.

Stavarek, Daniel (2004). Stock Prices and Exchange Rates in the EU and the USA: Evidence of their Mutual Interactions. MPRA Paper No. 7297

Stowe, J. D., Robinson, T. R., Pinto, J. E., and McLeavey, D. W. (2007). Equity Asset Valuation, New Jersey, John Wiley & Sons, Inc.

Tabak, B. (2006). The Dynamic Relationship Between the Stock Prices and Exchange Rates: Evidence for Brazil. Banco Central Do Brasil, Working Paper Series *124*. [Online] Available at: http://www.bcb.gov.br/pec/wps/ingl/wps124.pdf

Tahir, R. and Ghani, A. A. (2004). Relationship Between Exchange Rates and Stock Prices: Empirical Evidence from Bahrain's Financial Markets EcoMod2004 International Conference on Policy, Modeling, [Online] Available at: http://www.cepii.fr/anglaisgraph/meetings/2004/3006020704.htm

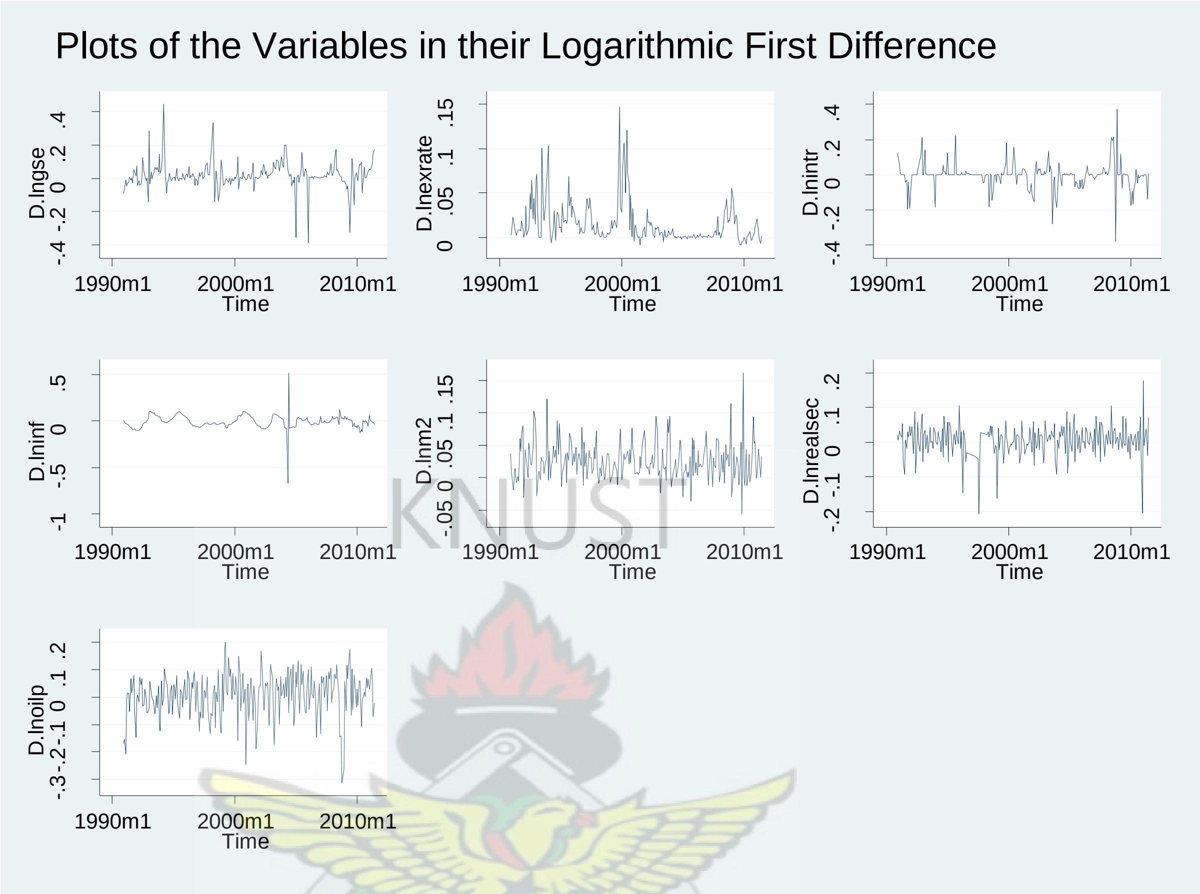
Tursoy, T., Gunsel, T., and Rjoub, H. (2008). Macroeconomic Factors, the APT and the Istanbul Stock Market. *International Research Journal of Finance and Economics*, Issue 22 [Online] Available at: http://www.eurojournals.com/irjfe_22_04.pdf

Wongbangpo, P., & Sharma, S. C. (2002). Stock market and macroeconomic fundamental dynamic interactions: ASEAN-5 countries. *Journal of Asian Economics*, 13, 27-51. http://dx.doi.org/10.1016/S1049-0078 (01)00111-7

Yildirtan, D. C. (2007). Effects of Macroeconomic Variables on Istanbul Stock Exchange Indices, the case of Turkish Stock Exchange Market [Online] Available at: http://www.iuss.info/2007/02-05-07.pdf

