IMPACT OF MACRO ECONOMIC DETERMINANTS ON INFLATION IN SRI LANKA - A STATISTICAL APPROACH

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DECLARATION OF THE CANDIDATE AND SUPERVISOR

I hereby declare this project report is the product of my own and is based on a research that I performed independently without the participation of any other person or authority. The references made to other researches here have been acknowledged appropriately with due appreciation. The sources of data and information external to the dissertation and the research have been acknowledged appropriately. Also the substance in this research has never been submitted for any other degree, anywhere else. I hereby give my consent to making this available by photocopy for inter-library loans, and for the title and summary of the dissertation to be made available for use by other institutions of learning.

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ABSTRACT

This study attempts to analyze the experience of inflation in Sri Lanka for the period 1960 to 2013 using the econometric framework of Johanson and Juselius cointegration approach, Granger causality analysis and vector error correction model (VECM). The data used are annual series of Colombo Consume Price Index as a proxy variable for inflation rate, gross national product, broad money supply, budget deficit and exchange rate. The empirical results of the study indicate the existence of long run dynamic relationships among the variables. However, VECM identified that broad money supply growth and exchange rate depreciation have significant positive effects on inflation. The errors of the VECM model was found as white noise. The results would be useful how business and industry play on the economy of the country. Furthermore, the results of this study emphasize the need to put in place a stable macroeconomic policy environment relating to these variables in an effort to maintain price stability, since low inflation would enhance economic growth.

Keywords: Budget deficit, Co-integration, Granger causality, Inflation, Money supply

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Inflation is often referred to as the biggest man made enemy. While some argue that a certain rate of inflation is desirable, others are skeptic as to what such desirable rate is and if such a phenomenon exists (Madurapperuma, 2007). Money is often cited as the cause for inflation while there is also attribution to high oil prices, cost of imported goods and hence "cost push" inflation (Central Bank of Sri Lanka, 2012). Inflation is the rate of increase of the general price level. In Sri Lanka it is measured in terms of changes in Colombo consumer price index (CCPI), calculated by the Department of Census and Statistics. Such an index would indicate the relative cost of a specified basket of goods and services over time, compared with the cost of such basket of goods and services during a particular (base) year (Department of Census and Statistics, 2012).

High and stable economic growth and low inflation are the two main goals of macroeconomic policy. Hence it is important to investigate the existence and nature of the link between these two variables (Central Bank of Sri Lanka, 2012). According to the modern economics practices, maintaining economic and price stability has become one of the core objectives of government of Sri Lanka as in many other developing countries. The concern with maintaining price stability stems not only from the need to maintain overall macroeconomic stability, but also from the fact that price stability forms a better environment for investment, output, and employment etc. Over the decades, experience of many countries suggests that price stability promotes economic growth. Therefore policy makers believe, when inflation crosses a reasonable limit in the economy that can adversely affect other macroeconomic variables and in turn undermines its steady level of the economy (Kesavarajah, 2011).

In recent years, experiences in both developed and developing countries have shown that rise in the price of essential commodities, particularly food and oil items affected almost all the countries in the world (Central Bank of Sri Lanka, 2012). Hence every country was under pressure to control the inflation level and the Central Banks of these countries have taken various measures to maintain the price stability. Sri Lanka's economy is not exceptional with respect to this issue since it heavily depends on these two items.

Sri Lanka gained political independence in 1948. In the history of Sri Lankan economic development the year 1977 is a turning point of the economic development. This is due to the fact that Sri Lanka embarked economic liberalization after 1977. As a part of that reform Sri Lanka introduced financial liberalization policies with a view to enhancing growth. Following the economic liberalization, the expansionary economic policies followed by the government and the Central Bank of Sri Lanka resulted in improvements in various macroeconomic indicators including economic growth, which remained above five percent (Central Bank of Sri Lanka, 2012). At the same time, continuous rise in the general price level in the economy has emerged an important macroeconomic problem all over the country.

1.2 Trend of Inflation in Sri Lanka

Since becoming independent from Britain in February 1948, the parties which ruled the country did not implement any national plan or policy on the economy, veering between left and right wing economic practices. The government during 1970-77 period applied close economic policies and practices and after 1977 applied open economy policies.

Figure: 1.1 shows the trends of inflation rate in Sri Lanka before the post-economic liberation period (close economy period) expressed as the annual percentage change in the Colombo Consumer Price Index (CCPI). Figure: 1.2 shows the trends of inflation rate in Sri Lanka after the post-economic liberation period (open economy period).

