RELATIONS BETWEEN MACROECONOMIC VARIABLES AND THE STOCK MARKET INDEX: EVIDENCE FROM SRI LANKA

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Degree of Master of Science

Department of Mathematics

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Dissertation submitted in partial fulfillment of the requirements for the degree Master of Science in Operational Research.

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CD Included

DECLARATION

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text and a list of references is given.

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ABSTRACT

This study examines whether the performance of Colombo Stock Exchange(CSE), as measured by the All Share Price Index (ASPI), is affected by a set of macroeconomic variables namely, Interest rate, Broad money supply, Index of Industrial Production and Inflation by using quarterly data obtained from Central Bank of Sri Lanka from 2004:Q1 to 2016:Q3. The Vector. Autoregressive (VAR) framework was adopted by initially looking at the long run and short run relationship between stock market and the macroeconomic variables via the Johansen cointegration technique. To further explore the dynamic co-movement among the variables and the adjustment process towards the long run equilibrium, vector error-correction model (VECM) was used. Finally, Impulse Response Function (IRF) and Variance Decomposition (VDC) are employed in order to illustrate the importance of each macroeconomic variable to the stock market movement when a shock is imposed to the system. The analysis reveals that macroeconomic variables and the stock market index are co-integrated and, hence, a long-run equilibrium relationship exists between them. It is observed that the stock prices positively relate to the industrial production but negatively relate to inflation. The interest rate and money supply are found to be insignificant in determining stock prices in the long run. The results showed that both inflation and money supply significantly and inversely affect stock return in the short run. The results of Granger causality test further indicate that there exists unidirectional causality from inflation to stock return. Furthermore, based on the results of impulse response function and variance decomposition analysis, it is confirmed that that stock market index has stronger dynamic relationship with industrial production index and inflation as compared to money supply and interest rate. Therefore Central Bank of Sri Lanka must undertake pragmatic policies aimed at controlling inflation within acceptable limits, since inflation is seen to inversely affect stock return.

Key Words: All Share Price Index, causality, cointegration, Macroeconomic variables

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

Abbreviation	Description
ADF	Augmented Dickey–Fuller
AIC	Akaike Information Criterion
AR	Autoregressive
ARCH	Auto Regressive Conditional Heteroscedasticity
ARDL	Autoregressive Distributed Lag
ASPI	All Share Price Index
BP	Balance of Payment
CCPI	Colombo Consumer Price index
CSE	Colombo Stock exchange
DSE	Dhaka Stock Exchange
ECM	Error Correction Mechanism
EGARCH	Exponential Generalized Autoregressive Conditional Heteroskedasticity
ER	Exchange Rate
GDP	Gross Domestic Production
GDS	Gross Domestic Savings
GNP	Gross National Production
HQ	Hannan–Quinn
IIP	Index of Industrial Production
IR	Interest Rate
IRF	Impulse Response Function
ISE	Istanbul Stock Exchange
ISE	Istanbul Stock Exchange
JB	Jarque–Bera
KSE	Karachi Stock Exchange
M2	Broad money Supply
OLS	Ordinary Least Squares
PP	Phillips-Perron
SC	Schwartz Criterion
SMI	Stock Market Index
VAR	Vector Auto Regression
VDC	Variance Decomposition
VECM	Vector Error Correction Model
WPI	Wholesale Price Index

CHAPTER 1 INTRODUCTION

1.1 Background of the Study

Over the past few decades, the interaction of share returns and the macroeconomic variables has been a subject of interest among academics and practitioners. It is often argued that stock prices are determined by some fundamental macroeconomic variables such as the interest rate, the exchange rate and the inflation etc. Investors generally believe that monetary policy and macroeconomic events have a large influence on the volatility of the stock price. This implies that macroeconomic variables can influence investors' investment decision and motivates many researchers to investigate the relationships between share returns and macroeconomic variables.

The stock market is an important area of economics and finance. Stock markets play a pivotal role in growing industries and commerce of a country that eventually affect the economy. Its importance has been well acknowledged in industries and investors perspectives. The investors carefully watch the performance of stock markets by observing the composite market index, before investing funds. Moreover, the stock markets of emerging economies are likely to be sensitive to factors such as changes in the level of economic activities, changes in the political and international economic environment and also related to the changes in other macroeconomic factors. Investors evaluate the potential economic fundamentals and other firm specific factors or characteristics to formulate expectations about the stock markets [31].

The well-organized stock market mobilizes the savings and activates the investment projects, which lead to economic activities in a country. The key function of stock market is to act as mediator between savers and borrowers. It mobilizes savings from a large pool of small savers and channelizes these funds into fruitful investments. The Stock market also supports reallocation of funds among corporations and sectors. It also provides liquidity for domestic expansion and credit growth [32].

Efforts to predict the performance of stock market have attracted significant attention of financial analysts and represent a popular area of financial research. The critical importance of the relationship of share returns and the macroeconomic variables has attracted attention of policy makers, investment analysts and economists as well. Stock market of any country acts as the mirror of economy. From the earlier few decades the importance of stock market around the world opened a new road of research into the economic growth and stock market development [26]. Stock exchange performance has attained significant role in global economics and financial markets, due to their impact on corporate finance and economic activities [17]. The impact of economic fundamentals on stock prices or stock returns has been a long debated issue amongst the academicians and professionals [31].

Share market plays a vital role in collecting funds for public corporations whose stocks are traded publicly since it is a place where excessive funds in the economy are transferred to fund deficit units in that economy. Therefore, upgrade of stock exchange is a well-established indicator about the performance of a particular economy. The performance of share prices is observed to be dependent on factors such as macroeconomic variables, domestic and international economy, market expectation about the future growth, socio-political events, monetary and fiscal policies, international transaction etc. Among the numerous factors that affect the share prices, the one that has attracted massive interest of researchers is macroeconomic variables. Almost all empirical studies raised the question of how the stock exchange performance in a particular economy relates to changes in macroeconomic variables [8]. Stock market is considered as a barometer for the performance of the economy. Accordingly, it is argued by many academicians and practitioners that stock prices are affected by the state of economic conditions represented by different macroeconomic variables [24].

It is believed that government financial policy and macroeconomic events have large influence on general economic activities in an economy including the stock market. This motivates many researchers to investigate the dynamic relationship between stock returns and macroeconomic variables [9]. Assuming that macroeconomic fluctuations pose influence on stock prices through their effect on future cash flows and the rate at which these cash flows are discounted, the relationship between stock prices and macroeconomic variables has been widely investigated [40].

How macroeconomic variables and share prices relate is very critical, not only for investors and industry players, but to macroeconomic policy makers as well. An understanding of the linkage between macroeconomic variables and the stock market is also useful for policy makers, given that this linkage is a useful contribution in developing policies in order to support economic growth. There have been innumerable researches in the field of the relationship between the stock index and individual macroeconomic variables to prove that macroeconomic variables and stock index relate significantly. For instance, Fama and Schwert [13] affirmed that macroeconomic indicators influence stock return. Over the past few decades, there had been increase belief that activities in the real economy have some impact on share prices. For instance, Chen et al. [29] established that changes in the macroeconomic variables have some impact on future dividend and also on discount rates, thereby affecting share prices. The increasing attention on the subject is due to the fact that economic theory considers share prices to be a key measure of changes in economic activities.

In modern economy, the capital market plays a very significant role. Significant attention is being paid to the analysis of the stock market because stock markets are among the most critical segment of the economy. The wellbeing of an economy as well as the depth in the capital markets is crucial for the development of a robust real sector in the system and the development of any country [28]. Financial markets are inextricably linked to some of the political and macroeconomic decisions. These decisions such as weak macroeconomic environment, poor policymaking and implementation have the potential of affecting the capital market.

The stock exchange acts as the most important market for capital and a well developed capital market is essential to promote economic development [23]. Colombo Stock

Exchange (CSE) in Sri Lanka was considered to be one of the top performing stock markets in the world until 2010. After the end of the civil war in the country it has attracted a lot of investors and firms during a time period where all the uncontrollable factors like political stability and security concerns were rapidly changing [11]. Inception of share trading under the Colombo Share Brokers Association in 1896 can be identified as the origin of the stock market activities in Sri Lanka. The establishment of a formal stock exchange in 1985 and the incorporation of the Colombo Stock Exchange marked a milestone in the history of share trading in Sri Lanka. The CSE is a company limited by guarantee, and was established under the Companies Act No. 17 of 1982. At present, 295 companies representing 20 business sectors have been listed in CSE with a Market Capitalization of Rs. 3,068.3 Bn. Transactions of the CSE are conducted with a completely automated system which was introduced in 1997 [21]. Over past two decades, the CSE has recorded a remarkable rate of growth in its trading activities [4].

Since adopting an open economic policy in 1977, the government of Sri Lanka has taken a number of steps to liberalize and develop the financial sector in an attempt to maximize its contribution towards the economic development of the country. As a result of these radical changes and other concessions given to equity investors, the stock market in Sri Lanka - CSE attracted the attention of both local and foreign investors and grew rapidly in the recent decades [4].

The performance of the economic environment is measured through macroeconomic variables. There exists a long-term relationship between the changes in stock prices and the macroeconomic variables [18]. According to Chen et al. [29], there is a long-run economic equilibrium relationship between prices of stocks and macroeconomic variables. This is supported by Mukherjee and Naka [44] who showed that economic variables influence stock market returns through their effects on future dividends and discount rates.

Investigations of relationship between macroeconomic factors and performance of stock markets at many emerging economies including that of Sri Lanka are relatively limited on one hand and required to be repeated as the underlying economic settings of such economies have rapidly changed over the years. Post war economic context and subsequent macro-economic revitalizations in Sri Lanka influenced the performance of capital market of Sri Lanka and hence the investigations on 'how does and at what extent the Sri Lankan stock market responds to such macroeconomic developments?' is an important empirical question [16].

Though there are empirical studies in Sri Lanka investigating the impact of macroeconomic factors on stock prices or stock market behavior, the findings may differ when it is repeated with different sample periods and also in different frequency of the data. This study aims to establish the relationship between macroeconomic indicators and share price movement of CSE. All Share Price Index (ASPI) was used to measure the performance of CSE. The main macroeconomic variables examined include 91-day Treasury bill rate, Broad Money Supply, Index of Industrial Production and Inflation. The study employs information on quarterly basis from 2004:Q1 to 2016:Q3 to examine the short run, long run and causal relationship between macroeconomic variables and stock prices utilizing Augmented Dickey Fuller Unit root test, Johannsen co-integration, Vector Error Correction Model (VECM), Granger causality test, Impulse Response Function (IRF) and Variance Decomposition (VDC). Sri Lanka being an emerging stock market in the world, this study would be useful in many aspects of decision making and understanding of the economy.

1.2 Problem Statement

The development and growth of the capital market is crucial for investment, economic growth and development. Knowing how the market will behave as a response to macroeconomic changes is essential for those who are looking for returns on their investments and policy makers. As a result, studies have been undertaken to assess the relationship between macroeconomic variables and share prices. Frequently, research in this area has found statistical proof to support the theory that macroeconomic factors affect the stock market.

Conducting a study to ascertain the possible association between macroeconomic factors and stock market becomes more imperative. The purpose of this research is to examine how the macroeconomic variables affect stock performance of CSE. To address this issue, the following research question is formulated:

What is the influence of macroeconomic variables on the stock index?

To give an answer to the research question four macroeconomic variables have been selected namely, 91-day Treasury bill rate, Broad Money Supply, Index of Industrial Production and Inflation. These macroeconomic factors can be considered as important determinants of stock performance, since each of them features prominently in the stock market. Furthermore, these macroeconomic variables have been investigated in numerous prior studies including Humpe and Macmillan [5], Ahmed [41], Mukherjee and Naka [44], Rauf and Fernando [8], Brahmasrene [43], Hosseini et al. [42], Naik and Padhi [31], Rahman et al. [2] and Sohail and Hussain [32].

1.3 Objectives

- To examine the existence of long-run relationship between macroeconomic variables and stock market index.
- To examine the existence of short-run relationship between macroeconomic variables and stock market index.
- To explore the nature of causal relationship that exists between the stock market index and macroeconomic variables, i.e., is it unilateral or bilateral.

1.4 Research Questions

- Can macroeconomic variables be used to predict stock exchange prices in Sri Lanka?
- Are macroeconomic variables and ASPI related in the long run?
- Are macroeconomic variables and ASPI related in the short run?
- Are there causal relationships between ASPI and macroeconomic variables?

1.5 Significance of the Study

Upon the completion of the study, it will contribute more to the existing body of literature on the macroeconomic variables that affect share prices in emerging markets like Sri Lanka. The importance of this study can be vast and valuable in numerous angels. Firstly, for the policy makers as they need to understand the impact of their policies on the ASPI. Secondly, for investors as they need to understand how the market will move given certain changes in the macroeconomic environment. Thirdly, for researchers in the field to estimate the impact of policies and to predict future movements of the ASPI.

Also, since the stock market is among the most sensitive segment of the economy, the study will help shape macroeconomic policies of the government. For instance, the study will help inform the policy of the government towards improving macroeconomic variables that positively impact on the capital market.

For the policy implication, it is hoped that the findings would help the regulatory bodies to better understand the stock market behavior towards achieving the desired monetary goals. By knowing which macroeconomic variables affect the stock market the most, both the personal and corporate investors would be able to proactively strategize their investments according to the change of the monetary policy.

1.6 Scope of the Study

The study encompasses companies that are listed on the Colombo Stock Exchange from 2004:Q1 to 2016:Q3. Although several factors affect the stock market index, the study concentrates on macroeconomic variables. The macroeconomic indicators employed in the study include Broad Money Supply, 91-day Treasury bill rate, Index of Industrial Production and Inflation. All Share Price Index (ASPI) is used to represent share price performance.

1.7 Outline

This study is organized as follows. Chapter two presents the literature review concerning the linkage between macrceconomic variables and stock performance. Chapter three presents the methodology and introduces the data that will be used. The data analysis, results and discussion of this research will be presented in chapter four. The conclusion and recommendations are provided in chapter five.

CHAPTER 2 LITERATURE REVIEW

Vast studies in the emerging markets show a relationship between macroeconomic variables and stock market performance. The result revealed that macroeconomic variables have impact on the investor's decision of investment and motivate many researches to investigate the relationship between macroeconomic variables and stock prices.

Aside the numerous theories explaining how macroeconomic variables and share price return relate, several empirical studies have also been undertaken to corroborate the theoretical postulations. These empirical studies can broadly be categorized into two. The category that looks at how macroeconomic variables have impacted on stock prices and the second category that focuses how macroeconomic factors affect stock market volatility. This study adopts the first category since the study focuses on the stock prices. The current study aims at examining empirically the impact macroeconomic variables on the ASPI of CSE.

The co-movement between stock price and macroeconomic factors has become very important over the past few decades as the stock price is determined on the basis of macroeconomic variables [26]. Several studies and researches are conducted in order to find out the impact of macroeconomic variables on the stock price. Researchers argue that stock prices depend on macroeconomic factors such as oil price, inflation, industrial production, exchange rate, market capitalization, price to earnings ratio, money supply, employment rate, risk premium, consumer price index and the market rate of interest etc. Many investors believe that fluctuation in these factors have positive or negative impact on the stock price and they make decisions for investment on the basis of these factors. These factors strongly affect the investors and also influence the researchers to find out the relationship between stock price and macroeconomic factors. Several techniques, methods and models are used by the researches in order to see the relationship between stock market and macroeconomic variables such as Unit Root test, cointegration test, Vector Error Correction Model, Granger causality tests, Innovation Accounting, Multiple regression and a number of other methods.

In the past decades, many industry researchers, financial analysts and practitioners have attempted to predict the relationship between stock markets movement and macroeconomic variables. They have conducted empirical studies to examine the effect of stock price on macroeconomic variables or vice-versa or relationship between the two and the results of all those studies have provided different conclusions according to the combination of variables, methodologies and tests used. Here some previous research works and their empirical conclusions that are related to current study are discussed.

Sohail and Hussain [32] examined the long-run and short-run relationships between Lahore Stock Exchange and macroeconomic variables in Pakistan using monthly data and the results of VECM analysis showed that there was a negative impact of consumer price index on stock returns, while, industrial production index, real effective exchange rate, money supply had a significant positive effect on the stock returns in the long-run.