Yucel, T. and Kurt, G. (2003). Foreign Exchange Rate Sensitivity and Stock Price: Estimating Economic Exposure of Turkish Companies. [Online] Available at: http://www.etsg.org/ETSG2003/papers/yucel.pdf

APPENDIX A


Plots of the Variables in their Logarithmic First Difference
D.lngse
D.lnexrate
D.lnintr
D.lninf
D.lnm2
D.lnrealsec
D.lnoilp
1990m1
2000m1
2010m1
Time

APPENDIX B

Do File for Stata11

*Encoding the data and declaring the data as time series

```
gen time=m(1990m11)+_n-1

format t %tm

tsset time


*Transformation of variables

gen lngse=log(gse)

gen lnexrate=log(exrate)

gen lnintr=log(intr)

gen lninf=log(inf)

gen lnm2=log(m2)

gen lnrealsec=log(realsec)

gen lnoilp=log(oilp)
```

*Plot of the Variables in their levels and first difference

```
quietly twoway (line lngse time), name (a1)

quietly twoway (line lnexrate time), name (a2)

quietly twoway (line lnintr time), name (a3)

quietly twoway (line lninf time), name (a4)

quietly twoway (line lnm2 time), name (a5)

quietly twoway (line lnrealsec time), name (a6)

quietly twoway (line lnoilp time), name (a7)

graph combine a1 a2 a3 a4 a5 a6 a7
```

```
twoway (line d.lngse time), name (b1)
twoway (line d.lnexrate time), name (b2)
twoway (line d.lnintr time), name (b3)
twoway (line d.lninf time), name (b4)
twoway (line d.lnm2 time), name (b5)
twoway (line d.lnrealsec time), name (b6)
twoway (line d.lnoilp time), name (b7)
graph combine b1 b2 b3 b4 b5 b6 b7
```



```
*Unit Root Testing of the Variables
dfuller lngse, lags(15)
dfuller lnexrate, lags(15)
dfuller lnintr, lags(15)
dfuller lninf, lags(15)
dfuller lnm2, lags(15)
dfuller lnrealsec, lags(15)
dfuller lnoilp, lags(15)
dfuller lngse, lags(15) trend
dfuller lnexrate, lags(15) trend
dfuller lnintr, lags(15) trend
dfuller lninf, lags(15) trend
dfuller lnm2, lags(15) trend
dfuller lnrealsec, lags(15) trend
dfuller lnoilp, lags(15) trend
pperron lngse, lags(15)
```

```
pperron lnexrate, lags(15)
pperron lnintr, lags(15)
pperron lninf, lags(15)
pperron lnm2, lags(15)
pperron lnrealsec, lags(15)
pperron lnoilp, lags(15)
pperron lngse, lags(15) trend
pperron lnexrate, lags(15) trend
pperron lnintr, lags(15) trend
pperron lninf, lags(15) trend
pperron lnm2, lags(15) trend
pperron lnrealsec, lags(15) trend
pperron lnoilp, lags(15) trend
dfuller d.lngse, lags(15)
dfuller d.lnexrate, lags(15)
dfuller d.lnintr, lags(15)
dfuller d.lninf, lags(15)
dfuller d.lnm2, lags(15)
dfuller d.lnrealsec, lags(15)
dfuller d.lnoilp, lags(15)
dfuller d.lngse, lags(15) trend
dfuller d.lnexrate, lags(15) trend
dfuller d.lninf, lags(15) trend
dfuller d.lnm2, lags(15) trend
dfuller d.lnrealsec, lags(15) trend
```

```
dfuller d.lnoilp, lags(15) trend

pperron d.lngse, lags(15)

pperron d.lnexrate, lags(15)

pperron d.lnintr, lags(15)

pperron d.lninf, lags(15)

pperron d.lnm2, lags(15)

pperron d.lnrealsec, lags(15)

pperron d.lnoilp, lags(15)

pperron d.lngse, lags(15) trend

pperron d.lnexrate, lags(15) trend

pperron d.lnintr, lags(15) trend

pperron d.lninf, lags(15) trend

pperron d.lnm2, lags(15) trend

pperron d.lnrealsec, lags(15) trend

pperron d.lnoilp, lags(15) trend


*Summary Statistics

summarize gse   exrate intr inf m2 realsec oilp, detail


*Vector Autoregressive Model Estimation

var d.lngse d.lnexrate d.lnintr d.lninf d.lnm2 d.lnrealsec d.lnoilp

varsoc

varstable

varstable, graph

varlmar, mlag(12)
```

```
varnorm, jbera skewness kurtosis

vargranger

fcast compute m1_, step(24)

fcast graph m1_d.lngse m1_d.lninf m1_d.lnexrt m1_d.lnintr

fcast graph m1_D_lngse

fcast graph m1_D_lninf

fcast graph m1_D_lnexrt

fcast graph m1_D_lnintr

varbasic d.lngse d.lnexrt d.lninf d.lnintr d.lnm2 d.lnrealsec d.lnoilp, lags(1/1)

step(12)irf
```