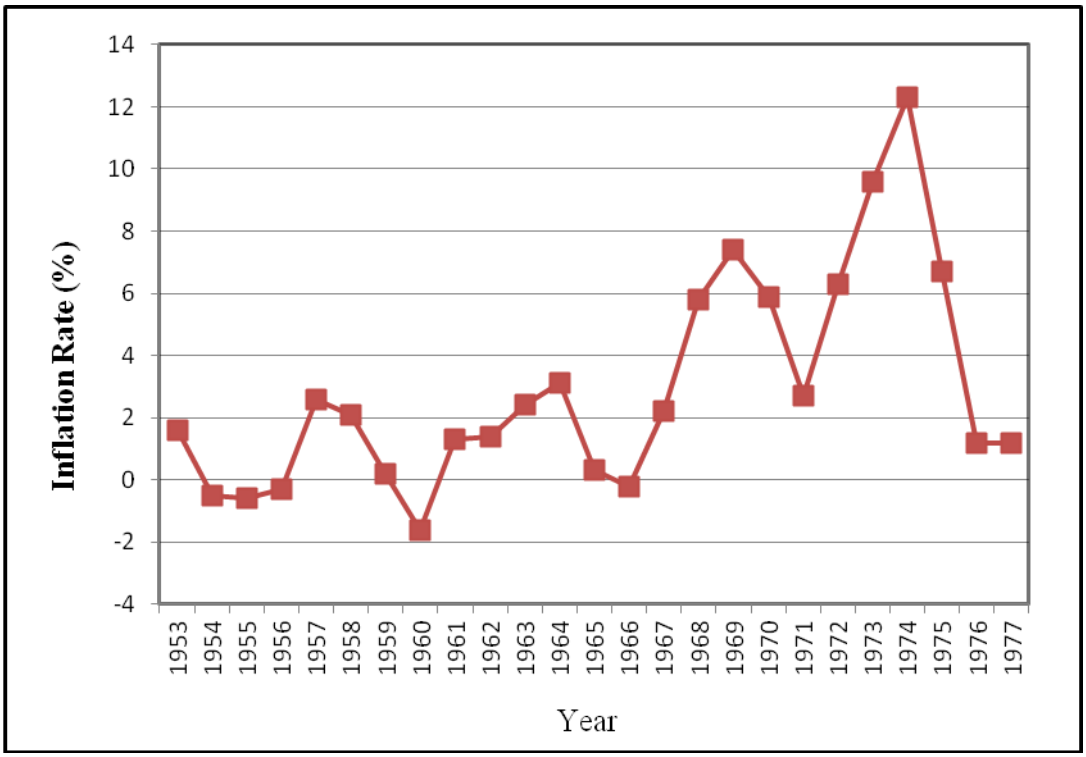

Figure 1.1: Trend of Inflation in Sri Lanka, 1953 - 1977

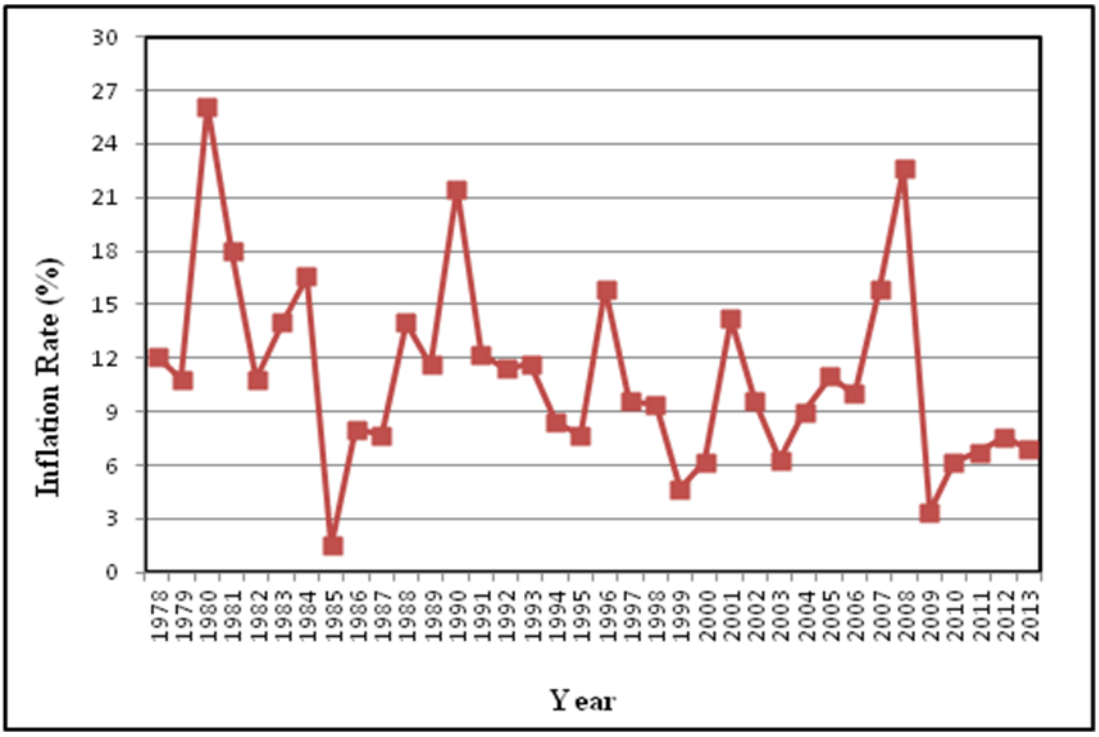

Figure 1.2: Trend of Inflation in Sri Lanka, 1978 - 2013

Comparison of Figure 1.1 and Figure 1.2, it indicates that, following the economic liberalization, inflation rate in Sri Lanka has been highly volatile according to Fig 1.2. The inflation increased to 26 percent, 21.5 percent and 22.5 percent in the years of 1980, 1990 and 2008 respectively. Since 1991, the rate decreased gradually up to 2002. However, after 2003, the inflation rate gradually increased until 2008. In 2008, the inflation rate recorded was at a peak of 22.6 percent. However, in 2009, the inflation rate decreased to 3.4 percent, but in 2013, it has gone to 6.9 percent (Fig 1.2).

Table 1.1 provides a comparison of inflation rates in Sri Lanka with other countries in the region.

Table 1.1: Inflation Rate in SAARC Countries, 1990 - 2013

Country	1990-2005	2006	2007	2008	2009	2010	2011	2012	2013	Average (1990 - 2013)
Bangladesh	5.7	6.8	9.1	8.9	5.4	8.1	10.7	8.7	7.6	6.5
Bhutan	7.8	5.0	5.2	8.3	4.4	7.0	8.9	10.9	11.1	7.7
India	7.4	6.7	6.2	9.1	12.4	10.4	8.4	10.4	10.9	8.1
Maldives	6.0	3.5	6.8	12.0	4.5	6.2	11.3	10.9	4.4	6.5
Nepal	7.5	8.0	6.2	6.7	12.6	9.5	9.6	8.3	9.9	8.0
Sri Lanka	10.6	10.0	15.8	22.6	3.4	6.2	6.7	7.6	6.9	10.3
Afghanistan	17.0	5.3	12.5	23.4	10.0	7.1	10.4	4.5	7.1	10.1
Pakistan	7.8	8.0	7.8	10.8	17.6	10.1	13.7	11.0	7.4	8.8

Source: IMF, World Economic Outlook, Washington, DC, October 2013

It can be seen, that the average inflation rate during 1990 - 2005 is somewhat lower than that the corresponding value during 2006 - 2013 in all countries with exceptional to Sri Lanka and Afghanistan. Thus it can be hypothesized that rising oil prices and food prices have contributed for inflationary pressure in all the countries in the region. Furthermore, all countries were able to maintain their inflation at a single digit level. It should be noted that the average inflation rate in Sri Lanka is

higher than that of the average rate of South Asian countries. This could be due to the fact that the values at 2008 (22.6).

One of the many explanations for the continuing increase in price level is the monetarist theory of the excessive growth in money supply. A consequence of financial deregulation in Sri Lanka has been the growth in all monetary aggregates. The lack of fiscal restraint has been a prime factor underlying this monetary expansion (Central Bank of Sri Lanka, 2012). The adoption of liberalized trade and payment policies together with the introduction of a floating exchange rate system added further pressure on prices. The impact of exchange rate movements on the rate of inflation has also come to acquire greater significance and is therefore included as a likely explanatory variable in the empirical study that follows.

1.3 Measures of Inflation in Sri Lanka

Inflation is one of the most frequently used terms in economic discussions, yet the concept is variously misconstrued. Inflation is the rate of increase of the general price level. It is measured in terms of changes in price indices. Such an index would indicate the relative cost of a specified basket of goods and services over time, compared with the cost of such basket of goods and services during a particular (base) year. The annual average inflation rate is based on the average index value during a given year as compared with the previous year for the same period. In Sri Lanka there are several price indices calculated by the Central Bank of Sri Lanka and the Department of Census and Statistics. Few main indices are Colombo Consumer Price Index (CCPI) which is the key index quoted for inflation reporting. The inflation rate for the current year (X_t) is computed as follows.

$$X_t = \frac{(Y_t - Y_{t-1})}{Y_t} * 100$$

Where

X_t = Inflation rate in current year t,

Y_t = Colombo consumer price index in current year t and

Y_{t-1} = Colombo consumer price index in previous year t-1

In the definition of inflation, two key words must be borne in mind. First, is aggregate or general, which implies the rise in prices that constitutes inflation must cover the entire basket of goods in the economy as distinct from an isolated rise in the prices of a single commodity or group of commodities? The implication here is that changes in the individual prices or any combination of the prices cannot be considered as the occurrence of inflation. However, a situation may arise such that a change in an individual price could cause the other prices to rise. This again does not signal inflation unless the price adjustment in the basket is such that the aggregate price level is induced to rise. Second, the rise in the aggregate level of price must be continuous for inflation to be said to have occurred. (Department of Census and Statistics, 2012)

1.4 Importance of the Study

Various studies have been conducted from time to time in Sri Lanka for explain why inflation is highly fluctuation. This study is aimed to various factors contributed to this highly volatile inflation situation using explanatory variables such as the real gross national product, growth of money supply, budget deficit and exchange rate. Thus expected output is would be more beneficial implementing fiscal, monetary policies and taking decisions regarding to the economic development by the policy maker in government and other stakeholder.