Eita [20] conducted an investigation using VECM econometric methodology and revealed that Namibian stock market prices are chiefly determined by economic activity, interest rates, inflation, money supply and exchange rates. Further the results showed that an increase in economic activity and the money supply increases stock market prices, while increases in inflation and interest rates decrease stock prices.

Ahmad and Ghazi [1] investigated whether the Amman Stock Exchange in Jordan affected by a set of macroeconomic variables namely, Real Gross Demotic Product, Consumer Price Index, Credit to Privet Sector, Weighted Average Interest Rate on Time Deposit and dummy variable which explain the global financial crises period using quarterly data by employing Johansen cointegration test, Vector Error Correction model (VECM), Impulse Response Function (IRF) and Variance Decomposition (VDC). They found that there was a bi-directional long run relationship exists between stock price index and credit to the private sector, weighted average interest rate on time deposits and consumer price index.

A number of studies have been investigated on the causal relationship between macro-economic indicators and stock exchange prices. Rehman et al. [17] examined the causal relationship between macroeconomic indicators and stock market prices in Pakistan by using inflation, exchange rate, balances of trade and index of industrial production as macroeconomic variables and stock exchange prices have been represented by the general price index of the Karachi Stock Exchange. They carried out the analysis by using Augmented Dickey Fuller unit root test, Johansen's co-integration and Granger's causality test and found that cointegration exists between industrial production index and stock exchange prices and no causal relationship was found between macroeconomic indicators and stock exchange prices in Pakistan.

Many researches have focused on the impact of macroeconomic variables on stock price movements in developing economies. In their study, Muhammad and Rasheed [30] have examined the exchange rates and stock price relationships for Pakistan, India, Bangladesh and Sri Lanka using monthly data from 1994 to 2000. The results showed that there was a bi-directional long-run causality between these variables for only Bangladesh and Sri Lanka. No associations between exchange rates and stock prices were found for Pakistan and India.

Gunasekarage et al. [4] examined the influence of macroeconomic variables on stock market equity values in Sri Lanka. They used money supply, treasury bill rate (as a measure of interest rates), consumer price index (as a measure of inflation) and exchange rate as macroeconomic variables and Colombo all share price index (ASPI) to represent the stock market. Unit root test, cointegration, vector error correction models (VECM), impulse response functions (IRF) and variance decompositions (VDC) techniques were used in their analysis and found both long-run and short-run relationships between the stock market index and the macroeconomic variables.

Menike [23] investigated the effects of macroeconomic variables such as money supply, exchange rate, inflation rate and interest rate on stock prices in emerging Sri Lankan stock market using multivariate regression Analysis. The results showed a higher explanatory power of macroeconomic variables in explaining stock prices and also found that inflation rate and exchange rate react negatively to stock prices in the Colombo Stock Exchange (CSE). Rauf and Fernando [8] also have used same macroeconomic variables as Manike used, to investigate the impact of macroeconomic variables on stock prices in the Sri Lankan stock market using multiple regression analysis and found that inflation rate, exchange rate and money supply collectively explain 60% to 78% of the variation on stock price and further found that the inflation rate has significantly negative impact on the stock price while money supply has significantly positive relationship with stock price. Senanayake and Wijeyanayake [11] also carried out the same investigation using multiple regression analysis with an additional macroeconomic variable Gross Domestic Product (GDP) and found that Money supply and inflation have a major impact over the stock market performance and exchange rates do not have any significant influences over the CSE.

Kulathunga [21] examined the impact of macroeconomic factors on stock market development in Sri Lanka using descriptive statistics and multiple regression analysis over the monthly data between 2002 and 2014. Stock market turnover was used as the proxy of stock market development whereas inflation volatility, deposit interest rate, lending interest rate, exchange rate volatility and gross domestic production were used as the key macroeconomic factors. The results suggested that all macroeconomic factors influence the stock market development.

Jahufer and Irfan [6] analyzed the connections that exists between ASPI of CSE and four major macroeconomic factors such as inflation, exchange rate, money market rate and money supply. They used cointegration and vector error correction model (VECM) and found that there exist long run and short run relationships between stock price index and macroeconomic variables.

Nijam et al. [16] identified the impact of macroeconomic variables on stock market performance in Sri Lanka by using regression analysis. They used All share price index of Colombo stock exchange and five macroeconomic variables, namely, Gross domestic product (GDP), Inflation proxied by wholesale price index(WPI), Interest rate (IR), Balance of payment (BP) and Exchange rate (ER) for the analysis and found that macroeconomic variables and the stock market index (All share price index) in Sri Lanka are significantly related. It is observed that the stock market index significantly positively relates to GDP, ER and IR while it negatively relates to inflation proxied by wholesale price index of Sri Lanka. The Balance of payment is found to be insignificant in determining the stock market performance in Sri Lanka.

Khalid [26] explored the long-run relationship between macroeconomic variables and stock return in Karachi Stock Exchange (KSE) using monthly data of inflation, exchange rate, treasury bill rate and Stock return by employing cointegration, Granger causality, impulse response function (IRF) and variance decomposition (VDC). The result showed that there is no co-movement exists between variables and KSE return and exchange rate Granger causes the stock return and inflation Granger causes the treasury bill rate.

Brahmasrene and Jiranyakul [43] examined the relationship between stock market index and selected macroeconomic variables during the post-financial liberalization (pre-financial crisis) and post-financial crisis in Thailand. They found that the stock market index, the industrial production index, money supply, exchange rate and world oil prices contained a unit root and were integrated with order one. Money supply had a positive impact on the stock market index while the industrial production index, the exchange rate and oil prices had a negative impact. In this study, during the post-financial crisis, all variables were integrated at different orders. Cointegration existed between the stock market index and macroeconomic variables. In addition, the Granger causality test indicated money supply was the only variable positively affecting the stock market returns.

Christopher et al. [10] examined the relationship between the New Zealand Stock Index and a set of seven macroeconomic variables from January 1990 to January 2003 using cointegration tests. They employed the Johansen Maximum Likelihood and Granger-causality tests to determine whether the New Zealand Stock Index is a leading indicator for macroeconomic variables. In addition, they investigated the short run dynamic linkages between NZSE40 and macroeconomic variables using innovation accounting analyses. The NZSE40 was consistently determined by the interest rate, money supply and real GDP and there was no evidence that the New Zealand Stock Index is a leading indicator for changes in macroeconomic variables.

Adam and George [9] examined the role of macroeconomic variables on stock prices movement in Ghana. They used the Databank stock index to represent Ghana stock market and inward foreign direct investments, the treasury bill rate (as a measure of interest rates), the consumer price index (as a measure of inflation) and the exchange rate as macroeconomic variables. They analyzed both long-run and short-run dynamic relationships between the stock market index and the macroeconomic variables from 1991:Q1 to 2006:Q4 using Johansen's multivariate cointegration test and innovation accounting techniques. They found that there is cointegration between macroeconomic variables identified and Stock prices in Ghana indicating long run relationship. Results of Impulse Response Function (IRF) and forecast error Variance Decomposition (VDC) indicated that the macroeconomic variables identified significantly influence on share price movements in Ghana.

Naik and Padhi [31] investigated the relationship between the Indian stock market index (BSE Sensex) and five macroeconomic variables namely, industrial production index, wholesale price index, money supply, treasury bills rates and exchange rates over the period from April 1994 to June 2011. Their analysis revealed that the macroeconomic variables and the stock market index are co-integrated and, hence, a long-run equilibrium relationship exists between them. It was observed that the stock prices positively relate to the money supply and industrial production but negatively relate to inflation. The exchange rate and the short-term interest rate were found to be insignificant in determining stock prices. In the Granger causality sense, macroeconomic variables cause the stock prices in the long-run but not in the short-run. Also they found that there exists bidirectional causality between industrial production and stock prices whereas,. unidirectional causality from money supply to stock price, stock price to inflation and interest rates to stock prices.

Robert [37] investigated the time series relationship between stock market index prices and the macroeconomic variables of exchange rate and oil price for Brazil, Russia, India, and China (BRIC) using the Box-Jenkins ARIMA model. There was no significant relationship between respective exchange rate and oil price on the stock market index prices of either BRIC country, due to the influence of domestic and international macroeconomic factors on stock market returns. Also, there was no significant relationship between present and past stock market returns, due to the markets of Brazil, Russia, India, and China due to the weak-form of market efficiency.

Rahman et al. [2] explored the interactions between selected macroeconomic variables and stock prices of Malaysia in a VAR framework. Upon testing a vector error correction model, they showed that changes in Malaysian stock market index performed a cointegrating relationship with changes in money supply, interest rate, exchange rate, reserves and industrial production index. Furthermore, based on the variance decomposition analysis, they implied that Malaysian stock market had stronger dynamic interaction with reserves and industrial production index as compared to money supply, interest rate and exchange rate.

Akbar et al. [24] examined the relationships between the KSE100 index of Karachi Stock Exchange of Pakistan and a set of macroeconomic variables over sampling period in January 1999 to June 2008. Co-integration, Granger causality and VECM tests were used to analyze the relationship between stock prices and macroeconomic variables. They found that stock prices and macroeconomic variables were co-integrated. The results further suggested that stock prices were positively related with money supply and short-term interest rates and negatively related with inflation and foreign exchange reserves.

Pal and Mittal [22] examined the long-run relationship between the Indian capital markets and key macroeconomic variables such as interest rates, inflation rate, exchange rates and gross domestic savings (GDS) of Indian economy. In their research, quarterly time series data spanning the period from January 1995 to December 2008 has been used. The unit root test, the co-integration test and error correction mechanism (ECM) have been applied to derive the long run and short-term statistical dynamics. They found that there is co-integration between macroeconomic variables and Indian stock indices which is indicative of a long-run relationship.

Vejzagic and Zarafat [28] examined the long-term equilibrium relationships between selected macroeconomic variables and the FTSE Bursa Malaysia Hijrah Shariah Index. They showed that FTSE Bursa Malaysia Hijrah Shariah Index plays an important role in economy. Their results showed that Shariah Index has significant relationships with interest rate, exchange rate and money supply; where negatively related with interest rate and exchange rate while positively related with money supply.

Osamwonyi and Osagie [18] determined the relationship between macroeconomic variables and the Nigerian stock market index. They considered the annual data of several macroeconomic variables such as interest rate, inflation rate, exchange rate, fiscal deficit, GDP and money supply from 1975 to 2005 and tried to reveal the relative influence of these variables on the All Share Index of the Nigerian capital market. The Vector Error Correction Model (VECM) was used to study the short-run dynamics as well as long-run relationship between the stock market index and the six selected macroeconomic variables from the Nigerian economy. Their findings show that inflation rate, GDP, exchange rate, lagged SMI and money supply do influence SMI either in the short-run or long-run. Further their results showed that interest rate and money supply (M2) were negatively related to SMI and consumer price index as proxy for inflation rate was positively related to SMI. Fiscal deficit was positively related to SMI in the short-run while exchange rate is positively related to SMI in the short run but negative in the long run.

Another attempt has been made by Dharmendra Singh [12] to explore the relation between stock market index (BSE Sensex) and three key macro-economic variables of Indian economy by using correlation, unit root stationarity tests and Granger causality test. Results showed that the stock market index, Index of Industrial Production (IIP), exchange rate, and Wholesale Price Index (WPI) contained a unit root and were integrated of order one. The Granger causality test indicated that IIP was the only variable having bilateral causal relationship with BSE Sensex. WPI was having strong correlation with Sensex but it was having unilateral causality with BSE Sensex. Sharma and Mahendru [15] also have done the same study by using multiple regression model with macroeconomic variables such as exchange rate, foreign exchange reserve, inflation rate and gold price. Their results showed that exchange rate and gold price were highly effect to the stock prices in India.

Acikalin et al. [40] investigated the relationships between returns in Istanbul Stock Exchange (ISE) and macroeconomic variables of Turkish economy using cointegration tests and VECM. They found long-term stable relationships between ISE and four macroeconomic variables, GDP, exchange rate, interest rate and current account balance and unidirectional relationships between macro indicators and ISE index.

Hosseini et al. [42] investigated the relationships between stock market indices and four macroeconomic variables, namely crude oil price, money supply (M2), industrial production and inflation rate in China and India. They have used the Augmented Dickey-Fuller unit root test, Johansen-Juselius Multivariate Cointegration and VECM and identified that there were both long and short run linkages between macroeconomic variables and stock market index in each of these two countries.

Attari and Safdar [19] examined the relationships among the macroeconomic variables and stock returns using the Exponential Generalized Autoregressive Conditional

Heteroskedasticity (EGARCH). They used interest rate, inflation and gross domestic product as macroeconomic variables and for representation of stock market, Karachi Stock Exchange (KSE-100 Index) was used. The ADF and ARCH tests were used to check the stationarity and homoscedasticity in the data respectively. The results showed that macroeconomic variables have substantial influence on the stock prices. Ismail et al. [39] and Ayaz Khan [7] also identified the influence of macroeconomic variables on Karachi Stock Exchange (KSE-100 Index) by using Autoregressive Distributed lag (ARDL) technique. Their results showed that in the long run each factor significantly contribute to the stock price while in shot run some factors were significant.

Mukherjee and Naka [44] employed the Johansen cointegration test in the VECM and found that the Japanese stock market is cointegrated with six macroeconomic variables namely, exchange rate, money supply, inflation rate, industrial production, long term government bond rate and the short term call money rate. The results of the long-term coefficients of the macroeconomic variables were consistent with the hypothesized equilibrium relationships. Furthermore, Maysmai and Koh [35] used the Johansen cointegration test in the VECM and found that the Singapore stock market is cointegrated with five macroeconomic variables.

Naik [34] investigated the relationships between the Indian stock market index (BSE Sensex) and five macroeconomic variables, namely, industrial production index, wholesale price index, money supply, treasury bills rates and exchange rates. The study used monthly data for these variables over the period April 1994 to June 2011. The author employed Johansen co-integration and VECM for their analysis. The result observed that in the long-run, the stock prices were positively related to money supply (M3). The study established that money supply causes stock prices only in the long-run but no causality from stock price to money supply as found either in the long run or in the short run.

Chen et al. [29] have examined equity returns relative to a set of macroeconomic variables for developed countries and found that the set of macroeconomic variables which can significantly explain stock returns includes growth in industrial production, changes in the risk premium, twists in the yield curve, measures of unanticipated inflation and changes in expected inflation during periods of volatile inflation. Later, Ratanapakorn and Sharma [33] have examined the relationship between the US stock price index and macroeconomic variables using quarterly data for the period of 1975 to 1999. Employing Johansen's cointegration technique and VECM they found that the stock prices positively relate to industrial production, inflation, money supply, short term interest rate and also with the exchange rate, but, negatively related to long term interest rate. Their causality analysis revealed that every macroeconomic variable considered caused the stock price in the long run.

Maysami et al. [36] also examined the relationship among the macroeconomic variables and sector wise stock indices in Singapore using monthly data from January 1989 to December 2001. They employed the Johansen co-integration and VECM approaches and found a significant long-run equilibrium relationship between the Singapore stock market and the macroeconomic variables tested.

Ahmed and Osman [25] have investigated the long run equilibrium and short-term dynamics between DSE stock index and a set of macroeconomic variables like money supply, 91day T-bill rate, interest rate GDP and industrial production index. The cointegration test suggested that there exist two cointegrating vectors and one is statistically significant. In the VECM test, they found that the lagged stock index was adjusted to long run equilibrium by 43.82% by the combined lagged influence of all the selected macroeconomic variables. Granger causality test provided only one unidirectional causality from interest rate change to stock market return.

Ahmed [41] employed the Johansen's approach of co-integration and Toda – Yamamoto Granger causality test to investigate the relationship between stock prices and the macroeconomic variables using quarterly data for the period of March 1995 to March 2007. The results indicated that there was an existence of a long-run relationship between stock price and FDI, money supply and index of industrial production. Causality was found running from stock price movement to movement in industrial production.

According to the above literature there are many empirical studies that have been conducted to examine the relationship between macroeconomic variables and stock returns. Most of these researches are carried out in developed countries in order to help their investors to identify the risks and relationships, which are associated with investments. Investigations of relationship between macroeconomic factors and performance of stock markets at many emerging economies including Sri Lanka are relatively limited and required to be repeated as the underlying economic settings of such economies have rapidly changed over the years. Post war economic context and subsequent macroeconomic revitalizations in Sri Lanka influenced the performance of capital market of Sri Lanka and hence the investigations on 'how does and at what extent the Sri Lankan stock market responds to such macroeconomic developments?' is an important empirical question [16]. After the completion of this study, it is hoped that investors would be able to use the results to obtain better returns from investments.