1.5 Objectives of the Study

In view of the above, the objectives of the study are;

- To examine the impact of major macroeconomic determinants such as real gross national product (GNP), broad money supply (MS), budget deficit (BD), and exchange rate (ER) on inflation (INF)
- To develop a VEC model for inflation in Sri Lanka
- To validate the model

1.6 Organization of Thesis

There are five chapters in this study. Chapter one is an introduction which contains the background, measures of inflation, importance of the study, objectives of the study, and organization of the thesis. Chapter two presents the theoretical and empirical literature review regarding relationship between inflation rate and other macro economics variables and its impact. The third chapter describes the materials and methodology that will be used, and chapter four delivers the results and discussion. Chapter five comprises of the conclusion.

CHAPTER TWO

LITERATURE REVIEW

2.1 General Concept of Inflation Rate

The determinants of inflation are discussed widely in both theoretical and empirical literature. Some of the most cited factors influencing inflation are connected with the exchange rate regime and money supply growth. Some economists highlight the structural factors such as market imperfection and cost pressures including import prices. At the same time other economists focus on demand pressures including the government expenditure, the amount of revenue collected etc.

The Purchasing Power Parity (PPP) theory (Jhingan, 1990) explains the changes in exchange rates in terms of differentials in inflation between countries. It suggests, in a common currency arrangement, the rate of inflation of the dominant country should influence the inflation rates of smaller countries. In other words, it assumes that the prices of the trading countries should be the same when expressed in the common currency, with the differential being accounted for by tariffs and transport costs. According to the cost push theory ((Jhingan, 1990), prices rise due to increasing cost of the factors of production. This theory maintains that prices of goods and services rise because wages are pushed up by trade unions' bargaining power or by the pricing policies of oligopolistic and monopolistic firms with market power. On the other hand, Demand pull theory suggests, inflationary pressures arise because of excess demand for goods and services resulting from expansionary monetary and fiscal policies. The demand pull explanation recommends restrictive monetary and fiscal policies whilst the costs push explanation favors policies directed at the process of price formation and wage determination. Quantity theory of money (QTM) (Gujarati and Porter, 2003) suggests that inflation is mainly a result of an increase in money supply and rates of change in money supply as having a positive

correlation with inflation while growth in real income has a negative correlation with inflation.

2.2 Related Studies in Sri Lanka

Kesavarajah (2011) examined to analyze the experience of inflation in Sri Lanka for the period 1978 to 2010 using the econometric framework of Johanson and Juselius cointegration approach, vector error correction model (VECM) and Granger causality analysis. The study found that money supply; exchange rate and budget deficit are Cointegrated, indicating that there is a stable long run dynamic relationship. The long run inflation function indicates that increases in money supply, budget deficit and exchange rate depreciation are playing significant role in long run inflation in Sri Lanka.

Ratnasiri (2009) examined the main determinants of inflation in Sri Lanka over the period 1980 to 2005 using vector autoregressive analysis (VAR). The results indicate that money supply growth and rice price increases are the main determinants of inflation in Sri Lanka in the long run. He also found that exchange rate depreciation and output gap have no statistically significant effect on inflation.

Bandara (2000) investigated the short run dynamics of inflation, using the cointegration approach and found that both money supply and exchange rate movements have significant influences on the behavior of inflation in Sri Lanka. Based on the error correction model (ECM) he indicated that money supply doesn't have any significant impact on the rate of inflation, while exchange rate depreciation and foreign price levels have significant positive effects on domestic inflation.

A study by Cooray (2008) used two models: an open economy model and a closed economy model to find a long run relationship between the price level, real GNP, exchange rate and import prices for Sri Lanka. The results suggest greater support for the open economy model. With the opening up of the economy, import prices and exchange rate movements appear to have a significant impact on the general level of

prices. This study suggests the importance of supply side factors in determining the general price level.

A very basic study was carried out by the Ajantha Madurapperuma (2007) using the inflation data and the real growth of GDP of 184 countries. The data available were the estimates of inflation and estimated real GDP growth for the year 2006 or 2005, most cases being for 2006. The country ranking as per the GDP growth (higher growth lower number) and the country ranking as per the inflation (higher inflation lower number) gave a positive significant correlation ($r = 0.375$, $p < 5\%$) suggesting a weak but possible relationship of high inflation and high growth. It also gave a very low positive correlation ($r = 0.125$, $p > 5\%$) between inflation rate and the growth rate suggesting very weak correlation. This study cannot be conclusive due to the vast diversity of the economies and also the non incorporation of lag effects. However it may be useful to form a basis for further research.

2.3 Related Studies in Other Countries

Akhtaruzzaman (2005) employed the cointegration and vector error correction modeling (VECM) technique to identify the variables, which are believed to generate inflation in Bangladesh. The results of the study reveal that inflation in Bangladesh is negatively related with real income. However, the depreciation of exchange rate, growth of money supply, deposit interest rate is statistically significant in explaining the inflationary process in Bangladesh.

Chhibber (1989) developed detailed econometric models which considered both monetary and structural factors of inflation in Zimbabwe. The study showed that nominal monetary growth, foreign prices, exchange and interest rates, unit labor costs and real income are main determinants of inflation in Zimbabwe.

Kishor and Kundan (2009) studied the role of the real money gap, the deviation of real money balance from its long run equilibrium level for predicting inflation in

India. Using quarterly data on manufacturing inflation from 1982 to 2007, it was found that the real money gap is a significant predictor of inflation in India.

Khan and Sagib (2008) investigated the effects of political instability on inflation in Pakistan, applying the generalized method of moments (GMM) and using data from 1951- 2007. They examined this link in two different models. The results of the monetary model suggest that the effects of monetary determinants are rather marginal and that they depend upon the political environment of Pakistan. The non-monetary model's findings explicitly establish a positive association between measures of political instability and inflation. This is further confirmed on analyses based on interactive dummies that reveal political instability significantly leads to high inflation.

Amos (2009) studied financial time series modeling using inflation data spanning from January 1994 to December 2008 for South Africa. In the study two time series models which are the seasonal autoregressive integrated moving average (SARIMA) model and the generalized autoregressive conditional heteroscedasticity (GARCH) model were fitted to the data for encountering trend and seasonal terms and accommodating time varying variance respectively. A best fitting model for each family of models offering an optimal balance between goodness of fit and parsimony was selected. The SARIMA model of order (1,1,0)(0,1,1) and GARCH model of order (1,1) were chosen to be the best fitting models for determining the two years forecasts of inflation rate of South Africa. However, GARCH model of order (1,1) was observed to be superior in producing future forecasts because of its ability to capture variations in the data.

Chaudry and Chaudhary (2005) examined the determinants of inflation in Pakistan using autoregressive distributed lag modelling (ARDL) approach to cointergration using the following model:

$$\text{Log}(P_t) = \alpha_0 + \alpha_1 \log(M_t) + \alpha_2 \log(Y_t) + \alpha_3 \log(F_t) + U_t$$

P_t = Price level,

Y_t = reap output,

M_t = M2 definition of money supply,

F_t = unit price of imported goods

They found that the growth rate of import prices is the most important determinant of inflation in Pakistan both in the short run and long run, which is followed by the growth rate of output in terms of importance. The effect of money supply on inflation is negligible and statistically insignificant.