CHAPTER 3 METHODOLOGY

3.1 Variables Justification and Hypothesis

This research is aimed at identifying relationship between stock return and macroeconomic variables. Four macroeconomic variables were identified and chosen as likely factors to possess the power of explaining stock returns on the CSE. The variables considered for the purposes of this study are all share price index, interest rate, money supply, industrial production and inflation. The interest rate and the money supply represent the money market, whereas the inflation and IIP represent the goods market. The stock prices belong to the securities market [33]. The variables are defined and further explained as follows:

3.1.1 All Share Price Index (ASPI)

This variable captures the performance of the market and it is the dependent variable in the analysis. ASPI represent aggregate equity returns of the market. This is a capital weighted index which covers all traded securities and thus indicates the price fluctuations of all listed companies. ASPI is the longest and most common measure of Sri Lankan Stock market. The weighted mechanism allows price movements in larger companies to decide the index value, on assumption that large companies have greater influence on counties economy in Sri Lanka. The base year and the base value of the index is 1985 and 100 respectively.

3.1.2 Interest Rate

The relationship between interest rates and stock prices is well established. An increase in interest rate will increase the opportunity cost of holding money and investors substitute holdings interest bearing securities for share, hence falling stock prices. The treasury bill rate is used as a measure of interest rate in this study because investing in treasury bills is seen as opportunity cost for holding shares [9]. High treasury bill rates encourage investors to purchase more government instruments. Mukherjee and Naka [44] hypothesized that changes in both short and long-term government bond rates would affect the nominal risk-free rate and thus affect the discount rate. Fama and Schwert [13] observed that the relationship applied to both the current period as well as for lagged values of the interest rates. The interest rates can influence the level of corporate profits which in turn influence the price that investors are willing to pay for the stock through expectations of higher future dividends payment. Most companies finance their capital equipments and inventories through borrowings. A reduction in interest rates reduces the costs of borrowing and thus serves as an incentive for expansion. This will have a positive effect on future expected returns for the firm. As companies purchase substantial amount of stocks with borrowed money, an increase in interest rates would make stock transactions more costly. Investors will require a higher rate of return before investing.. This will reduce demand and lead to a price depreciation [36]. Therefore, in this study, it is hypothesized that there will be a negative relationship between interest rate and stock market.

3.1.3 Broad Money Supply (M2)

Broad Money Supply is defined as circulating money and money in accounts, plus savings accounts and deposits. An increase in money supply results in increased liquidity available for buying securities, resulting in higher security prices. On the other hand, an increase in money supply could also result in increased inflation, which in turn may trigger an increase in interest rate and dampen stock prices. An increase in money supply would indicate excess liquidity available for buying securities, resulting in higher security prices [36]. In the opinion of Mukherjee and Naka [44], the effect of money supply on stock prices is an empirical question. Theoretically, the money supply has a negative impact on stock prices because, as money growth rate increases, the inflation rate is also expected to increase; consequently the stock price should decrease. However, an increase in the money supply would also stimulate the economy and corporate earnings would increase. This would likely results in an increase in future cash flows and stock prices [10]. The negative effects might be countered by the economic stimulus provided by money growth, also known as the corporate earnings effect, which may increase future cash flows and stock prices. Maysami and Koh [35], who found a positive relationship between money supply changes and stock returns in Singapore, further support this hypothesis. The relationship between stock price and money supply was found significantly positive in the study of Ratanapakorn and Sharma [33], however the results were contrary to the findings of Humpe and Macmillan [5] for Japan.

3.1.4 Industrial Production

Tainer [14] is of the view that the industrial production index is procyclical; that is, it rises during economic expansion and falls during a recession. It is typically used as a proxy for the level of real economic activity, that is, a rise in industrial production would signal economic growth. Geske and Roll [38] hypothesized a similar positive relationship through the effects of industrial production on expected future cash flows. The productive capacity of an economy indeed depends directly on the accumulation of real assets, which in turn contributes to the ability of firms to generate cash flow. Findings of Chen et al. [29] based on a US stock portfolio, indicated that future growth in industrial production is a significant factor in explaining stock returns. Hence, suggesting a positive relationship between real economic activities and stock prices [36]. Similarly, it is hypothesized that there will be a positive relationship between industrial production and stock prices in current study.

3.1.5 Inflation

High rates of inflation increase the cost of living and a shift of resources from investments to consumption. This leads to a fall in the demand for market instruments which lead to reduction in the volume of stock traded. Also the monetary policy responds to the increase in the rate of inflation with economic tightening policies, which in turn increases the nominal risk-free rate and hence raises the discount rate in the valuation model [9]. The results of studies by Fama and Schwert [13] and Chen et al. [29], pointed to a negative relation between inflation and stock prices. Therefore, in this study, it is hypothesized that there will be a negative relationship between inflation and stock market.

3.2 Data Description and Source

This study aims at testing the long and short run causality relationship between the stock index and main macroeconomic variables in Sri Lanka. Quarterly time series data were used in exploring the relationship between the macroeconomic variables and ASPI index relating Colombo stock exchange. The included macroeconomic variables in this study are 91 day treasury bill rate (representing the interest rate), broad money supply (M2), index of industrial production (IIP) (representing real output or real economic activity) and Colombo consumer price index (CCPI) (representing the inflation). Quarterly data were collected for the period of 2004:Q1 to 2016:Q3 from the monthly bulletins of Central Bank of Sri Lanka. The description of variables used in this research study is given below.

LNY – Log of ASPI

LNX_1 – Log of Interest rate (91 day T-Bill rate)

LNX_2 – Log of Broad money supply (M2)

LNX_3 – Log of Index of Industrial Production (IIP)

LNX_4 – Log of Colombo Consumer Price Index (CCPI)

The choice of these macroeconomic variables was based on the followings. Money supply represented by M2 provides a measure of liquidity in the economy and any change in money supply should therefore have an impact on the investment decisions of the individual investors. The treasury bill rate acts as the rate of return offered by the risk-free asset and the shifting of funds between risky equity and risk-free assets by portfolio managers is significantly influenced by the movements of this rate. The rise (fall) in inflation reduces (increases) the purchasing power of investors and thus should have an impact on equity investment decisions of local investors. The IIP is used as the measure of the real economic activity because it may explain more return variation than other measures of real economic activities such as real GNP and private investment.

3.3 Model Specification

Since the study uses macroeconomic variables, it is more appropriate to interpret percentage changes (elasticities) of variables than absolute changes. Log-scale informs on relative changes (multiplicative), while linear-scale informs on absolute changes (additive). As this study focused on modelling the relationship between macroeconomic variables and stock market index, and the mechanism acts via a relative change (percentage change), log-scale is critical to capturing the behavior seen in the data. By taking the absolute difference in log space, the actual change can be measured. Therefore the data used in this study was transformed into natural logarithms in order to obtain elasticity coefficients, remove the effect of outliers, improve the interpretability of data and consequently the statistical analysis [31]. In log linear form the function becomes:

$$\ln(Y_t) = \beta_0 + \beta_1 \ln(X_{1_t}) + \beta_2 \ln(X_{2_t}) + \beta_3 \ln(X_{3_t}) + \beta_4 \ln(X_{4_t}) + e_t \quad (1)$$

where β_0 is a constant, $\beta_1, \beta_2, \beta_3$ and β_4 are the sensitivity of each of the macroeconomic variables to stock prices and e_t is a stationary error correction term [9].

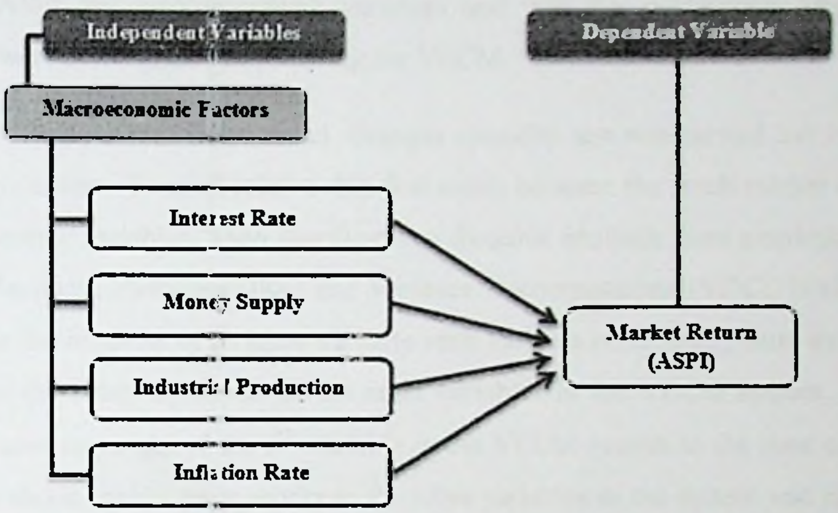


Figure 3.1: Conceptual framework of ASPI and macroeconomic variables

3.4 Research Methodology

The principal method employed to analyze the time series behavior of the data involves cointegration and the estimation of a Vector Error Correction Model (VECM). This has become a well-established methodology when testing the long run relationships among variables.

The first step of this process involves a test for stationarity to find out the order of integration of the variables. For this purpose, Augmented Dickey-Fuller (ADF) and Phillips-Perron tests for unit roots were employed. Once the order of integration of each variable has been determined, the cointegration analysis was performed to determine whether the time series of these variables display a stationary process in a linear combination. For this purpose, the Johansen (1991) method of multivariate cointegration was employed. A finding of cointegration implies the existence of a long term relationship between the market index and the macroeconomic variables. Cointegrating relationships were found among the variables suggesting the long run relationship between ASPI and macroeconomic variables and then the relationship among these variables were determined by estimating the VECM.

Once the VECM model is estimated, Granger causality test was carried out in order to identify the nature of causal relationship that exists between the stock market index and macroeconomic variables. Then two short-run dynamic analyses were employed namely Impulse Response Functions (IRF) and Variance Decompositions (VDC). Both allow to investigate the behavior of an error shock to each variable on its own future dynamics as well as on the future dynamics of the other variables in the VECM system. The IRFs show impulse responses of the i^{th} variable in the VECM system to the time paths of its own error shock against error shocks to the other variables in the system and plotting the IRFs is a practical way to visualize the response [4]. The VDCs demonstrate the proportion of the movement of the n-step ahead forecast error variance of the i^{th} variable in the system attributable to its own error shock as opposed to error shocks to the other variables in the system.

Finally, diagnostic checking was carried out to certify the accuracy of the fitted model.

3.5 Theoretical Background

A Number of econometric models were employed to analyze the data used for the study. These included Unit root test, Johansen cointegration, VECM, Granger causality test, Impulse Response Function (IRF) and Variance decomposition (VDC). Set of diagnostic tests were also used such as CUSUM test, Normality test, Breusch-Godfrey serial correlation LM test, Breusch-Pagan-Godfrey heteroscedasticity test, Correlogram Q-Statistics of residuals and Correlogram Q-Statistics of squared residuals. These models are further discussed as follows.

3.5.1 Order of a Series

Suppose that non stationary series is said to be differenced d times in order to make the series to be stationary. Then it is said to be integrated of order d. It can be also written as $I(d)$.

Suppose $Y_t = Y_{t-1} + u_t$.

Then Y_t is $I(1)$ where $Y_t - Y_{t-1}$ is $I(0)$.

3.5.2 Stationarity Test (Unit Root Test)

The present study employs the time series data analysis technique to study the relationship between the stock market index and the selected macroeconomic variables. In a time series analysis, the ordinary least squares (OLS) regression results might provide a spurious regression if the data series are non-stationary. Thus, the data series must obey the time series properties i.e. the time series data should be stationary, meaning that, the mean and variance should be constant over time and the value of covariance between two time periods depends only on the distance between the two time period and not the actual time at which the covariance is computed.

The most popular and widely used test for stationarity is the unit root test. The presence of unit root indicates that the data series is non-stationary. Two standard procedures of unit root test namely the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests were performed to check the stationary nature of the series.

3.5.2.1 Augmented Dickey Fuller (ADF) Test

One of the most popular among the unit root tests is the Augmented Dickey-Fuller (ADF) test. ADF test is an extension of Dickey-Fuller test. The ADF test entails regressing the first difference of a variable Y on its lagged level, exogenous variable(s) and k lagged first differences which can be given as follows.

$$\Delta Y_t = \alpha + \beta T + \rho Y_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta Y_{t-i} + e_t \qquad (2)$$

where Y_t is the variable in period t, T denotes a time trend, Δ is the difference operator, e_t is an error term disturbance with mean zero and variance σ^2 and k represents the number of lags of the differences in the ADF equation.

The null hypothesis indicates that there is a unit root among the variables whilst the alternative hypothesis indicates there is none.

H_0: Variable has a unit root

H_1: Variable hasn't a unit root

The ADF is restricted by its number of lags. It decreases the power of the test to reject the null hypothesis of a unit root, because the increased number of lags necessitates the estimation of additional parameters and a loss of degree of freedom. The number of lags is being determined by minimum number of residuals free from autocorrelation. This could be examined for the standard approach such as Akaike's Information Criterion (AIC) and Schwartz Criterion (SC).

3.5.2.2 Phillips-Perron (PP) Test

Phillips and Perron (1988) adopts a nonparametric method for controlling higher-order serial correlation in a series. The test regression for the Phillips-Perron (PP) test is the AR (1) process. While the ADF test corrects for higher order serial correlation by adding lagged differenced terms on the right-hand side, the PP test makes a correction to the t-statistic of the coefficient from the AR(1) regression to account for the serial correlation in e_t. The correction is nonparametric. The advantage of Phillips-Perron test is that it is free from parametric errors. Phillips-Perron (PP) test allows the disturbances to be weakly dependent and heterogeneously distributed. In view of this, PP values have also been checked for stationarity [41]. The Phillips-Perron (PP) unit root tests differ from the ADF tests mainly in how they deal with serial correlation and heteroskedasticity in the errors.

Consider a model

$Y_t = \theta_0 + \phi Y_{t-1} + a_t$

Where a_t is serially correlated. Then Phillips-Perron test equation can be written as,

$\Delta Y_t = \theta_0 + \delta Y_{t-1} + a_t$

The hypothesis to be tested is,

$$H_0: \delta = 0$$

$$H_1: \delta < 0$$

The PP tests correct for any serial correlation and heteroskedasticity in the errors a_t of the test regression by directly modifying the test statistics $t_{\delta=0}$ and $n\hat{\delta}$. These modified statistics, denoted Z_t and Z_δ are given by,

$$Z_t = \sqrt{\frac{\hat{\sigma}^2}{\hat{\lambda}^2}}\, t_{\hat{\delta}} - \frac{1}{2}\left(\frac{\hat{\lambda}^2 - \hat{\sigma}^2}{\hat{\lambda}^2}\right)\left(\frac{n(s.e.(\hat{\delta}))}{\hat{\sigma}^2}\right)$$

$$Z_\delta = n\hat{\delta} - \frac{1}{2}\left(\frac{n^2\left(s.e.(\hat{\delta})\right)}{\hat{\sigma}^2}\right)(\hat{\lambda}^2 - \hat{\sigma}^2)$$

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

$\sigma^2 = \lim_{n\to\infty} n^{-1} \sum_{t=1}^{n} E(a_t^2)$ and $\lambda^2 = \lim_{n\to\infty} \sum_{t=1}^{n} E\left(\frac{1}{n}\sum_{t=1}^{n} a_t^2\right)$

Under the null hypothesis that $\delta = 0$, the PP Z_t and Z_δ statistics have the same asymptotic distributions as the ADF t-statistic and normalized bias statistics.

3.5.3 Cointegration Test and Vector Error Correction Model

With the non-stationary series, cointegration analysis has been used to examine whether there is any long run relationship exists. However, a necessary condition for the use of cointegration technique is that the variable under consideration must be integrated in the same order and the linear combinations of the integrated variables are free from unit root.

If the series used become stationary at the same level $I(1)$ (i.e. they are non-stationary at level but stationary at first difference), then it would be possible to the linear combination of the variables to be stationary at the zero level $I(0)$ which means that the data are cointegrated. It is also possible to have more than one linear combination, and so more than cointegration relationship between the variables exists. This linear combination is called the cointegrating equation and reflects a long-run equilibrium relationship among the variables.