Samuel and Ussif (2001) investigated determinants of inflation in Tanzania using ordinary least square (OLS) estimation and error correction model (ECM).

$$\text{Log}(p_t) = \alpha_0 + \alpha_1 \log(M_t) + \alpha_2 \log(GDP_t) + \alpha_3 \log(EXRATE_t) + U_t$$

In this model, the variables are price level (p_t), money supply (M_t), GDP (GDP_t) and exchange rate ($EXRATE_t$). They found that in Tanzania, output and monetary factors are the main determinants of inflation. In addition, the exchange rate also becomes a significant variable in inflation in the long run.

In Nigeria, a number of studies have been undertaken on the subject of money supply and prices. A particular case is Ajayi (1978) who investigated the relationship between money, prices and interest rates in Nigeria. He concluded that money is one of the significant causes of rising price level. His finding reflected the traditional approach where the relationship between money and prices is assumed to be direct and one way.

Another contributing work is that of Okpanachi (2004) which examined the relationship between government defiant, price level and capital formation in Nigeria. The findings of the study were summarised as follows:

(i) Budgetary deficit increases supply; (ii) That the price level could be explained in terms of other measures of deficit financing such as

domestic credit creation and internal credit marginalization; (iii) That there exists a positive and significant relationship between variation in price level and in domestic credit creation; and (iv) That the deficit financing influences capital formation.

On exchange rates, GDP and balance of payment deficit, the monetarists settled with the premise that deficit balance of payment tends to lead to disequilibrium in domestic money market and that excess money supply that often comes from expansionary expenditure on foreign goods and assets can cause exchange rate depreciation under a floating exchange rate system. However, in a fixed exchange rates system such expansion is financed by government by drawing on external reserves in order to meet the deficit.

Nevertheless, some studies that negated the effect of exchange rate or imported inflation on domestic price level. Chibber & Safik (1991) for example, argued that there is no relationship between exchange rate and inflation. Basing his argument on empirical studies of selected African countries, he concluded that devaluation could exert upward pressure on the general price level only in the short run. He argued that the extent to which devaluation of local currency engenders inflation is largely a function of the impact of such policy measures on revenues and expenditure (budget) of government, together with the monetary policy that is simultaneously pursued.

Sowa and kwakye (1991) also concluded using Ghana data, from their studies that exchange rate as a variable could not have a significant direct relationship with price movement. However, study of Uganda inflationary data between 1988 and 1989 by Elbadawi (1990) revealed that monetary expansion and deprecation of exchange rate were responsible for Uganda's inflation. It is therefore a case of lack of consensus on the subject of impact of the various variables on inflation.

Nazar, Farshid, and Mojtaba (2010) used a time series of inflation in Iran from 1959 - 2009 and examined the affiliation between inflation and inflation uncertainty through exponential generalized autoregressive conditional heteroscedasticity (EGARCH) framework. The results indicated that there was an asymmetric liaison

between inflation and inflation uncertainty. The positive shocks to inflation had a greater effect on inflation uncertainty as compared with negative effects. Granger causality test also verified that inflation granger-caused inflation uncertainty.

Schuh (1974) and Timer (1984) are two economists that have studied the relationship between inflation rate and farmers' welfare development. They stated that interaction between monetary policy and agriculture sector for increasing farmers' welfare could be affected by inflation rate and intensive export-import of agriculture. McFall Lamn (1980) has built the simultaneous-econometrical model to see the relationship between inflation rate and farmers' welfare. He said that inflation rate is a transition medium for monetary policy on determining farmers' welfare in the agriculture sector development. Tangermann (1973) also claimed that the inflation rate may lead to a negative impact for 'the terms of trade' in agriculture sector when this sector dependent to intermediate input of other sectors. Geoffrey and Timothy (2009) on their study about 'commodity prices and food inflation' argued that inflation rate can stimulate not only on change of cost share in agriculture input price but also in agriculture market competition between wholesalers and retailers in their 'strategic pricing' of agriculture products.

Blank and Blinder (1985) using data from 1959 - 1983 period, studied the relationship between macroeconomic variables such as growth, unemployment, business cycles, inflation and poverty in the United States. They found, despite unending incantations about how inflation weighs most heavily on the poor, that there was no evident correlation between poverty and inflation. They confirmed that unemployment, not inflation, had the strongest bearing on the well-being of the poor.

Cardoso (1992) studied the effect of inflation on poverty between 1970 and 1990 in the Latin American countries. She argued that Inflation increases poverty in two ways. First, the inflation tax can reduce disposable real income. Second, if nominal wages increase less than the price of goods consumed by wage earners, workers' real income will decline. She found evidence that in Latin America, inflation affected the poor through inflation tax but the effect was very small. Higher rates of inflation had

resulted in higher inflation taxes but unless the inflation was extremely high (above 100%) this increase in inflation tax was less than 1%. However, she showed that the main effect of inflation on poverty was manifested through real wages. She found that accelerating inflation reduces real wages and increases poverty. According to her results, real wages fall by 14 percent when inflation doubles.

Kassim and Munir (2009) was able to establish the non-linearity between inflation rate and GDP growth rate in Malaysia. His study analyzed the relationship between inflation rate and economic growth rate in the period 1970-2005 in Malaysia. A specific question that is addressed in this study is what the threshold inflation rate for Malaysia. The findings suggest that there is one inflation threshold value exist for Malaysia. This evidence strongly supports the view that the relationship between inflation rate and economic growth is nonlinear. The estimated threshold regression model suggests 3.89% as the threshold value of inflation rate above which inflation significantly retards growth rate of GDP.

Marta (2004) examines monetary policy in Albania during the transition period. Estimates from a vector Auto Regression Model (VAR) of key macroeconomic variables which include money growth, inflation, exchange rate, remittances and the trade balance, demonstrate the weak link between money supply and inflation up to mid 2000. They conclude that exchange rate stability has played a key role in keeping inflation low for most of the transition period, and that the range of monetary policy instruments available to the authorities has widened in recent years and this has been associated with more stable and predictable changes in money supply and the price level. The result demonstrates that Albania has come a long way in terms of controlling inflation, liberalizing financial markets and improving the predictability of inter-relations among key macroeconomic variables.

Holod (2000) explores the identified vector autoregression to model the relationship between CPI, money supply and exchange rate in Ukraine. The results show that exchange rate shocks significantly influence price level behaviour. Further, the study also found that money supply responds to positive shocks in price level. The study

contributes to the sizable literature on IT using overly sophisticated vector error correction model with complex identification structure. There is however an element of data mining in the generation of impulse response functions.

Metin (1998) analyzed the empirical relationship between inflation and growth for the Turkish economy by a multivariate co-integration analysis. Metin (1998) developed model shows that the scaled income growth significantly affects inflation in Turkey. The qualified model of inflation was constant and it estimated a model previously. In this paper developed model because if inflation change one percent so it significantly affect to growth rate.

2.4 Summary

The review on the relevant studies from local and foreign provided strong base for the present study. The review also helped in identifying the research models that has been used in similar researches, identifying different variables used by them as proxies to represent the actual financial development and inflation rate and also to identify the most appropriate methodology to be used in this type of an empirical research. The mostly used methodology for such studies was Johansen's Co-integration method with a Vector Error Correction model (VECM) approach.

CHAPTER THREE

MATERIALS AND METHODS

3.1 Secondary Data

During this study period, various factors contributed to this highly volatile inflation situation. Particularly, real gross national product, budged deficit, money supply and depreciation of the Sri Lankan currency against the dollar contributed to this outcome. Then annual data of the above variables were acquired. Furthermore, structural factors have also had an impact on this high level of inflation.

3.1.1 Data Sources

The annual time series data of all series for the period 1960 to 2013 were obtained from various annual reports of Department of Census and Statistics and Central Bank of Sri Lanka.

3.2 Details of Variables Used

3.2.1 Colombo Consumers' Price Index (CCPI)

A consumers' price index serves a number of purposes. It is an indicator to measure the changes in the general level of consumer prices and used as one of the key indicators of inflation. Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services. Consumers' price index is also used for socio-economic analysis and policy purposes, mainly in the determination of monetary and income policies. It is used in the analysis of the trends in wages and other monetary incomes, for indexation of salaries and wages etc. Consumers' price index is also used to deflate the current values in national accounts to obtain real values and therefore, a

major determinant of the GDP deflator, which is a more comprehensive indicator in the overall inflation in a country. An obsolete and inappropriate index could lead to misleading signals in policy formulation and decision making. Colombo Consumers' Price Index (Base 2002=100) was used as official Consumer Price Index till May 2011. A Consumers' Price Index requires regular revision based on current Consumer Expenditure Surveys. It is common practice of the countries that the basket of goods & Services and the weights of the CPI be updated in five years intervals to accommodate the changing expenditure patterns and to incorporate changes of goods & Services available in the market. Accordingly new CCPI (Base 2006/07=100) has been calculated since June 2011 based on Household Income & Expenditure Survey-2006/07 (Department of Census and Statistics, 2012). In Sri Lanka CCPI is computed using Laspeyres formula as shown below. (Department of Census and Statistics, 2012)

$$CCPI_t = \frac{\Sigma W_t * [P_t/P_0] * 100}{\Sigma W_t}$$

Where;

P_t = Price of commodity i in the current period t

P_o = Price of the commodity i in the reference period

W_i = Weight associated with commodity i n the current period t

3.2.2 Gross National Product (GNP)

GNP at market price is defined as the market value of all the final goods and services produced in the domestic territory of a country by normal residents during an accounting year including net factor income from abroad.

GNP = Gross Domestic Product (GDP) + Net Factor Income from Abroad

GNP is the core concept of national income accounting. GDP is a territorial concept because it includes whatever is produced within the domestic territory of a country

irrespective of whether the producer is a resident or a non-resident (i.e., foreigner). But GNP is an economic concept because it includes productive efforts of only residents of a country within and outside the country. Net factor income from abroad is the difference between the factor income earned from abroad by the normal residents of a country and the factor income earned by non-residents in that country.

3.2.3 Budget Deficit (BD)

The budget deficit is the difference between national government revenues and expenditures, expressed as a percent of GDP. A positive (+) number indicates that revenues exceeded expenditures (a budget surplus), while a negative (-) number indicates the reverse (a budget deficit). Normalizing the data, by dividing the budget balance by GDP, enables easy comparisons across countries and indicates whether a national government saves or borrows money. Countries with high budget deficits (relative to their GDPs) generally have more difficulty raising funds to finance expenditures, than those with lower deficits.

BD = Government's Total Expenditures - Government's Total Income

3.2.4 Broad Money Supply (BMS)

The changes in money supply are a primary causal factor affecting price stability. In general, three definitions of monetary aggregates are used in analyzing monetary developments in Sri Lanka. The first is 'reserve money' consisting of currency issued by the Central Bank and commercial banks' deposits with the Central Bank. This is also called base money or high-powered money, as commercial banks can create deposits based on reserve money which are components of a broader definition of money supply, through their process of creating credits and deposits. The second is narrow money, defined as the sum of currency held by the public and demand deposits held by the public with commercial banks. The third is broad money defined as the sum of currency held by the public and all deposits held by the public with commercial banks. Studies have shown that the most appropriate monetary variable

to analyze the relationship between the money supply and the general price level is the broad money supply.

BMS = Narrow Money Supply + Quasi Money

3.2.5 Exchange Rate (ER)

Most countries use their own currencies as a medium of exchange, similar to the rupees in Sri Lanka and the dollar in the United States. They are deemed to be the legal tender or legally valid to make all local payments. Whenever a country with its own unique currency has to make payments to other countries which have different currencies, it has to exchange its currency with other currencies at a given rate of exchange. The rate at which one currency may be exchanged against another is called "the exchange rate". The exchange rate is formally defined as the number of units of one currency that can be exchanged for a unit of another. Thus, it is the price at which the national currency is valued in relation to a foreign currency. The importance of the exchange rate differs from country to country. Generally, for closed economies, its importance is less. For open economies, such as Sri Lanka, however, the exchange rate is very important as it affects the prices of exports as well as imports.

3.3 Methodology of Statistical Analysis

This study attempts to develop a statistical model for inflation and to find a long run or short run relationship among the explanatory variables of inflation namely, money supply, GNP, exchange rate and budget deficit using Vector autoregressive model (VAR), Johanson co-integration approach and vector error correction model (VECM) approach.

3.3.1 Model Specification

The inflation model estimated in this study can be expressed in equation (1) and can represent this function in a mathematical linear model as shown in equation (2).

$$INF = f(BD, GNP, MS, EXR) \quad \textbf{(1)}$$

$$INF_t = \beta_1 + \beta_2 BD_t + \beta_3 GNP_t + \beta_4 MS_t + \beta_5 ER_t + U_t \quad \textbf{(2)}$$

As in general most of economic variables are homoscedasticity in variance. Log transformation is used to reduce the heteroscedasticity. Thus equation (2) can be expressed in a log-linear form, as shown in (3).

$$lgINF_t = \beta_1 + \beta_2 lgBD_t + \beta_3 lgGNP_t + \beta_4 lgMSt + \beta_5 lgER_t + U_t \quad \textbf{(3)}$$

Where;
Dependant variable = Inflation (INF)
Independent variables = Budget deficit (BD), gross national product (GNP), money supply (MS) and exchange rate (ER).
U_t = Error term
The impact of budget deficit (BD), gross national product (GNP), money supply (MS) and exchange rate (ER) on inflation is given by β_2, β_3, β_4 and β_5

3.3.2 Testing for Stationary - Unit Root Test

To have a meaningful understanding of the relationship between two or more economic variables using VAR methodology, the time series data should satisfy some stationary properties. Hence any time series analysis should start by checking the order of integration of each variable. The augmented dickey fuller (ADF) and Philip Perron (PP) tests are used to examine the presence of unit roots in the data series.

3.3.2.1 Augmented Dickey-Fuller Test (ADF Test)

The general form of augmented dickey fuller (ADF) (1979) test can be written as follows.

$$\Delta X_t = a + b_t + pX_{t-1} + \Sigma \Delta X_{t-1} + U_t$$

Where,

X_t = Individual time series,

ΔX_t = First difference of the series X_t

Here, $\Delta X_t = X_t - X_{t-1}$

K = Lag order

t = Linear time trend

U_t = Serially uncorrelated random term with zero means and constant variance

A = Constant

The above ADF test suggest that a time series has unit root if p-values is not significantly different from zero, and it is stationary if p-values is significantly different from zero. This test will be used to test whether a series follows a random walk without a drift $y_t = \phi_1 y_{t-1} + e_t$ or a random walk with a drift $y_t = \phi_0 + \phi_1 y_{t-1} + e_t$. Then the hypothesis tested under ADF test is:

$H_0 : \phi = 1$ (has a unit root) vs $H_1 : \phi < 1$ (has root outside unit circle)

If the unit root is present then $\phi = 1$ and so the model would be non-stationary in this case. The regression model can be written a

$$y_t - y_{t-1} = \nabla y_t = (\phi_1 - 1)\nabla y_{t-1} + e_t = \delta y_{t-1} + e_t$$

Where $\delta = (\rho - 1)$ and ∇ is the first difference operator.