To conduct the co-integration test, the Johansen (1991) approach was used. The Johansen's cointegration method is regarded as full information maximum likelihood method that allows for testing cointegration in a whole system of equations. The Johansen methods of cointegration can be written as the following vector autoregressive framework of order p $(VAR(p))$.

$$X_t = A_0 + \sum_{j=1}^{p} B_j X_{t-j} + e_t \qquad (3)$$

where X_t is an $n \times 1$ vector of non stationary $I(1)$ variables, A_0 is an $n \times 1$ vector of constants, p is the maximum lag length, B_j is an $n \times n$ matrix of coefficient and e_t is a $n \times 1$ vector of white noise terms.

Johansen's (1991) VECM, which employs the full information maximum likelihood method, is implemented in the following steps [44]:

1. Test whether all variables are integrated of order one by applying a unit root test.
2. Find the truncated lag(k) such that the residuals from each equation of the VECM are uncorrelated.
3. Regress ΔX_t against the lagged differences of ΔX_t and ΔX_{t-k}, and estimate the eigenvectors (cointegrating vectors) from the canonical correlations of the set of residuals from these regression equations.
4. Determine the order of cointegration.

To use the Johansen's (1991) method, equation (3) needs to be turned into a vector error correction model which can be written as,

$$\Delta X_t = A_0 + \sum_{j=1}^{p-1} \Gamma_j \Delta X_{t-j} + \Pi X_{t-1} + e_t \qquad (4)$$

where, Δ is the first difference operator, $\Gamma_j = -\sum_{i=j+1}^{p} B_i$ and $\Pi = -I + \sum_{i=j+1}^{p} B_i$, and I is an $n \times n$ identity matrix. The Π matrix reveals the adjustment to disequilibrium following an exogenous shock.

The test for cointegration between the X's is calculated by observing the rank of the Π matrix via its eigenvalues. The rank of a matrix is equal to the number of its characteristic roots that are different from zero. The hypothesis is $H_0\colon \Pi = \alpha\beta'$ where α and β are $n \times r$ loading matrices of eigenvectors. The cointegration rank is given by r and each column of β is a cointegrating vector (showing a long-run relationship). The elements of the α matrix represent the adjustment or loading coefficients, and give the speed of adjustment of the endogenous variables in response to disequilibrium shocks, while the elements of the Γ matrices capture the short-run dynamic adjustments. The test procedure relies on relationships between the rank of a matrix and its characteristic roots (or eigenvalues). The rank of Π equals the number of its characteristic roots that differ from zero, which in turn corresponds to the number of cointegrating vectors [42]. The aim is to test the number of r cointegrating vectors such as $\beta_1, \beta_2, \dots, \beta_r$. The number of characteristic roots can be tested by considering the following trace statistic and the maximum eigenvalue test.

$$\lambda_{trace}(r) = -T\sum_{i=j+1}^{p} \ln(1-\hat{\lambda}_j) \quad \text{and} \quad \lambda_{max}(r, r+1) = -T\ln(1-\hat{\lambda}_{r+1})$$

where, r is the number of cointegrating vectors under the null hypothesis, T is the number of usable observations and $\hat{\lambda}_j$ is the estimated value for the j^{th} ordered characteristic roots or the eigenvalue from the Π matrix.

A significantly non-zero eigenvalue indicates a significant co-integrating vector. The trace statistics is a joint test where the null hypothesis is that the number of co-integration vectors is less than or equal to r against an unspecified general alternative that there are more than r. Whereas, the maximum eigenvalue statistics test the null hypothesis that the number of cointegrating vectors is less than or equal to r against the alternative of $r+1$. The presence of cointegrating vectors supports the application of a dynamic VECM that depicts the feedback process and speed of adjustment for short run deviation towards the long run equilibrium and reveals short run dynamics in any variables relative to others [31].

Once cointegrating relationship has been established, the results are used in applying the VECM which measures the long run relationship. VECM permits testing for co-integration in a whole system of equation in one step without requiring a specific variable to be normalized. Another advantage of VECM is the non-requirement for a prior assumption of endogenity or exogenity of the variables [2].

3.5.4 Granger-Causality Test

A variable X is said to be Granger cause Y if Y can be predicted with greater accuracy by using past values of X [12]. In order to examine whether there are lead-lag relationships between ASPI index and various macroeconomic variables, the Granger-causality test was employed. If the time series of a variable is nonstationary, i.e. $I(1)$, the variable is converted into $I(0)$ by first differencing and the Granger-causality test can be applied as follows:

$$\Delta X_t = \alpha_0 + \sum_{i=1}^{k} \alpha_i \Delta X_{t-i} + \sum_{j=1}^{k} \beta_j \Delta Y_{t-j} + u_t \qquad (5)$$

$$\Delta Y_t = \beta_0 + \sum_{j=1}^{k} \beta_j \Delta Y_{t-j} + \sum_{i=1}^{k} \alpha_i \Delta X_{t-i} + v_t \qquad (6)$$

where ΔX_t and ΔY_t are the first difference of time series variable while the series is nonstationary.

To test whether Y Granger causes X, following hypothesis can be tested.

H_0: Y doesn't Granger cause X

H_1: Y Granger cause X

The null hypothesis for the equation (5) is $H_0: \sum_{j=1}^{k} \beta_j = 0$ suggesting that the lagged terms ΔY don't belong to the regression implying that Y doesn't Granger cause X. That means Y Granger cause X only if β_j is statistically significant.

To test whether X Granger causes Y, following hypothesis can be tested.

H_0: X doesn't Granger cause Y

H_1: X Granger cause Y

Similarly, the null hypothesis for the equation (6) is $H_0: \sum_{i=1}^{k} \alpha_i = 0$, that is the lagged terms ΔX do not belong to the regression implying that X doesn't Granger cause Y. That means X Granger cause Y only if α_i is statistically significant. These hypotheses are tested using F-test [10].

3.5.5 Innovation Accounting

The cointegration analysis only captures the long-run relationship among the variables and it does not provide information on responds of variables in the system to shocks or innovations in other variables. To find how the stock index responds to shocks or innovation in the macroeconomic variables, Innovation Accounting such as Impulse Response Function (IRF) and forecast error variance decompositions (VDC) based on VECM was evaluated.

3.5.5.1 Impulse Response Function (IRF)

The impulse response functions are responses of all variables in the model to a one unit structural shock to one variable in the model. This function investigates the time horizon of variables and their response for any sudden shock in any variable in the model with time passes. The impulse responses are plotted on the Y-axis with the periods from the initial shock on the X-axis [10].

An impulse response gives the response of one variable, to an impulse in another variable in a system that may involve a number of other variables as well.

A $VAR(p)$ model can be written as,

$$Y_t = c + \Phi_1 Y_{t-1} + \cdots + \Phi_p Y_{t-p} + a_t.$$

If the system is stable, the effects of shocks in the variables of the system are most easily seen in its Wold moving average (MA) representation,

$$Y_t = \mu + \Psi(L)a_t = \mu + a_t + \Psi_1 a_{t-1} + \Psi_2 a_{t-2} \cdots$$

$$\Psi(L) = [\Phi(L)]^{-1}$$

Redating at time $t + s$ gives,

$$Y_{t+s} = \mu + a_{t+s} + \Psi_1 a_{t+s-1} + \Psi_2 a_{t+s-2} + \cdots + \Psi_s a_t + \Psi_{s+1} a_{t-1} + \cdots$$

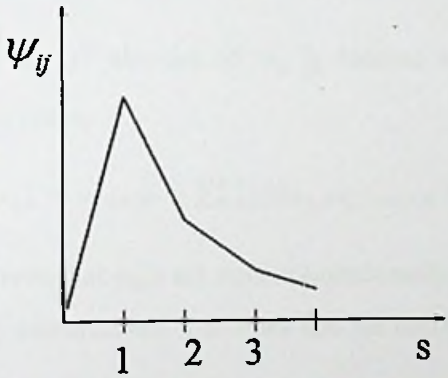
$\frac{\partial Y_{t+s}}{\partial a'_t} = \Psi_s$

The matrix Ψ_s contains the effect of a unit increase in each of the variable's innovations at time t on all the variables in Y at time $t + s$.

$\frac{\partial y_{i,t+s}}{\partial a'_{jt}} = [\psi_{ij,s}]$ is the reaction of i variable to a unit change in innovation j.

The row i, column j element of the matrix Ψ_s, $(\psi_{ij,s})$, is then the specific impulse response of a unit increase in the j^{th} variable's innovation at time t (a_{jt}), for the i^{th} variable at time $t + s$ $(y_{i,t+s})$, holding all other innovations constant.

A plot of row i, column j element of Ψ_s as a function of s is called the impulse response function, and gives the cumulative effect on variable i of an innovation in j.



3.5.5.2 Variance Decomposition (VDC) Test

Granger causality tests of the VECM can indicate only Granger exogeneity or endogeneity of the dependent variables within the sample period. They cannot gauge the degree of exogeneity among the variables beyond the sample period. In order to provide further evidence on the relationships of the variables under investigation, the VDC was used to gauge the consistency of causality tests. The VDC exhibits the proportion of the forecast error of each variable that is accounted for by each of the other variables. Therefore, the VDC enables us to determine the relative importance of each variable in generating fluctuations in other variables in VECM [33].

At forecast origin T, an h-step ahead forecast is obtained recursively as

$y_{T+h|T} = A_1 y_{T+h-1|T} + \cdots + A_p y_{T+h-p|T}$, where $y_{T+j|T} = y_{T+j}$ for $j \leq 0$.

The corresponding forecast error is

$y_{T+h} - y_{T+h|T} = u_{T+h} + \Phi_1 u_{T+h-1} + \cdots + \Phi_{h-1} u_{T+1}$.

Expressing this error in terms of the structural innovations $\varepsilon_t = (\varepsilon_{1t}, \ldots, \varepsilon_{Kt})' = B^{-1}Au_t$ gives,

$y_{T+h} - y_{T+h|T} = \Psi_0 \varepsilon_{T+h} + \Psi_1 \varepsilon_{T+h-1} + \cdots + \Psi_{h-1}\varepsilon_{T+1}$, where $\Psi_j = \Phi_j A^{-1} B$.

If the ij^{th} element of Ψ_n is denoted by $\psi_{ij,n}$, the k^{th} element of forecast error vector becomes,

$y_{T+h} - y_{T+h|T} = \sum_{n=0}^{h-1}(\psi_{k1,n}\varepsilon_{1,T+h-n} + \cdots + \psi_{kK,n}\varepsilon_{K,T+h-n})$.

Given that ε_{kt}s are contemporaneously and serially uncorrelated and have unit variances by construction, it follows that the corresponding forecast error variance is

$\sigma_k^2(h) = \sum_{n=0}^{h-1}(\psi_{k1,n}^2 + \cdots + \psi_{kK,n}^2) = \sum_{j=1}^{K}(\psi_{kj,0}^2 + \cdots + \psi_{kj,h-1}^2)$.

The term $(\psi_{kj,0}^2 + \cdots + \psi_{kj,h-1}^2)$ is interpreted as the contribution of variable j to the h-step forecast error variance of variable k. This interpretation makes sense if ε_{it}s can be viewed as shocks in variable i. Dividing the preceding terms by $\sigma_k^2(h)$ gives the percentage contribution of variable j to the h-step forecast error variance of variable k,

$\omega_{kj,h} = (\psi_{kj,0}^2 + \cdots + \psi_{kj,h-1}^2)/\sigma_k^2(h)$ [45].

3.5.6 Wald Test

Wald test is used to determine whether a certain predictor variable is significant or not. It rejects the null hypothesis of the corresponding coefficient being zero.

H_0: The coefficients of variables = 0

H_1: At least one coefficient of variables $\neq 0$

Under the Wald statistical test, the maximum likelihood estimate $\hat{\theta}$ of the parameter of interest θ is compared with the proposed value θ_0, with the assumption that the difference between the two will be approximately normally distributed. Typically the square of the difference is compared to a chi-squared distribution. The Wald statistic is given by,

$$W = \frac{(\hat{\theta} - \theta_0)^2}{Var(\hat{\theta})} \sim \chi_1^2$$

But under H_0, the parameter of interest is usually 0 (i.e. $\theta_0 = 0$). Then the Wald statistic simplifies to

$$W = \frac{(\hat{\theta})^2}{Var(\hat{\theta})}$$

3.5.7 Distributional Assumptions

It is clear from the literature review, that most of the researches done on stock returns confirm that there is a tendency for the stock market returns to deviate from normality. But it should be tested in the study in order to gain correct estimates. The normality of the returns can be tested using the Jarque-Bera test for normality. This test will measure the skewness and kurtosis of the series compared to the normal distribution.

H_0: Series is normally distributed

H_1: Series is not normally distributed

Jarque-Bera test statistic is given below.

$$L = \frac{N}{6}\left(S^2 + \frac{(K-3)^2}{4}\right)$$

where S is for Skewness, K is for Kurtosis and N is the number of observations. Under the null hypothesis, $L \sim \chi^2_{2,5\%}$. Therefore if $L > \chi^2_{2,5\%}$, then H_0 will be rejected.

3.5.8 Diagnostic Tests for the Fitted Models

The main objective under this section is to check the model adequacy. There are few tests that can be carried out under the model adequacy testing and they are denoted below.

3.5.8.1 The CUSUM test

The CUSUM test is based on the cumulative sum of the recursive residuals. The CUSUM test takes the cumulative sum of recursive residuals and plots its value against the upper and lower bounds of the 95% confidence interval at each point. The test finds parameter instability if the cumulative sum goes outside the area between the two critical lines. The CUSUM test is based on the statistic

$$W_t = \frac{\sum_{r=k+1}^{t} u_r}{s} \; ; t = k+1, \dots, T$$

where u is the recursive residual defined above, and s is the standard error of the regression fitted to all T sample points. Movement of W_t outside the critical lines is suggestive of coefficient instability.

3.5.8.2 Ljung-Box Q-Statistics for standardized squared residuals

This test is done in order to test the serial correlation in standardized squared residuals up to lag k.

H_0: Standerdized squared residuals are not serially correlated up to lag k

H_1: Standerdized squared residuals are serially correlated up to lag k

Test statistic will be

$$Q_{LB} = T(T+2)\sum_{j=1}^{k}\frac{\Gamma_j^2}{T-j}$$

where Γ_j is the j^{th} autocorrelation of standardized squared residuals and T is the number of observations. Under the null hypothesis, $Q_{LB} \sim \chi^2_{k,5\%}$. Therefore if $Q_{LB} > \chi^2_{k,5\%}$, then H_0 will be rejected.

3.5.8.3 ARCH-LM test

ARCH-LM tests the autoregressive conditional heteroscedasticity (ARCH) in residuals.

H_0: There is no ARCH effect up to order q in the standardized residuals

H_1: There is ARCH effect up to order q in the standardized residuals

ARCH-LM test statistic is computed from the below mentioned auxiliary equation.

$$e_t^2 = \beta_0 + \left(\sum_{s=1}^{q}\beta_s\, e_{t-s}^2\right) + v_t$$

where e_t is the residuals.

Under this test there are two test statistics that will be generated. F-statistic tests for the joint significance of all the lagged squared residuals. The Obs*R-squared statistics means the number of observations times the R^2 from the above regression. If both of these test statistics rejects the null hypothesis, then it can be said that the model is adequate.

3.5.8.4 Breusch-Godfrey Serial Correlation LM Test

Consider a linear regression of any form, for example

$$Y_t = \alpha_0 + \alpha_1 X_{t,1} + \alpha_2 X_{t,2} + u_t$$

where the errors might follow an AR(p) autoregressive scheme, as follows:

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \cdots + \rho_p u_{t-p} + \varepsilon_t$$

The simple regression model is first fitted by ordinary least squares to obtain a set of sample residuals $\hat{u}_t$. Breusch and Godfrey proved that, if the following auxiliary regression model is fitted,

$$\hat{u}_t = \alpha_0 + \alpha_1 X_{t,1} + \alpha_2 X_{t,2} + \rho_1 \hat{u}_{t-1} + \rho_2 \hat{u}_{t-2} + \cdots + \rho_p \hat{u}_{t-p} + \varepsilon_t$$

and if the usual R^2 statistic is calculated for this model, then the following asymptotic approximation can be used for the distribution of the test statistic,

$$nR^2 \sim \chi^2_p,$$

when the null hypothesis $H_0: \rho_i = 0 \quad for\ all\ i$ holds (that is, there is no serial correlation of any order up to p). Here n is the number of data points available for the second regression, that for $\hat{u}_t$,

$$n = T - p,$$

where T is the number of observations in the basic series. Note that the value of n depends on the number of lags of the error term (p).