Unit roots can be tested by running the above regression. Hypothesis is given below.

Null hypothesis: H_0: $\delta = 0$ (Non stationary, Unit root exist)

Alternate hypothesis: H_1 : $\delta \neq 0$ (Stationary)

If $\delta = 0$, then $\rho = 1$, which implies that the series is non-stationary. If the series is non-stationary, the first difference of the series is tested for unit roots. If the series becomes Stationary after first differencing, the first difference series can be used in regression model (Augmented Dickey-Fuller, 1989).

3.3.2.2 Philip Perron Test

Philip Perron (PP) test under Bartlett Kernel and newly west bandwidth were conducted to test the stationary of the series. Phillips and Perron (1988) tests for unit roots are a modification and generalization of DF's procedures. While DF tests assume that the residuals are statistically independent (white noise) with constant variance, Phillips-Perron (PP) tests consider less restriction on the distribution of the disturbance term (Enders, 1995). Phillips-Perron tests undertake non-parametric correction to account for autocorrelation present in higher AR order models. The tests assume that the expected value of the error term is equal to zero, but PP does not require that the error term be serially uncorrelated. The critical values of PP tests are similar to those given for DF tests (Phillips and Perron, 1988).

3.3.3 Johansen Co-integration Test

Co-integration is an econometric property of time series variables. If two or more series are themselves non-stationary, but a linear combination of them is stationary, then the series are said to be co-integrated. A series of co-integration tests is carried out to examine whether there exists a long run relationship among the variables. The statistical test is carried out using Johansen co-integrated test (Johansen, 1991). Which allows to test whether more than one co-integrating relationship exist or not.

Hypothesis :

H_0 = Ð = 0 (co-integration does not exists)

H_1 = Ð < 0 (co-integration exist)

This method requires that variables entering the co-integration relationship to be integrated of the same order and yields two likelihood statistics known as trace and maximum Eigen value statistics which are given by;

$\lambda_{trace}(r) = -T \Sigma \ln(1 - \lambda_i)$

$\lambda_{max}(r, r+1) = -T \ln(1 - \lambda_{r+1})$

Where,

T = Number of observation

i = i^{th} eigen value λ_i

r = 0, 1, 2, ……..,n-1

The trace statistic tests the null hypothesis of at most r co-integration relations against the alternative of more than r co-integrating relations.

3.3.4 Determination of Lag Length for VAR Model

The lag length for the VAR model may be determined using model selection criteria. The general approach is to fit VAR models with orders m = 0, ... , p_{max} and choose the value of m which minimizes some model selection criteria (Lutkepohl, 2005).

The three most commonly used information criteria for selecting the lag order are the Akaike information criterion (AIC) (Akaike, 1974), Schwarz information criterion (SIC) (Schwarz, 1978), Hannan-Quin information criteria (HQ) (Hannan, and Quinn, 1979). Thus, among the three criteria AIC always suggests the largest order, SIC chooses the smallest order and HQ is between. Of course, this does not preclude the possibility that all three criteria agree in their choice of VAR order. The HQ and SIC criteria are both consistent, that is, the order estimated with these criteria converges in probability or almost surely to the true VAR order p under quit general conditions,

if p_{max} exceeds the true order. These criteria mainly indicate the goodness of fit of alternatives (models) so they should be used as complements to the LR test. The LR test (Sequential modified LR test statistic) should be used as a primary determinant of how many lags to include (Peiris, 2012). The likelihood ratio test statistics is given by

$LR = (T - m)(\ln|\Sigma_r| - \ln|\Sigma_u|) \sim \chi^2_{(q)}$ and under H_0 $LR \sim \chi^2_{(q)}$,

If the LR statistics < critical value, reject the null hypothesis of the restricted system.

3.3.5 Long-Run Relationship

A rough long-run relationship can be determined by the co-integration test and then this relationship can be utilized to develop a refined dynamic model which can have a focus on long-run aspect such as the two VECM of a usual VAR in Johansen test (Engle, and Granger, 1987).

3.3.6 Granger Causality Test

Correlation does not necessarily imply causation in any meaningful sense of that word (Johansen, 1990). The econometric graveyard is full of magnificent correlations, which are simply spurious or meaningless. Interesting examples include a positive correlation between teachers' salaries and the consumption of alcohol and a superb positive correlation between the death rate in the United Kingdom and the proportion of marriages solemnized in the church of England and so economists claim that correlations which are less, in spite of significance, obviously meaningless. The Granger (1969) approach to the question is to find of whether causes is to see how much of the current values can be explained by past values and then to see whether adding lagged values can improve the model.

It is important to note that the statement "Granger causes" does not imply that is the effect or the result of Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term (Johansen, 1988). When you select the Granger Causality view in Eviews, you

will first see a dialog box asking for the number of lags to use in the test regressions. In general, it is better to use more rather than fewer lags, since the theory is couched in terms of the relevance of all past information. Thus it is advised to pick a lag length that corresponds to reasonable beliefs about the longest time over which one of the variables could help predict the other (Juselius, 2006).

A question that frequently arises in time series analysis is whether or not one economic variable can help to forecast another economic variable. One way to address this question was proposed by Granger (1969) and popularized by Sims (1972). Testing causality, in the Granger sense, involves using F-tests to test whether lagged information on a variable Y provides any statistically significant information about a variable X in the presence of lagged X. If not, then Y does not Granger-cause X (Engle, and Granger, 1987).

3.3.7 Vector Error Correction Model (VECM)

An error correction model is a dynamical system with the characteristics that the deviation of the current state from its long-run relationship will be fed into its short-run dynamics. This is not a model that corrects the error in another model. Error Correction Models (ECMs) are a category of multiple time series models that directly estimate the speed at which a dependent variable Y returns to equilibrium after a change in an independent variable X. ECMs are a theoretically-driven approach useful for estimating both short term and long term effects of one time series on another (Engle, and Granger, 1987). This is generally developed, if the variables are co-integrated after Johansen co-integration test. This is known as restricted vector autoregressive (VAR) model.

3.3.8 Vector Auto Regression Model (VAR)

VAR is an econometric model used to capture the linear interdependencies among multiple time series. VAR models generalize the univariate auto regression (AR) models by allowing for more than one evolving variable. All variables in a VAR are treated symmetrically in a structural sense (although the estimated quantitative response coefficients will not in general be the same); each variable has an equation explaining its evolution based on its own lags and the lags of the other model variables.