3.5.9 Information Criteria

Below mentioned criterions are used within this study in the lag selection criteria in the cointegration analysis. The number of lags corresponding to the lowest information criterion values are selected.

3.5.9.1 Akaike Information Criteria

This will measure the relative quality of a statistical model for a given data set. But this won't give an indication of the quality of the model in absolute sense.

$$AIC = \frac{-2}{T} ln(likelihood) + \frac{2}{T}(number\ of\ parameters)$$

where T is the number observations.

3.5.9.2 Schwarz Criteria

This information criterion is also based on the likelihood function and it is very much close to the AIC but more powerful than it.

$$SC = \frac{-2}{T} ln(likelihood) + \frac{K}{T}(logT)$$

where T is the number observations and K is the number of free parameters.

3.5.9.3 Hannan–Quinn Information Criterion

HQ criterion can be considered as an alternative to Akaike information criterion and Bayesian information criterion.

$$HQC = -2L_{max} + 2Klog(\log N)$$

where L_{max} is the log-likelihood, K is the number of parameters and N is the sample size.

CHAPTER 4 DATA ANALYSIS AND DISCUSSION

4.1 Descriptive Statistics

The descriptive statistics of the variables used in the model are summarized and shown in Table 4.1. The table provides statistics such as the mean, median, standard deviation, the minimum and maximum values, skewness, kurtosis and Jarque-Bera statistic.

Table 4.1: Descriptive Statistics

	LNY	LNX1	LNX2	LNX3	LNX4
Mean	8.225104	2.270848	14.33672	8.180271	5.052731
Median	8.436525	2.198335	14.30892	8.238880	5.108125
Maximum	8.895493	3.058707	15.33106	8.580712	5.353279
Minimum	7.157891	1.747459	13.31528	7.483188	4.575020
Std. Dev.	0.575754	0.345220	0.601953	0.342232	0.211383
Skewness	-0.315406	0.598621	-0.029974	-0.655364	-0.621387
Kurtosis	1.564932	2.364284	1.777820	2.075355	2.431823
Jarque-Bera	5.221858	3.904738	3.181802	5.467581	3.968043
Probability	0.073466	0.141937	0.203742	0.064973	0.137515
Sum	419.4803	115.8132	731.1728	417.1938	257.6893
Sum Sq. Dev.	16.57462	5.958857	18.11740	5.856153	2.234142
Observations	51	51	51	51	51

The results of Table 4.1 reveals that, for the selected period, the stock return for the listed companies averaged 8.225 with a standard deviation of 0.57, indicating low levels of dispersion from the mean. The low standard deviation of LNY (ASPI) with respect to the mean is an indication of low volatility in the stock market. Skewness result shows the clustering of LNY (ASPI), LNX2 (Money supply), LNX3 (Industrial Production) and LNX4 (CCPI) on the negative side whereas LNX1 (91-day treasury bill rate) has positive skewness value. The values of skewness and kurtosis don't indicate the lack of symmetry in the distribution. Generally, if the value of skewness and kurtosis are 0 and 3 respectively, the observed distribution is said to be normally distributed. Furthermore, if the skewness coefficient is in excess of unity it is considered fairly extreme and the low (high) kurtosis value indicates extreme platykurtic (extreme leptokurtic). From Table 4.1, it is clear that the skewness of the variables is close to zero and kurtosis is close to 3. Therefore it is observed that frequency distributions of above mentioned variables are approximately normally distributed. The results of Jarque-Bera statistics and p-values don't reject the null hypothesis of normal distribution at 5% significance level for all variables confirming the normality of variables. The value of standard deviation indicates that ASPI and Broad money supply are looking to be more volatile as compared to 91-day treasury bill rate, index of industrial production and CCPI.

4.2 Test for Stationarity - Unit Root Test

An important concern in data analysis is to know whether a series is stationary (do not contain a unit root) or not stationary (contains a unit root). It is compulsory to test the economic time series for stationarity before proceeding for cointegration test and establishing long-run relationships. Because economic variables are expected to be stationary before they can be used for meaningful statistical analysis. If the variable is not stationary, a high R^2 value can be obtained although there is no meaningful relation between variables. However, practically, many economic time series are not stable and as such causes the conventional OLS-based statistical inferences to be spurious. To avoid this problem, the variables were subjected to stationarity test. Therefore the first stage is to test for the stationarity properties of the variables by employing the Unit Root Test.

The study used two different tests, such as Augmented Dickey Fuller (ADF) test and Phillips-Perron (PP) test for finding unit roots in time series. Both tests were performed on the examined variables at level and also at first difference to test the following hypothesis.

H_0: Variable has unit root

H_1: Variable does not have a unit root

The results of ADF test for each of the logged values of the variables $(LNY, LNX_1, LNX_2, LNX_3, LNX_4)$ in levels and first differences are reported in Table 4.2.

Table 4.2: ADF and PP unit root test results

Variables	Augmented Dickey-Fuller test statistic				Philips-Perron test statistic			
	Null Hypothesis: Variable is Non-Stationary				Null Hypothesis: Variable is Non-Stationary			
	Level		First Difference		Level		First Difference	
	Test Statistic	P-value	Test Statistic	P-value	Test Statistic	P-value	Test Statistic	P-value
lnY	-1.626712	0.4616	-5.914283	0.0000	-1.620842	0.4647	-5.936371	0.0000
lnX1	-1.712871	0.4187	-6.414394	0.0000	-1.886672	0.3358	-6.389281	0.0000
lnX2	-0.569579	0.8679	-6.354058	0.0000	-0.597080	0.8618	-6.350909	0.0000
lnX3	-2.203783	0.2076	-5.582542	0.0000	-3.397410	0.1157	-3.783760	0.0056
lnX4	-2.158512	0.2236	-6.023089	0.0000	-2.158737	0.2235	-6.023089	0.0000

By looking at the results of Table 4.2 it is clear that ADF and PP run at level appears that the p-values for all the included variables are greater than the critical value at 5% significance level. Therefore the null hypothesis cannot be rejected and can be concluded that all the variables are non-stationary. This implies that it is needed to take the first difference of those variables and check for stationarity.

The results of ADF and PP of first difference series show that the p-values for all the included variables are less than the critical value at 5% significance level suggesting the null hypothesis can be rejected and thus, can be concluded that all variables are stationary.

Both the tests revealed that all the variables were non-stationary in levels and stationary at first difference which is the common phenomenon in most of the economic time series. Hence, the two tests are undisputedly declared that all the variables are integrated of order one, i.e. $I(1)$ as shown in Table 4.2.

4.3 Testing the Long Run and Short Run Relationship Between the Variables

4.3.1 Cointegration Analysis

In order to decide what type of VAR model will be used in this study, after determination of unit roots and integration at first order, Johansen cointegration test was applied to check whether cointegration exists among these five variables. Cointegration analysis is important, since if the error term coming from the linear combination of two variables is stationary, then there is cointegration between the two variables. When there is no cointegration between the two variables, then there is no long term relationship between two variables [40].

The results of stationarity analysis shown in the Table 4.2 shows that all the modeled variables were integrated of same order, and therefore the Johansen (1991) technique was applied to explore the long-run relationships among the variables as this technique is appropriate, if all the model variables are integrated of same order.

The first step in multivariate cointegration analysis is the appropriate lag selection for the variables. For selection of appropriate lag length, five criteria were used namely sequential modified LR test statistic (LR), Final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ). Out of them, LR, FPE, AIC and HQ selected lag length of 3. The results are given in Table 4.3 below.

Table 4.3: Lag order selection criteria

VAR Lag Order Selection Criteria
Endogenous variables: LNY LNX1 LNX2 LNX3 LNX4
Exogenous variables: C
Date: 06/16/17 Time: 10:30
Sample: 1 51
Included observations: 47

Lag	LogL	LR	FPE	AIC	SC	HQ
0	68.01173	NA	4.71e-08	-2.681350	-2.484526	-2.607284
1	380.3011	544.8454	2.33e-13	-14.90643	-13.72549*	-14.46203
2	412.3611	49.11315	1.79e-13	-15.20686	-13.04179	-14.39213
3	457.4676	59.50213*	8.38e-14*	-16.06245*	-12.91326	-14.87739*
4	480.4931	25.47506	1.11e-13	-15.97843	-11.84512	-14.42304

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

In order to find out the number of cointegrating vectors, Trace statistic and Maximum Eigen value tests were used. The results for both Trace statistic and Maximum Eigen statistic are reported in Table 4.4.

According to the results of Table 4.4, the Trace test indicates 3 cointegrating equations at the 5% level and the Max-eigenvalue test indicates 4 cointegrating vectors at the 5% level. It is clearly shown that both trace and maximum-eigenvalue tests suggest at least three cointegration vectors. This result suggests that at least three cointegration vectors exist among stock market index and other macroeconomic variables.

Table 4.4: Johansen cointegration test

Date: 06/16/17 Time: 10:32
Sample (adjusted): 5 51
Included observations: 47 after adjustments
Trend assumption: Linear deterministic trend
Series: LNY LNX1 LNX2 LNX3 LNX4
Lags interval (in first differences): 1 to 3

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.610489	109.8840	69.81889	0.0000
At most 1 *	0.463344	65.56944	47.85613	0.0005
At most 2 *	0.373296	36.31672	29.79707	0.0077
At most 3	0.262663	14.35451	15.49471	0.0737
At most 4	0.000704	0.033110	3.841466	0.8556

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.610489	44.31458	33.87687	0.0020
At most 1 *	0.463344	29.25272	27.58434	0.0303
At most 2 *	0.373296	21.96221	21.13162	0.0382
At most 3 *	0.262663	14.32140	14.26460	0.0490
At most 4	0.000704	0.033110	3.841466	0.8556

Max-eigenvalue test indicates 4 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Therefore, along with [1], the study used three cointegrating vectors in order to establish the long-run relationships among the variables. The variables are found to be cointegrated after running Johansen technique meaning that they share a common stochastic trend and will grow proportionally in the long-run. That is there is no tendency to deviate from their linear relationship by an ever growing amount.

4.3.2 Long Run Relationship

Above identified cointegration equations are shown below in Table 4.5 and they are used to identify the longrun relationship between variables. After normalization the cointegrating vectors on LNY and normalized cointegrating coefficients were estimated as reported in Table 4.5.

Table 4.5: Normalized cointegration coefficients

Vector Error Correction Estimates
Date: 06/16/17 Time: 10:34
Sample (adjusted): 4 51
Included observations: 48 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	CointEq2	CointEq3
LNY(-1)	1.000000	0.000000	0.000000
LNX1(-1)	0.000000	1.000000	0.000000
LNX2(-1)	0.000000	0.000000	1.000000
LNX3(-1)	-2.310302	2.089160	-3.033485
	(0.17004)	(0.70553)	(0.81458)
	[-13.5866]	[2.96110]	[-3.72400]
LNX4(-1)	0.797451	0.071844	-1.989365
	(0.29030)	(1.20451)	(1.39067)
	[2.74697]	[0.05965]	[-1.43050]
C	6.648983	-19.78048	20.60142

The variables are converted into log transformation and hence these values represent long term elasticity measures [31]. Due to the normalization process, the signs are reversed to enable proper interpretation. The long-run cointegrating relation between the macroeconomic factors and stock prices normalized on LNY is given by,

$$LNY(-1) = -6.649 + 2.31\ LNX3(-1)\ -\ 0.797\ LNX4(-1)$$

$$Log(ASPI(-1)) = -6.649 + 2.31\ Log(IIP(-1))\ -\ 0.797\ Log(CCPI(-1))$$

According to the first normalized equation, stock return (LNY(-1)) shows significantly negative relation with Colombo consumer price index (LNX4(-1)) in long-run which suggested that stock market did not provide hedge against inflation. According to the coefficients, it can be interpreted that a 1% increase in the Log(CCPI(-1)) leads to a 0.79% decrease in the Log(ASPI(-1)) in the long run.

High rates of inflation increase the cost of living and a shift of resources from investments to consumption. This leads to a fall in the demand for market instruments which lead to reduction in the volume of stock traded. Also the monetary policy responds to the increase in the rate of inflation with economic tightening policies, which in turn increases the nominal risk-free rate and hence raises the discount rate in the valuation model [43]. Therefore negative relationship between inflation and stock market index is expectable.

The negative relationship between stock prices and consumer price index was consistent with the results of Mukherjee and Naka [44], Humpe and Macmillan [5], Sohail and Hussain [32], Eita [20], Akbar et al. [24], Khalid [26] and Menike [23]. However, findings were at variance with the findings of Ratanapakorn and Sharma [33].

According to the first normalized equation, there is a statistically significant positive relationship between stock returns and Index of Industrial Production according to the t-test values shown. By looking at the coefficient of Log(IIP(-1)), it can be interpreted that a 1% increase in the Log(IIP(-1)) leads to a 2.31% increase in the Log(ASPI(-1)) in the long run.

The result is consistent with the findings of Chen et al. [29] who tested whether a set of macro-economic variables explained unexpected changes in equity returns. They documented evidence that the economic variables such as industrial production, changes in the risk premium and twists in the yield curve are significant factors in explaining stock returns. The positive relationship between stock returns and Index of Industrial Production is similar with the findings of many researchers including Ratanapakorn and Sharma [33], Humpe and Macmillan [5], Rahman et al. [2], Hosseini et al. [42] and Khalid [26].

The second normalized equation is estimated as below:

LNX1(-1) = 19.78 - 2.089 LNX3(-1) - 0.072 LNX4(-1)

Log(Interest rate(-1)) = 19.78 - 2.089 Log(IIP(-1)) - 0.072 Log(CCPI(-1))

According to the second normalized equation, 91-day treasury bill rate (LNX1(-1)) shows significantly negative relation with index of industrial production (LNX3(-1)) in long-run. The negative relationship between 91-day treasury bill rate (LNX1(-1)) and Colombo consumer price index (LNX4(-1)) is not significant in the long run.

The third normalized equation is estimated as below:

LNX2(-1) = -20.60 + 3.033 LNX3(-1) + 1.989 LNX4(-1)

Log(M2(-1)) = -20.60 + 3.033 Log(IIP(-1)) + 1.989 Log(CCPI(-1))

According to the third normalized equation, Broad money supply (LNX2(-1)) shows significantly positive relation with index of industrial production (LNX3(-1)) in long-run. The negative relationship between Broad money supply (LNX2(-1)) and Colombo consumer price index (LNX4(-1)) is not significant in the long run.

4.3.3 Vector Error Correction Model (VECM)

The short run and long run causal relationship between the variables should be examined in a (VECM) framework [31].

The VECMs provide the correction terms that reflect influences of deviation of the relationship among the variables from long-run equilibrium and short-run parameters. In order to capture the long-run dynamics of the model, error correction mechanism was applied. The results of vector error correction model were reported in appendix 1.

This study especially looks for the relationship between LNY and other four macroeconomic variables. Therefore, only the relationship between LNY and the other macroeconomic variables were analyzed. This relationship can be given in the following model.

D(LNY) = C(1)*(LNY(-1) - 2.31*LNX3(-1) + 0.797*LNX4(-1) + 6.649) + C(2)*(LNX1(-1) + 2.089*LNX3(-1) + 0.072*LNX4(-1) - 19.78) + C(3)*(LNX2(-1) - 3.033*LNX3(-1) - 1.989*LNX4(-1) + 20.60) + C(4)*D(LNY(-1)) + C(5)*D(LNY(-2)) + C(6)*D(LNX1(-1)) + C(7)*D(LNX1(-2)) + C(8)*D(LNX2(-1)) + C(9)*D(LNX2(-2)) + C(10)*D(LNX3(-1)) + C(11)*D(LNX3(-2)) + C(12)*D(LNX4(-1)) + C(13)*D(LNX4(-2)) + C(14)

The parameters of this model were estimated and shown in the Table 4.6 below. Table 4.6 shows vector error correction model for LNY with significant error correction terms, showing explicit information on the long run and short-run dynamic interactions among those variables. The information about the long-run dynamic of the process is indicated by the sign and magnitude of this error correction coefficient. It indicates the direction and speed of adjustment towards the long-run equilibrium path which should be negative and significant.

The coefficients C(1), C(2) and C(3) of Table 4.6 are the one period lag of residuals of the cointegrating equation. Those are the error correction coefficients measuring the speed of convergence to the long-run steady state or speed of adjustment of disequilibrium in the period of study.

Table 4.6: VECM estimates

Dependent Variable: D(LNY)
Method: Least Squares
Date: 06/16/17 Time: 10:40
Sample (adjusted): 4 51
Included observations: 48 after adjustments
D(LNY) = C(1)*(LNY(-1) - 2.31030198638*LNX3(-1) + 0.797451480798 *LNX4(-1) + 6.64898325006) + C(2)*(LNX1(-1) + 2.08916007102 *LNX3(-1) + 0.0718444735208*LNX4(-1) - 19.7804756028) + C(3)*(LNX2(-1) - 3.03348497264*LNX3(-1) - 1.93936489839*LNX4(-1) + 20.6014237526) + C(4)*D(LNY(-1)) + C(5)*D(LNY(-2)) + C(6)*D(LNX1(-1)) + C(7)*D(LNX1(-2)) + C(8)*D(LNX2(-1)) + C(9)*D(LNX2(-2)) + C(10) *D(LNX3(-1)) + C(11)*D(LNX3(-2)) + C(12)*D(LNX4(-1)) + C(13) *D(LNX4(-2)) + C(14)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.380569	0.133815	-2.844003	0.0075
C(2)	-0.029504	0.094055	-0.313685	0.7557
C(3)	0.095017	0.088472	1.073978	0.2904
C(4)	0.218215	0.166477	1.310779	0.1987
C(5)	0.148196	0.154728	0.957781	0.3449
C(6)	0.001919	0.175179	0.010952	0.9913
C(7)	-0.190984	0.161159	-1.185065	0.2442
C(8)	-2.837205	1.437114	-1.974238	0.0565
C(9)	2.813922	1.353365	2.079204	0.0452
C(10)	0.630537	0.529814	1.190110	0.2422
C(11)	-1.029013	0.490610	-2.097416	0.0435
C(12)	-0.053313	0.385690	-0.138227	0.8909
C(13)	-1.007149	0.343855	-2.928996	0.0060
C(14)	0.043283	0.079843	0.542093	0.5913

R-squared	0.580264	Mean dependent var	0.030188
Adjusted R-squared	0.419777	S.D. dependent var	0.138773
S.E. of regression	0.105707	Akaike info criterion	-1.417805
Sum squared resid	0.379912	Schwarz criterion	-0.872038
Log likelihood	48.02733	Hannan-Quinn criter.	-1.211559
F-statistic	3.615641	Durbin-Watson stat	2.102164
Prob(F-statistic)	0.001292		

As only the first error correction term is significant with negative sign as given in Table 4.6, the results of vector error correction model (VECM) depicted that the adjustments in LNY are due to the first error correction term. This implies that long run movements of the variables are determined by one equilibrium relationship.

The negative sign implies that with absence of variation in the independent variables, the model's deviation from the long run relation is correct by increasing the dependent variable [9]. Bannerjee et al. [3] holds that a highly significant error correction term is further proof of the existence of a stable long-term relationship.

As indicated in Table 4.6, the estimate of C(1) which is the adjustment coefficient associated with the stock price index is -0.3805 and statistically significant. This is sufficient to reject any "no cointegration" hypothesis and confirm the presence of a stable long-run relationship between stock price index and other macroeconomic variables such as IIP and CCPI which is used as the proxy for inflation. This suggests that with absence of changes in independent variables IIP (LNX3) and inflation (LNX4)), deviation of the model from the long-run path is corrected by 38.05% increase in LNY per quarter. This means that deviation from the long run relationship takes approximately three quarters (1/0.3805 = 2.628) to eliminate the disequilibrium.

The key regression statistics shows that R^2 is high implying that overall goodness of fit of the VECM is satisfactory. Given the value of R^2, it can be concluded that the independent variables explain over 58% of the systematic variations in stock market index during the period studied. The F-statistic is significant at 1% level, showing a good fit of the model. The Durbin-Watson statistic shows absence of autocorrelation and hence the regression estimates seem unbiased.

4.4 Test of Short Run Relationship Between the Variables

The Vector Error Correction Model was employed to examine how the study variables are related in the short run. Wald test was used to identify any significant short run relationship between each macroeconomic variable and ASPI. The results are presented as follows.

4.4.1 Short run relationship between interest rate and ASPI

$H_0: C(6) = C(7) = 0$

$H_1: at\ least\ one\ C(i) \neq 0\ for\ i = 6,7$

Table 4.7: Wald test for the relationship between interest rate and ASPI

Wald Test:			
Equation: Untitled			
Test Statistic	Value	df	Probability
F-statistic	0.702382	(2, 34)	0.5024
Chi-square	1.404765	2	0.4954
Null Hypothesis: C(6)=C(7)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(6)		0.001919	0.175179
C(7)		-0.190984	0.161159
Restrictions are linear in coefficients.			

According to the results in Table 4.7, the p-value of Chi-square test statistic is 0.4954 > 0.05. Therefore H_0 is not rejected at 5% level of significance and can be concluded that there is no short run relationship (causality) from LNX1 (91-day treasury bill rate) to LNY (ASPI).

4.4.2 Short run relationship between money supply and ASPI

$H_0: C(8) = C(9) = 0$

$H_1: at\ least\ one\ C(i) \neq 0\ for\ i = 8,9$

Table 4.8: Wald test for the relationship between money supply and ASPI

Wald Test:			
Equation: Untitled			
Test Statistic	Value	Df	Probability
F-statistic	3.994501	(2, 34)	0.0277
Chi-square	7.989002	2	0.0184
Null Hypothesis: C(8)=C(9)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(8)		-2.837205	1.437114
C(9)		2.813922	1.353365
Restrictions are linear in coefficients.			

Results in Table 4.8 indicates that the p-value of Chi-square test statistic is 0.0184 < 0.05. Therefore H_0 is rejected at 5% level of significance and can be concluded that there is a short run relationship (causality) from LNX2 (broad money supply) to LNY (ASPI).

4.4.3 Short run relationship between industrial production and ASPI

$H_0: C(10) = C(11) = 0$

$H_1: at\ least\ one\ C(i) \neq 0\ for\ i = 10,11$

Table 4.9: Wald test for the relationship between industrial production and ASPI

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	2.376504	(2, 34)	0.1081
Chi-square	4.753008	2	0.0929

Null Hypothesis: C(10)=C(11)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(10)	0.630537	0.529814
C(11)	-1.029013	0.490610

Restrictions are linear in coefficients.

According to the results of Table 4.9, the p-value of Chi-square test statistic is 0.0929 < 0.1. Therefore H_0 is rejected at 10% level of significance and can be concluded that there is a short run relationship (causality) from LNX3 (IIP) to LNY (ASPI).

4.4.4 Short run relationship between inflation and ASPI

$H_0: C(12) = C(13) = 0$

$H_1: at\ least\ one\ C(i) \neq 0\ for\ i = 12, 13$

The results in Table 4.10 indicates that the p-value of Chi-square test statistic is 0.0102 < 0.05. Therefore H_0 is rejected at 5% level of significance and can be concluded that there is a short run relationship (causality) from LNX4 (CCPI) to LNY (ASPI).

Table 4.10: Wald test for the relationship between inflation and ASPI

Wald Test:			
Equation: Untitled			
Test Statistic	Value	df	Probability
F-statistic	4.588027	(2, 34)	0.0172
Chi-square	9.176054	2	0.0102
Null Hypothesis: C(12)=C(13)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)		Value	Std. Err.
C(12)		-0.053313	0.385690
C(13)		-1.007149	0.343855
Restrictions are linear in coefficients.			

4.5 Test of Causal Relationship Among the Variables

A number of arguments have been made regarding how certain macroeconomic variables impact on stock return. This study empirically examines the degree to which the selected macroeconomic variables impact on stock return in Sri Lanka. This analysis was undertaken using Granger causality test.

Cointegration indicates that long run relationship exists between the variables but fail to show the direction of the causal relationship. Engel and Granger suggest that if cointegration exist between the variables in the long run, then, there must be either unidirectional or bidirectional relationship between variables [31]. The Granger causality test is a statistical hypothesis test to determine whether one time series is significant in forecasting another. This test aims at determining whether past values of a variable help to predict changes in another variable. In this study, the Granger Causality test is conducted to study the causal relationship between the macroeconomic variables and the stock index. The Granger causality test with respect to stock return and macroeconomic variables is presented in Table 4.11.

Table 4.11: Pairwise Granger causality tests

Pairwise Granger Causality Tests
Date: 06/16/17 Time: 10:49
Sample: 1 51
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
DLNX1 does not Granger Cause DLNY	48	0.43550	0.6498
DLNY does not Granger Cause DLNX1		0.51740	0.5997
DLNX2 does not Granger Cause DLNY	48	2.45208	0.0981
DLNY does not Granger Cause DLNX2		2.21703	0.1212
DLNX3 does not Granger Cause DLNY	48	1.15496	0.3247
DLNY does not Granger Cause DLNX3		2.05711	0.1402
DLNX4 does not Granger Cause DLNY	48	6.80364	0.0027
DLNY does not Granger Cause DLNX4		0.63986	0.5323
DLNX2 does not Granger Cause DLNX1	48	3.58622	0.0363
DLNX1 does not Granger Cause DLNX2		0.30620	0.7378
DLNX3 does not Granger Cause DLNX1	48	0.61243	0.5467
DLNX1 does not Granger Cause DLNX3		0.69964	0.5023
DLNX4 does not Granger Cause DLNX1	48	1.67550	0.1992
DLNX1 does not Granger Cause DLNX4		3.02168	0.0592
DLNX3 does not Granger Cause DLNX2	48	1.17778	0.3177
DLNX2 does not Granger Cause DLNX3		2.25929	0.1167
DLNX4 does not Granger Cause DLNX2	48	0.76845	0.4700
DLNX2 does not Granger Cause DLNX4		0.60446	0.5509
DLNX4 does not Granger Cause DLNX3	48	0.15183	0.8596
DLNX3 does not Granger Cause DLNX4		0.41655	0.6619

According to the results presented in Table 4.11, it is clear that the null hypothesis, which indicated that DLNX4 does not Granger cause DLNY is rejected and concludes that DLNX4 indeed does Granger cause DLNY. That indicates inflation (CCPI) does Granger cause stock returns. However, the reverse is rejected and concludes that stock return does not Granger cause inflation. Therefore, there is a uni-directional causality exists from inflation (CCPI) to stock returns. The same result has been obtained by Dharmendra Singh [12] in the context of India.

Also the null hypothesis, which indicated that DLNX2 does not Granger cause DLNX1 is rejected and concludes that DLNX2 indeed does Granger cause DLNX1. That indicates broad money supply does Granger cause 91-day T-bill rate. However, the reverse is rejected and concludes that 91-day T-bill rate does not Granger cause broad money supply. Therefore, there is a uni-directional causality exists from broad money supply to 91-day T-bill rate. Therefore, it is concluded that broad money supply may help the forecasting of 91-day T-bill rate but not the other way around.

Even though the first causation from inflation (CCPI) to stock returns is in line with expectations, the latter one from broad money supply to 91-day T-bill rate contradicts with expectations. Nevertheless, similar causalities are also reported by Acikalin, Aktas and Unal [40]. Therefore, it can be inferred from the result that, inflation (CCPI) can be seen as a leading indicator that may influence or help in estimating the stock returns.

4.6 Innovation Accounting

Innovation accounting such as the Impulse Response Function (IRF) and the forecast error variance decompositions (VDC) is used in analyzing the interrelationships among the variables chosen in the system.

4.6.1 Impulse Response Function Analysis

To study the dynamics of the effects of shocks of macroeconomic variables on stock index, Impulse Response Function (IRF) analysis was used. The impulse responses are generated from the VECM. This function can produce the time path of dependent variable (LNY), in the system of equation developed within the VECM framework, to shocks from all the explanatory variables. This is orthogonalised using Cholesky decomposition. Table 4.12 depicts the Impulse Response Function of stock index to one generalized standard deviation shock in each macroeconomic variable.

Table 4.12: Response of LNY to one S.D. Innovations

Period	LNY	LNX1	LNX2	LNX3	LNX4
1	0.105707	0.000000	0.000000	0.000000	0.000000
2	0.097072	0.013071	-0.038252	0.035416	-0.023659
3	0.099334	0.045621	0.009054	0.042701	-0.086148
4	0.088592	0.025302	0.017849	0.036667	-0.086052
5	0.076150	0.017537	0.012243	0.044467	-0.087149
6	0.063837	0.006416	0.006483	0.058255	-0.091985
7	0.050686	0.012007	0.005165	0.068322	-0.094852
8	0.040111	0.019444	0.001530	0.077364	-0.098229
9	0.028375	0.034586	-0.000758	0.084818	-0.097240
10	0.023223	0.044485	-0.000927	0.090090	-0.089715

According to the results of the Table 4.12 it is clear that one standard deviation shock of inflation (LNX4) leads to a 0.023 units decrease in the stock market index (LNY) after 2 quarters, which corresponds to 2.3% drop in stock market index and at the end of 10 quarters, one standard deviation shock of inflation leads to a 0.09 units decrease in the stock market index which corresponds to 9% drop in stock market index. The negative response of stock market index to the one standard deviation shock of inflation is visible throughout the 10 quarters indicating the inverse relationship between inflation and stock market index.

Also, one standard deviation shock to IIP (LNX3) leads to a 0.035 units increase in the stock market index (LNY) after 2 quarters, which corresponds to 3.5% increase in stock market index and at the end of 10 quarters, one standard deviation shock of IIP leads to a 0.09 units increase in the stock market index after which corresponds to 9% increase in stock market index. Similarly, one standard deviation shock to 91-day T-bill rate (LNX1) leads to a 0.013 units increase in the stock market index (LNY) after 2 quarters, which corresponds to 1.3% increase in stock market index and at the end of 10 quarters, one standard deviation shock of 91-day T-bill rate leads to a 0.044 units increase in the stock market index which corresponds to 4.4% increase in stock market index. The positive response of stock market index to the one standard deviation shock of IIP and 91-day T-bill rate is visible throughout the 10 quarters which indicates that an increase in IIP and 91-day T-bill rate cause an increase in the stock market index.

One standard deviation shock to money supply (LNX2) leads to a 0.038 units decrease in the stock market index (LNY) after 2 quarters, which corresponds to 3.8% drop in stock market index. From 3rd quarter to 8th quarter, the response of stock market index to one standard deviation shock of money supply becomes positive and at the end of 10 quarters, one standard deviation shock of money supply leads to a 0.0009 decrease in the stock market index which corresponds to 0.09% drop in stock market index.

These results can be interpreted graphically as well. Figure 4.1 depicts the Impulse Response Function of stock index to one generalized standard deviation shock in each macroeconomic variable.

The impulse response shows that stock market prices (LNY) respond negatively to inflation (LNX4). A one standard deviation Cholesky positive innovation of inflation causes a revision downward of the forecast of the stock market. The negative response of stock market to inflation rate suggests that contractionary monetary policy can result in a reduction in stock market returns or development. A negative relationship between inflation and stock prices suggests that stocks are not a good hedge against inflation and hence negates the Fisher hypothesis [24]. This finding is consistent with the earlier findings of Eita [20], Ahmad and Ghazi [1], Gan et al. [10] and Chen et al. [29].