VAR model estimates and describe the relationships and dynamics of a set of endogenous variables. For a set of n time series variables $Y_t = (Y_{1t}, Y_{2t}, \ldots\ldots, Y_{mt})^T$ a VAR model of order p (VAR(p)) can be written as;

$$Y_t = A_0 + A_1 Y_{t-1} + A_2 Y_{t-2} + \ldots\ldots\ldots\ldots\ldots\ldots + A_p T_{t-p} + \varepsilon_t$$

Where,

P = Number of lags to be considered in the system

In matrix form two variables VAR (1) is written as;

$$\mathbf{y_t} = \begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} a_{10} \\ a_{20} \end{bmatrix} + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \begin{bmatrix} y_{1t-1} \\ y_{2t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \epsilon_{2t} \end{bmatrix}$$

Thus,

$$y_{1t} = a_{10} + a_{11}\, y_{1t-1} + a_{12}\, y_{2t-1} + \varepsilon_{1t}$$

$$y_{2t} = a_{20} + a_{21}\, y_{1t-1} + a_{22}\, y_{2t-1} + \varepsilon_{2t}$$

This is generally used, when the variables are not co-integrated after Johansen co-integration test and this is known as unrestricted vector autoregressive (VAR) model.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1 Temporal Variation of the Variables

For the co-integration analysis it is necessary to test whether all series are stationary. Time series plot for the inflation, gross national products, budget deficit, exchange rate and money supply are shown in Figures 4.1 - 4.5 respectively.