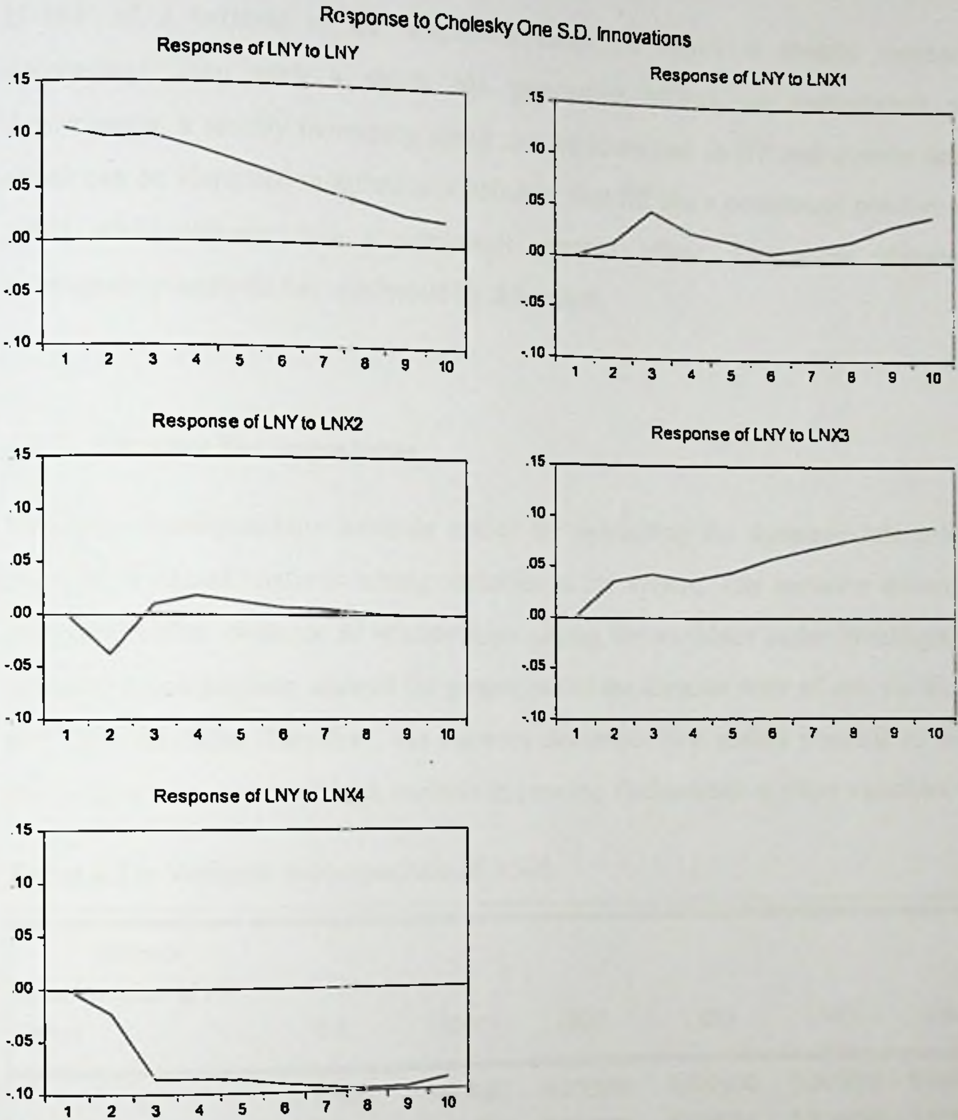


Figure 4.1: Impulse Response Function

The stock market responds negatively to shocks from money supply during the first two quarters, and the response becomes positive from the third quarter onwards. The response of stock market prices to 91-day T-bill rate and IIP is positive. A one standard deviation Cholesky innovation of 91-day T-bill rate and IIP causes a revision upward of the forecast of stock market prices. This suggests that an increase in 91-day T-bill rate and IIP causes an increase in stock market prices.

If IRF of a variable to an exogenous variable's shock is strictly increasing (or decreasing), then such a shock has permanent effects on endogenous variable. Accordingly, a strictly increasing shock can be identified in IIP and strictly decreasing shock can be identified in inflation concluding that IIP has a permanent positive effect to ASPI while inflation has a permanent negative effect. The result obtained from cointegration analysis has confirmed by this result.

4.6.2 Variance Decompositions

Variance decompositions serve as a tool for evaluating the dynamic interactions and strength of causal relations among variables in the system. The variance decomposition provided further evidence of relationships among the variables under investigation. The variance decomposition showed the proportion of the forecast error of one variable due to the other variables. Therefore, the variance decomposition makes possible to determine the relative importance of each variable in creating fluctuations in other variables [33].

Table 4.13: Variance decomposition of ASPI

Variance Decomposition of LNY: Period	S.E.	LNY	LNX1	LNX2	LNX3	LNX4
1	0.105707	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.155065	85.65974	0.710536	6.085265	5.216458	2.327996
3	0.212886	67.21963	4.969266	3.409442	6.790859	17.61080
4	0.250753	60.93265	4.599916	2.964106	7.032903	24.47043
5	0.280545	56.04617	4.065590	2.558444	8.130772	29.19903
6	0.307765	50.87330	3.421715	2.170284	10.33905	33.19565
7	0.333353	45.67500	3.046325	1.873900	13.01332	36.39145
8	0.358314	40.67245	2.922981	1.619209	15.88080	38.90456
9	0.383926	36.07207	3.364665	1.414707	18.75200	40.39656
10	0.407533	32.33875	4.177663	1.256073	21.52926	40.69825

Results in Table 4.13 shows that the stock index (LNY) is relatively less exogenous in relation to the shocks of other macroeconomic variables in the short run, such as LNX1, LNX2, LNX3 and LNX4. Because if considering only two quarters, the stock index (LNY) is the most important variable to account for its own innovation, which accounts for 85.65%. Broad money supply (LNX2) only contributes 6.08% to the forecast error variance while IIP (LNX3) accounts for 5.22% of the forecast error variance.

At the end of 10 quarters, 32% of the variance of stock index (LNY) is explained by its own shock and IIP (LNX3) and inflation (LNX4) are the next two important variables to be considered in explaining the forecast error variance, which accounts for 22% and 41% impact on stock index respectively. This implies that IIP and inflation prove to be the most significant factors that explain the movement in stock prices in the long run.

4.7 Residual Diagnostics

To confirm and trust the results from the VECM, it is necessary to make sure that the residuals are white noise. Therefore, following diagnostic checks were carried out to justify the accuracy of the fitted model.

4.7.1 The CUSUM test

The CUSUM test is based on the cumulative sum of the recursive residuals and plus and minus two standard errors are also shown at each point. Residuals outside the standard error bands suggest instability in the parameters of the equation. Plot of cumulative sum of recursive residuals of the model is shown in Figure 4.2.

According to Figure 4.2, since the cumulative sum doesn't go outside the area between the two critical lines, test finds parameter stability suggesting that parameter constancy exists in the sample period.

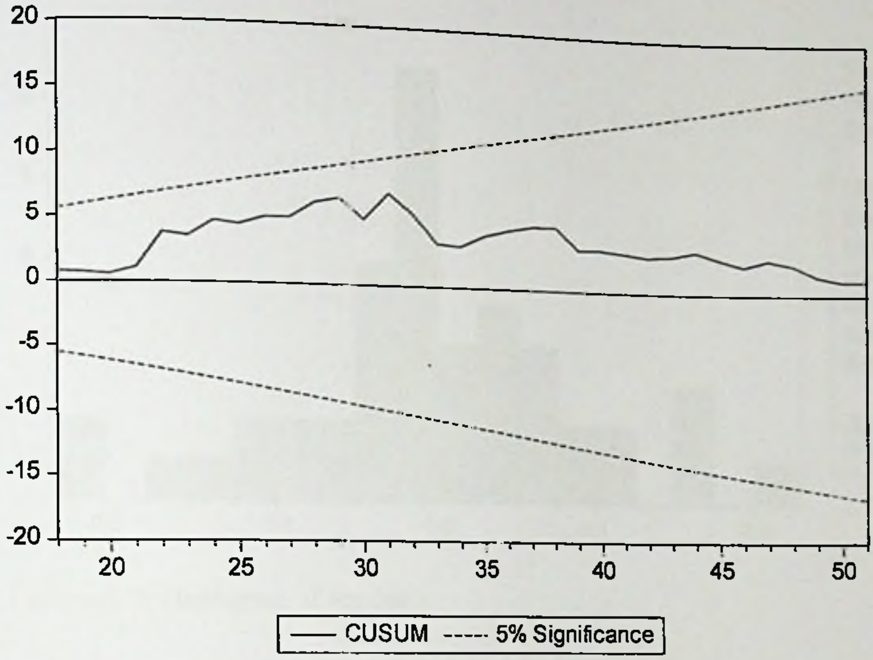


Figure 4.2: Plot of cumulative sum of recursive residuals

4.7.2 Normality Test

This test is important to find out whether the error term follows normal distribution and the hypotheses are stated as follows:

H_0: Residuals are normally distributed

H_1: Residuals are not normally distributed

By looking at the Figure 4.3, the histogram clearly shows that residuals are normally distributed. The normality of residuals is also confirmed by the Jarque-Bera test since the p-value (0.846383) is greater than the critical value at the 5% level. So, the null hypothesis cannot be rejected and can be concluded that the residuals are normally distributed.

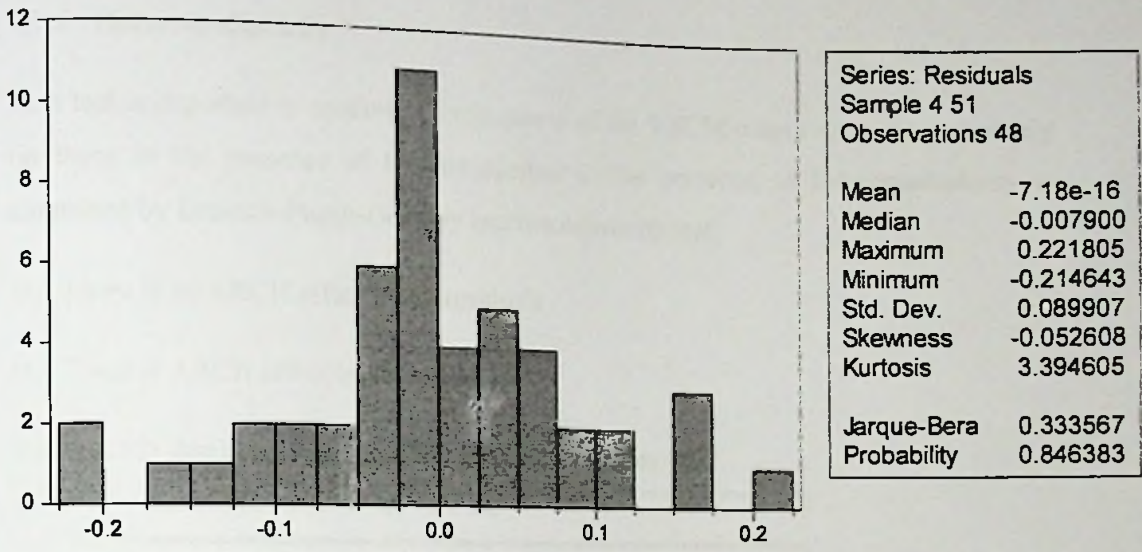


Figure 4.3: Histogram of residuals

4.7.3 Serial Correlation

The presence of serial correlation is examined by Breusch-Godfrey Serial Correlation LM Test. Residuals for VECM output are tested for serial correlation, using the following hypothesis:

H_0: There is no Serial correlation in the residuals

H_1: There is Serial correlation in the residuals

Table 4.14: Breusch-Godfrey serial correlation LM test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.971274	Prob. F(2,32)	0.3895
Obs*R-squared	2.747063	Prob. Chi-Square(2)	0.2532

The results of Table 4.14 indicate that the p-value is 0.3895 which is greater than critical value 0.05. Therefore, the null hypothesis is not rejected and the absence of autocorrelation can be concluded.

4.7.4 Heteroscedasticity

This test is important to confirm the robustness of the VECM output since we cannot rely on them in the presence of heteroscedasticity. The presence of heteroscedasticity is examined by Breusch-Pagan-Godfrey heteroscedasticity test.

H_0: There is no ARCH effect in the residuals

H_1: There is ARCH effect in the residuals

Table 4.15: Breusch-Pagan-Godfrey heteroskedasticity test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.398900	Prob. F(15,32)	0.2068
Obs*R-squared	19.00984	Prob. Chi-Square(15)	0.2133
Scaled explained SS	11.41978	Prob. Chi-Square(15)	0.7223

Results in Table 4.15 indicate that the p-value is 0.2068 which is greater than critical value 0.05. Therefore, the null hypothesis cannot be rejected and can be concluded that there is no ARCH effect in the residuals.

4.7.5 Correlogram Q-Statistics of residuals

This view displays the autocorrelations and partial autocorrelations of the equation residuals up to the specified number of lags and computes the Ljung-Box Q-statistics for the corresponding lags. Following hypothesis was tested in order to check whether the residuals are uncorrelated.

H_0: Residuals are uncorrelated

H_1: Residuals are correlated

By looking at the Table 4.16 which is the correlogram for the residuals, any pattern in the ACF or PACF cannot be identified which ensures the robustness of the results. Since the p-values are greater than 0.05 up to 20th lag, null hypothesis is not rejected and it is clear that the residuals are uncorrelated at 5% significance level.

Table 4.16: Correlogram of residuals

Date: 06/15/17 Time: 01:40
Sample: 4 51
Included observations: 48

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>1</td><td>-0.070</td><td>-0.070</td><td>0.2520</td><td>0.616</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>2</td><td>-0.140</td><td>-0.145</td><td>1.2679</td><td>0.531</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>3</td><td>-0.135</td><td>-0.160</td><td>2.2343</td><td>0.525</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>4</td><td>0.026</td><td>-0.022</td><td>2.2711</td><td>0.686</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>5</td><td>-0.126</td><td>-0.178</td><td>3.1550</td><td>0.676</td></tr>
<tr><td>. |** |</td><td>. |* . |</td><td>6</td><td>0.221</td><td>0.182</td><td>5.9359</td><td>0.430</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>7</td><td>-0.123</td><td>-0.152</td><td>6.8276</td><td>0.447</td></tr>
<tr><td>**| . |</td><td>***| . |</td><td>8</td><td>-0.313</td><td>-0.351</td><td>12.700</td><td>0.123</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>9</td><td>0.140</td><td>0.137</td><td>13.909</td><td>0.126</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>10</td><td>0.202</td><td>0.072</td><td>16.498</td><td>0.086</td></tr>
<tr><td>.*| . |</td><td>.*| . |</td><td>11</td><td>-0.155</td><td>-0.204</td><td>18.057</td><td>0.080</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>12</td><td>0.114</td><td>0.151</td><td>18.922</td><td>0.090</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>13</td><td>0.173</td><td>0.208</td><td>20.966</td><td>0.074</td></tr>
<tr><td>.*| . |</td><td>. | . |</td><td>14</td><td>-0.131</td><td>-0.050</td><td>22.175</td><td>0.075</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>0.013</td><td>0.012</td><td>22.188</td><td>0.103</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>16</td><td>0.069</td><td>-0.009</td><td>22.543</td><td>0.126</td></tr>
<tr><td>**| . |</td><td>.*| . |</td><td>17</td><td>-0.230</td><td>-0.087</td><td>26.630</td><td>0.064</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>18</td><td>-0.037</td><td>-0.002</td><td>26.742</td><td>0.084</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>19</td><td>0.168</td><td>-0.041</td><td>29.077</td><td>0.065</td></tr>
<tr><td>. | . |</td><td>. |* . |</td><td>20</td><td>-0.033</td><td>0.087</td><td>29.172</td><td>0.084</td></tr>
</table>

4.7.6 Correlogram Q-Statistics of squared residuals

This view displays the autocorrelations and partial autocorrelations of the squared residuals up to any specified number of lags and computes the Ljung-Box Q-statistics for the corresponding lags. Following hypothesis was tested in order to check whether the residuals are uncorrelated.

H_0: Residuals are uncorrelated Vs H_1: Residuals are correlated

Table 4.17: correlogram of squared residuals

Date: 06/15/17 Time: 01:42
Sample: 4 51
Included observations: 48

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.*| . |	.*| . |	1	-0.080	-0.080	0.3258	0.568
. |*. |	. |*. |	2	0.209	0.204	2.6103	0.271
.*| . |	.*| . |	3	-0.131	-0.106	3.5207	0.318
. | . |	. | . |	4	0.021	-0.036	3.5458	0.471
. | . |	. | . |	5	-0.001	0.050	3.5458	0.616
.*| . |	.*| . |	6	-0.080	-0.095	3.9120	0.689
.*| . |	.*| . |	7	-0.076	-0.102	4.2499	0.751
. | . |	. |*. |	8	0.062	0.105	4.4790	0.812
. |*. |	. |*. |	9	0.141	0.176	5.6950	0.770
. | . |	. | . |	10	0.028	-0.017	5.7460	0.836
. |*. |	. |*. |	11	0.107	0.075	6.4853	0.839
. |*. |	. |*. |	12	0.114	0.181	7.3554	0.833
. | . |	. | . |	13	0.064	0.023	7.6397	0.866
. |*. |	. | . |	14	0.094	0.063	8.2648	0.875
.*| . |	. | . |	15	-0.076	0.003	8.6850	0.893
.*| . |	.*| . |	16	-0.099	-0.130	9.4265	0.895
. | . |	. | . |	17	0.011	0.017	9.4353	0.926
. | . |	. | . |	18	-0.011	0.051	9.4459	0.949
. |*. |	. | . |	19	0.085	0.061	10.049	0.952
.*| . |	.*| . |	20	-0.098	-0.139	10.866	0.950

By looking at the Table 4.17 which is the correlogram for the squared residuals, any pattern in the ACF or PACF cannot be identified which ensures the robustness of the results. Since the p-values are greater than 0.05 up to 20th lag, null hypothesis is not rejected and it is clear that the residuals are uncorrelated at 5% significance level.

The results shown above indicates that the model passes the diagnostic tests of serial correlation, Normality of residuals and heteroscedasticity test at 5% significance level.

4.8 Discussion of Results

The role of the stock market in the economy is to raise capital and also to ensure that the funds raised are utilized in the most profitable opportunities. This empirical report performs the necessary analysis to answer whether changes in the identified macroeconomic variables affect stock prices of the Colombo Stock Exchange.

The variables were tested using Augmented Dickey Fuller test (ADF) and Phillips-Perron (PP) test with respect to their stationarity. The result shows that all the variables were not stationary at level but became stationary at first difference. Since all the variables were found to be integrated of same order, the Johansen cointegration technique was applied to explore the long-run relationships among the variables. The results clearly show that there is cointegration exists among the variables. In other words, there is long run equilibrium relationship among the study variables.

The analysis of the time series data revealed that, in the long run, IIP and inflation relate with stock return. There was a positive long run relationship between IIP and stock return and negative long run relationship between inflation and stock return. The negative relationship between inflation and stock price can be explained by the fact that additional funds flow due to inflation increase the supply in the stock market while the demand side remains unaffected. This static condition on the demand side of the security market puts downward pressure on the stock price. It is important for investors to follow the CCPI because periods of high inflation make difficult the market conditions.

These results are consistent with some previous studies as well. Nishat and Shaheen [27] noted industrial production as the largest positive predictor of equity prices in Pakistan, while inflation is the major negative determinant of stock prices in Pakistan [17]. Industrial production, which reflects real economic activity, affects the stock market index positively. As industrial production increases, sales and earnings of firms rise, which leads to increases in stock prices as investors feel confident of investments in the stock market. When inflation rises it is likely to lead to tight monetary policies, which result in increase in the discount rate. It means the cost of borrowing increases, which in turn leads to investment reduction in the stock market [42].

The study further established that in the short run, stock return and inflation have a significant negative relationship. This finding is not surprising because inflation reduces the real disposable income of individuals and consequently reducing investor's ability to save and invest. Hence, in theory, inflation and stock returns are expected to have a negative relationship. The finding is also in agreement with the findings of Gan et al. [10] and Ahmad and Ghazi [1] who found that stock return and inflation are negatively related in the short run.

Inflation rate is negatively related to stock index in both the short run and long run at 5% level of significance. Increasing inflation in the economy decreases the prices of stocks and thus market index moves downward.

In addition, the study found out that, inflation Granger cause stock returns. However, the reverse is invalid. This result implies that inflation is among the key indicators that influence stock return. The finding is in agreement with the findings of Fama and Schwert [13] and Nishat and Shaheen [27], who found unidirectional causality from inflation to stock returns.

The results of cointegration analysis reveal that in the long run, IIP and inflation relate with stock return. But the results of Granger causality test indicates that only inflation granger causes stock returns. According to Lutkephol and Kratzig [45] this result is acceptable. Generally, if there is a cointegration relation between two variables there must also be Granger-causality in at least one direction. Despite the very clear cointegration result, the causality tests sometimes do not suggest a strong relation. A cointegration analysis and a Granger-causality analysis look at the data from different angles. The causality tests are based on fairly large models with many parameters. The scarce sample information makes it difficult for such tests to reject the null hypothesis. In other words, the causality tests may have a power problem. This line of arguments shows that there is no conflict between the results from the cointegration analysis and the causality analysis. One of them just provides a clearer picture of the relation between the variables because of the different way it processes the sample information [45].

The IRF analysis showed that stock market prices respond negatively to inflation. The stock market prices responded negatively to shocks from money supply during the first two quarters, and the response becomes positive from the third quarter onwards. The response of stock market prices to 91 day T-bill rate and IIP was positive.

The VDC analysis provided further evidence of relationships among the variables under investigation. The results showed that the stock index was relatively less exogenous in relation to the shocks of the macroeconomic variables in the short run. Also the results implied that IIP and inflation prove to be the most significant factors that explain the movement in stock prices in the long run.

4.9 Predictive Power of the Vector Error Correction Model

The R-squared figure of 0.58 indicates that almost 58% of the variation of stock returns fluctuations are explained by dynamics in the macroeconomic variables used for this study.

This implies that, there are other significant variables which can explain about 42% of fluctuations of return on stock. Further, the F-statistics value of 3.6156 with probability

0.0012<0.05 shows that the selected macroeconomic variables put together greatly affect the stock returns.

The residual diagnostics also confirmed the accuracy of the fitted model. The cumulative sum of the recursive residuals showed the parameter stability in the sample period. Also the residual are found to be normally distributed and no serial correlation or heteroscedasticity was found in the residuals. Therefore from the diagnostic checking results, it is clear that the residuals of the VECM are white noise meaning that they do not contain any systematic information.

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study investigated long-run and short-run relationships between four macroeconomic variables such as interest rate, broad money supply, IIP and inflation, and stock market index (ASPI) in Colombo Stock Exchange.

Data on quarterly basis from 2004:Q1 to 2016:Q3 was analyzed using time series techniques. These techniques included are Augmented Dickey-Fuller unit root test, Phillips-Perron unit root test, Johansen cointegration test, Vector Error Correction Model, Granger causality test, impulse response analysis and variance decomposition. All the series used in this analysis were found non-stationary at levels but stationary at first difference.

The Johansen's cointegration test suggests that the stock market index has cointegrated with the macroeconomic variables. In the long-run, inflation had a negative impact on stock prices while IIP affected stock returns positively. This result implies that for the stock index to be improved in the long term, these macroeconomic variables should be stabilized and improved. The interest rate and broad money supply are not turning out to be the significant determinants of stock prices in the long run.

The VECM analysis depicted that the coefficient of error correction term was significant showing speedy adjustment. This suggests that with absence of changes in IIP and inflation, deviation of the model from the long-run path is corrected by 38.05% increase in ASPI per quarter. This means that deviation from the long run relationship takes approximately three quarters (1/0.3805 = 2.628) to eliminate the disequilibrium.

The results showed that inflation significantly and inversely affect stock return in the short run. The results further indicate that inflation Granger cause stock return. However, the reverse was found to be invalid.

The impulse response function in Figure 4.1 shows that the shock of inflation has a negative impact on the stock index throughout the testing period and this negative impact reached a maximum in the eighth quarter. These test results are similar to Chen et al. [29] findings.

The variance decomposition analysis revealed that a major proportion of the variability in the market index was explained by its own innovations while only a minority was explained by macroeconomic variables in the short run. In the long run, only 32% of the variance of stock index was explained by its own shock and IIP and inflation explained 22% and 41% impact on stock index respectively.

The present study confirms the beliefs that macroeconomic factors continue to affect the Sri Lankan stock market. On the basis of the above overall analysis, it can be concluded that two out of the four selected macroeconomic variables are relatively significant and likely to influence the stock prices of the Colombo Stock Exchange in the long run. These macroeconomic variables are inflation and IIP.

The study provides useful guidance for key stake holders such as investors, government and firms listed on the CSE. It is proposed that appropriate monetary measures should be adopted by monetary managers to control inflation so that the volatility of the stock markets can be minimized.

These findings may have important implications for decision-making by investors. For example, the finding that macroeconomic variables have varying impacts and significance on returns in a market may prove itself useful for portfolio diversification strategies as well as achieving better risk-return tradeoffs. Based on the findings of this study, the government will be able to set up policies that will be helpful in developing the stock market.

5.2 Recommendations

Based on the findings of the study, the study presents recommendations pertinent to the policy makers, financial market regulators and future researchers.

The results of the study provide useful lessons for stakeholders such as listed companies, policy makers, academicians etc. This work contributes empirically to the discussions about macroeconomic variables relate with stock market returns. Considering the results, recommendations are made as follows:

In the first place, Central Bank of Sri Lanka must undertake pragmatic policies aimed at controlling inflation within acceptable limits, since inflation is seen to inversely affect stock return.

Secondly, the listed firms must work assiduously to improve upon the attractiveness of the shares to investors. This is because a lot of investors see the stock market as an avenue for hedging their risks over a long period. This requires that the listed companies to undertake profitable ventures to enhance their profitability. This is so because investors are encouraged to invest with businesses with future prospects. The companies must undertake measures to cut down on cost of production as much as possible and also to increase productivity. The net effect will be increased profit margins and, consequently, an increase in the returns on their shares.

5.3 Suggestion for Further Research

The study suggests that further research should be conducted to examine the relationship between macroeconomic variables and share prices of listed companies in CSE by using other macroeconomic variables such as exchange rate, crude oil price, gold price, gross domestic product, balance of trade etc; and would be able to have more comprehensive results if the data used can be extended over a longer periods.

Since the Sri Lankan stock market is comparatively small relative to the stock market of other developed countries, the Sri Lankan stock market might also be very sensitive to global macroeconomic factors. Thus, future studies can extend this study to include those factors as well.

Although the linkages in the macroeconomic variables and the movement of the stock prices have been well researched in the developed countries, there are still avenues for research in this area for emerging economies. As in the case of Sri Lanka, further research could be conducted to examine the relationship between the macroeconomic variables and the various sectors in the stock market. A logical extension of the study can be done by including more variables and analyzing sector wise stock index.

5.4 Limitations

The study had several limitations to be mentioned. The study used quarterly data for a 12-years period. Perhaps a longer period of data could have yielded a more refined result. In addition study should also include other factors which are not covered in this paper such as economic growth (GDP), exchange rates, oil price, gold price etc. The present study is limited to only four selected macroeconomic variables. Inclusion of more variables with a longer time period may improve the results.

The stock markets of emerging economies are likely to be sensitive to the factors such as macroeconomic variables, domestic and international economy, socio-political events, monetary policy, international transactions, etc. This study is limited only to find the effect of macroeconomic variables on ASPI of stock market in Sri Lanka. If it is possible to consider the effect of above mentioned other variables as well, the results will be more meaningful.

On the basis of the above limitations, it is suggested that future studies on the same or related topic examine the relationship between stock index and macroeconomic variables.

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APPENDIX: Vector Error Correction Model Estimates

Vector Error Correction Estimates
Date: 06/16/17 Time: 10:34
Sample (adjusted): 4 51
Included observations: 48 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	CointEq2	CointEq3
LNY(-1)	1.000000	0.000000	0.000000
LNX1(-1)	0.000000	1.000000	0.000000
LNX2(-1)	0.000000	0.000000	1.000000
LNX3(-1)	-2.310302	2.089160	-3.033485
	(0.17004)	(0.70553)	(0.81458)
	[-13.5866]	[2.96110]	[-3.72400]
LNX4(-1)	0.797451	0.071844	-1.989365
	(0.29030)	(1.20451)	(1.39067)
	[2.74697]	[0.05965]	[-1.43050]
C	6.648983	-19.78048	20.60142

Error Correction:	D(LNY)	D(LNX1)	D(LNX2)	D(LNX3)	D(LNX4)
CointEq1	-0.380569	0.520618	0.022099	0.015189	-0.061073
	(0.13381)	(0.14461)	(0.01485)	(0.03533)	(0.07077)
	[-2.84400]	[3.60005]	[1.48855]	[0.42986]	[-0.86301]
CointEq2	-0.029504	-0.569347	0.001678	0.087636	0.181515
	(0.09406)	(0.10165)	(0.01043)	(0.02484)	(0.04974)
	[-0.31368]	[-5.60128]	[0.16078]	[3.52868]	[3.64921]
CointEq3	0.095017	-0.557712	0.002597	0.076487	0.182052
	(0.08847)	(0.09561)	(0.00982)	(0.02336)	(0.04679)
	[1.07398]	[-5.83307]	[0.26454]	[3.27413]	[3.89097]
D(LNY(-1))	0.218215	-0.457612	0.003914	0.077441	0.002910
	(0.16648)	(0.17991)	(0.01847)	(0.04396)	(0.08804)
	[1.31078]	[-2.54352]	[0.21192]	[1.76170]	[0.03306]
D(LNY(-2))	0.148196	-0.344184	0.002377	0.050058	-0.016558
	(0.15473)	(0.16722)	(0.01717)	(0.04086)	(0.08183)
	[0.95778]	[-2.05833]	[0.13846]	[1.22523]	[-0.20235]
D(LNX1(-1))	0.001919	0.269152	-0.002520	0.015702	0.012607
	(0.17518)	(0.18932)	(0.01943)	(0.04626)	(0.09264)
	[0.01095]	[1.42170]	[-0.12968]	[0.33945]	[0.13608]
D(LNX1(-2))	-0.190984	0.683139	-0.019606	-0.064318	-0.159599

	(0.16116)	(0.17417)	(0.01788)	(0.04255)	(0.08523)
	[-1.18507]	[3.92235]	[-1.09658]	[-1.51145]	[-1.87259]
D(LNX2(-1))	-2.837205	0.890607	-0.090623	0.129645	-0.369258
	(1.43711)	(1.55310)	(0.15944)	(0.37947)	(0.76002)
	[-1.97424]	[0.57344]	[-0.56839]	[0.34165]	[-0.48585]
D(LNX2(-2))	2.313922	1.321200	-0.344343	-0.530261	-0.994882
	(1.35336)	(1.46259)	(0.15015)	(0.35736)	(0.71573)
	[2.07920]	[0.90333]	[-2.29337]	[-1.48384]	[-1.39003]
D(LNX3(-1))	0.630537	1.185809	0.022305	0.445883	0.201061
	(0.52981)	(0.57257)	(0.05878)	(0.13990)	(0.28019)
	[1.19011]	[2.07102]	[0.37947]	[3.18721]	[0.71758]
D(LNX3(-2))	-1.029013	0.483152	-0.087348	-0.481097	-0.236238
	(0.49061)	(0.53020)	(0.05443)	(0.12955)	(0.25946)
	[-2.09742]	[0.91126]	[-1.60477]	[-3.71373]	[-0.91050]
D(LNX4(-1))	-0.053313	-0.723455	0.022817	0.189259	0.362690
	(0.38569)	(0.41682)	(0.04279)	(0.10184)	(0.20397)
	[-0.13823]	[-1.73567]	[0.53324]	[1.85837]	[1.77814]
D(LNX4(-2))	-1.007149	0.460838	-0.032244	0.040224	-0.070112
	(0.34385)	(0.37161)	(0.03815)	(0.09079)	(0.18185)
	[-2.92900]	[1.24013]	[-0.84523]	[0.44302]	[-0.38555]
C	0.043283	-0.096734	0.059714	0.031010	0.065727
	(0.07984)	(0.08629)	(0.00886)	(0.02108)	(0.04223)
	[0.54209]	[-1.12107]	[6.74119]	[1.47088]	[1.55658]
R-squared	0.580264	0.650814	0.447584	0.681963	0.496757
Adj. R-squared	0.419777	0.517302	0.236365	0.560361	0.304340
Sum sq. resids	0.379912	0.443709	0.004676	0.026488	0.106255
S.E. equation	0.105707	0.114238	0.011727	0.027912	0.055903
F-statistic	3.615641	4.874571	2.119059	5.608139	2.581673
Log likelihood	40.02733	44.30187	153.5666	111.9449	78.60580
Akaike AIC	-1.417805	-1.262578	-5.815275	-4.081038	-2.691908
Schwarz SC	-0.872038	-0.716811	-5.269508	-3.535271	-2.146142
Mean dependent	0.030188	0.004167	0.040704	0.021170	0.012780
S.D. dependent	0.138773	0.164427	0.013420	0.042096	0.067025

Determinant resid covariance (dof adj.)	2.31E-14
Determinant resid covariance	4.12E-15
Log likelihood	454.3850
Akaike information criterion	-15.39104
Schwarz criterion	-12.07746