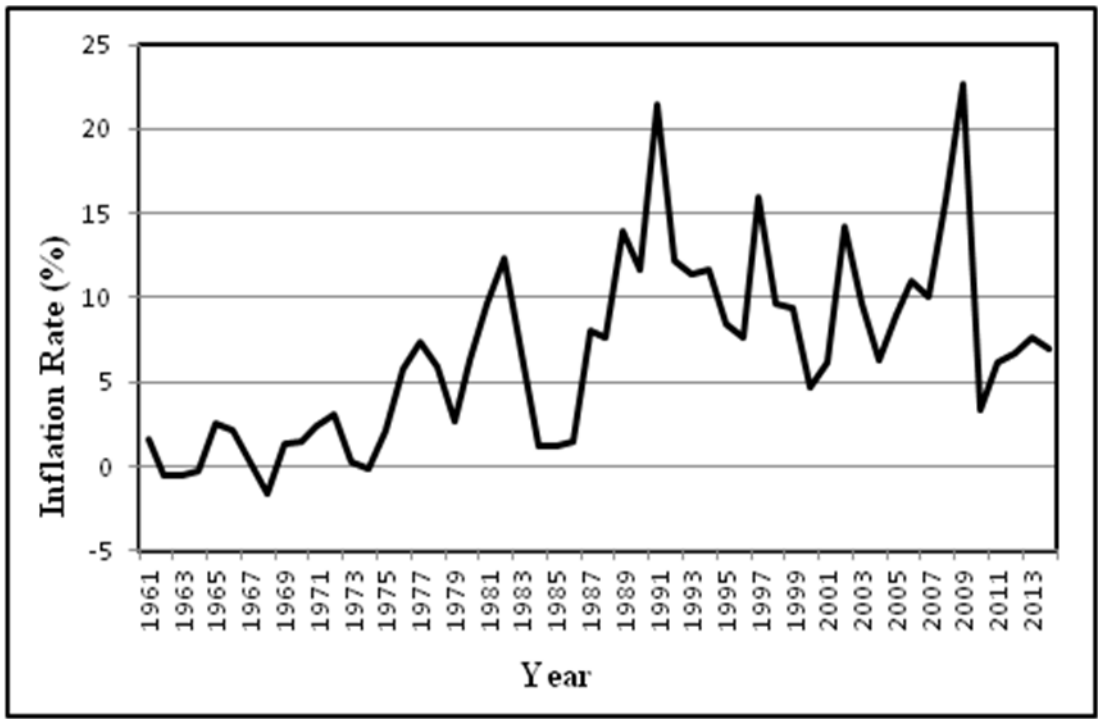

Figure 4.1: Time Series Plot for Inflation

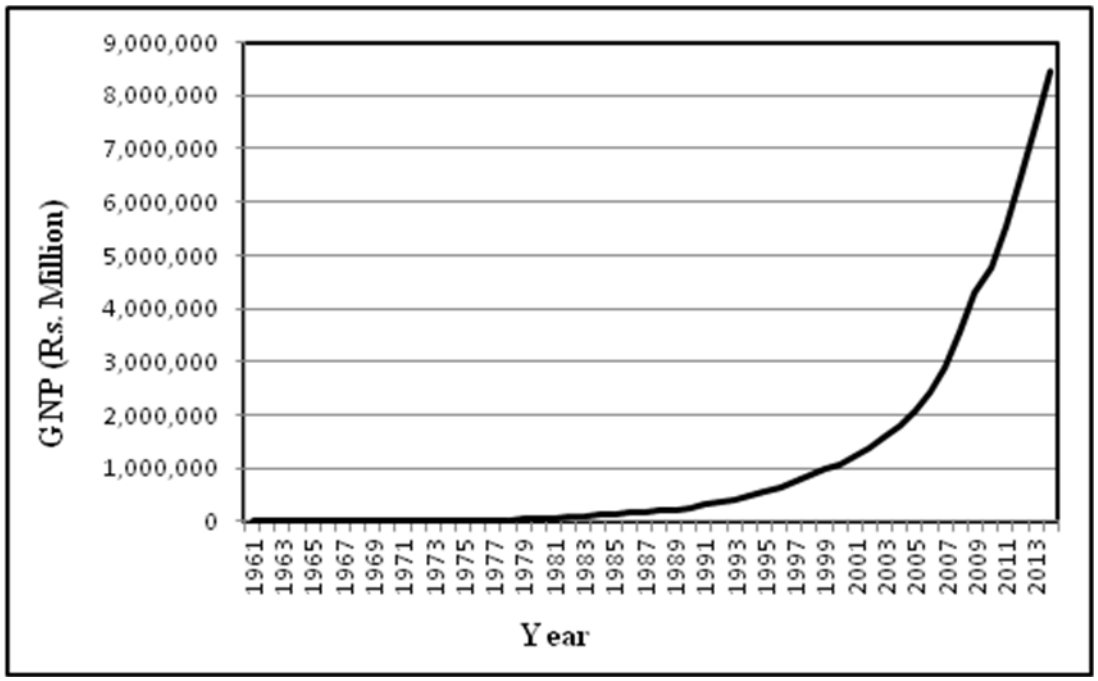

Figure 4.2: Time Series Plot for Gross National Product

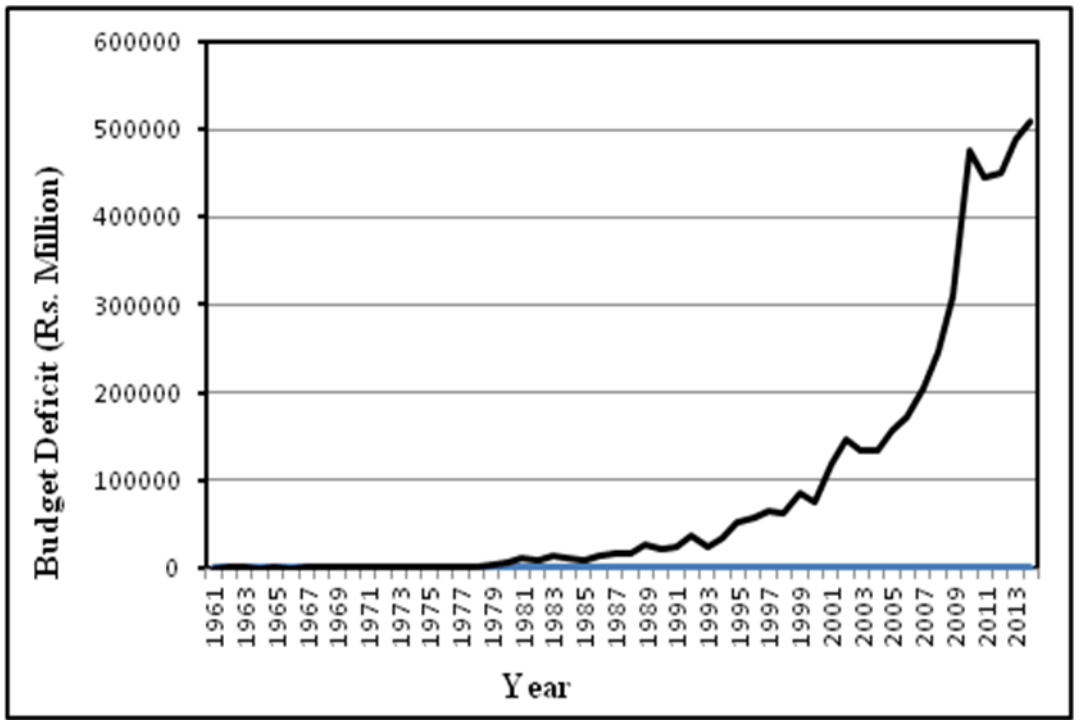

Figure 4.3: Time Series Plot for Budget Deficit

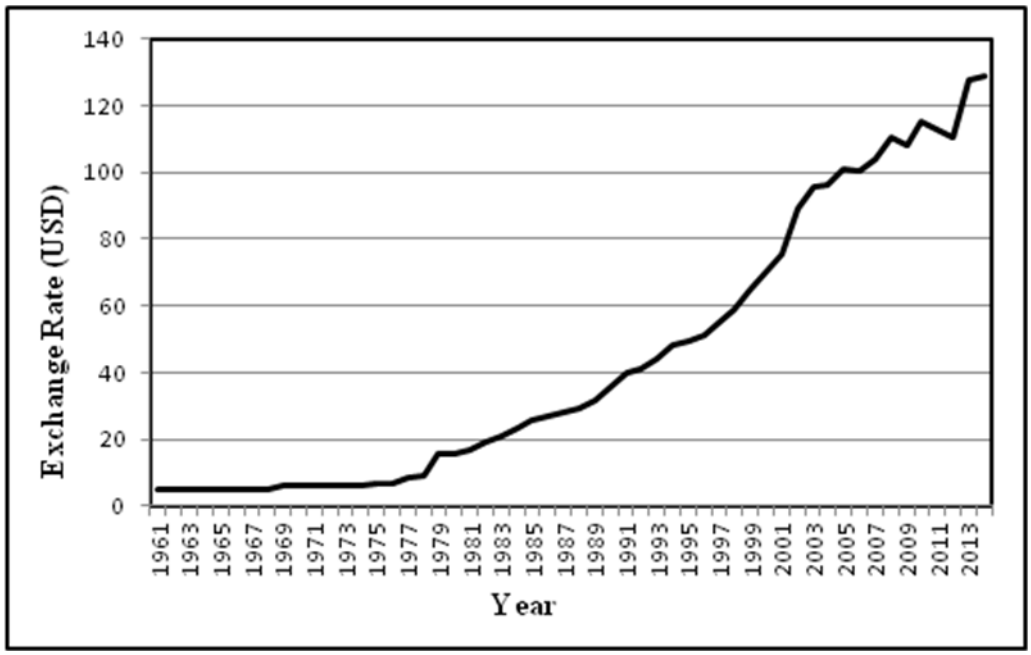

Figure 4.4: Time Series Plot for Exchange Rate

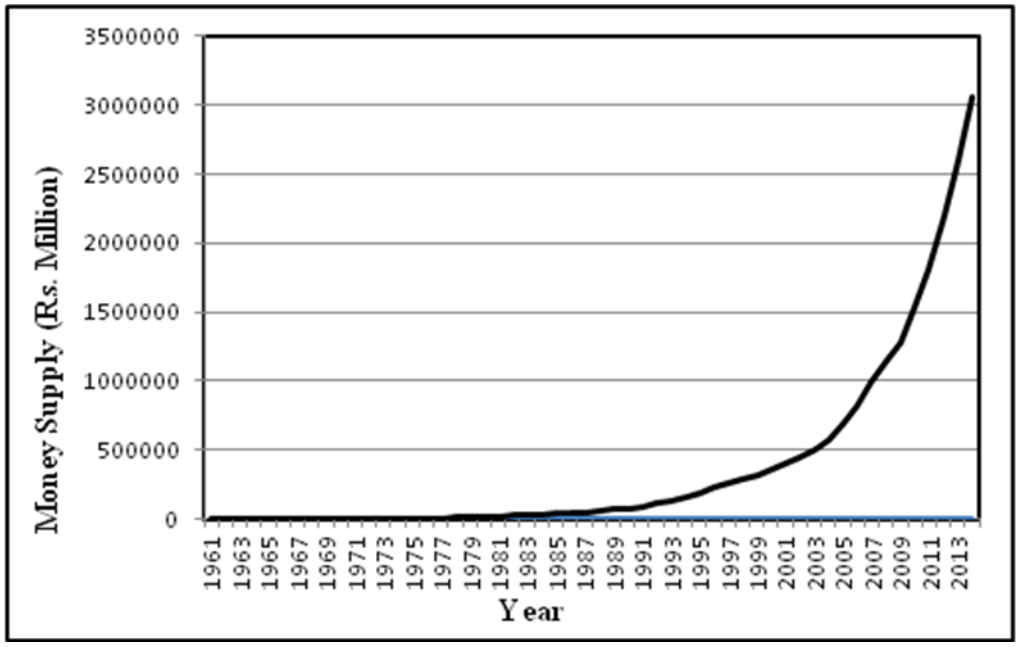

Figure 4.5: Time Series Plot for Money Supply

As can be seen in the above figures gross national products, budget deficit, exchange rate and money supply series have upward trend except inflation. It indicates that they are non-stationary.

4.2 Check for Stationary

Table 4.1: Results of Augmented Dickey-Fuller (Unit root test) and P-P Tests

Series	ADF		P-P	
	Test Statistics	P - Value	Test Statistics	P - Value
INF	-4.580472	0.0010	-4.568362	0.0030
BD	6.102233	1.0000	0.664566	0.9995
ER	-1.503979	0.8145	-1.375602	0.8568
GNP	8.140879	1.0000	20.89016	1.0000
MS	-1.094295	0.9183	41.75780	0.9999
Critical Value (1%)	-4.140858			
Critical Value (5%)	-3.496960			
Critical Value (10%)	-3.177579			

Results in Table 4.1 clearly indicate that the respective P values of four series are greater than the significance levels. Therefore four series are non-stationary except inflation.

4.3 Stability of the Variables

Log transformation is applied for the all series as variance stabilization measure. Time series plots for log transformation of inflation, gross national products, budget deficit, exchange rate and money supply.

ADF test and P-P test were applied to verify the stationary of the log transformation series and results are shown in Table 4.2

Table 4.2: Results of Augmented Dickey-Fuller (Unit root test) and P-P Tests for Log Transformation Series

Series	ADF		P-P	
	Test	P - Value	Test	P - Value
LINF	-4.100312	0.0111	-3.954630	0.0164
LBD	-3.247886	0.0864	-3.302024	0.0770
LER	-1.585474	0.9719	-1.891027	0.6452
LGNP	-2.932947	0.1610	-3.337711	0.0713
LMS	-2.664365	0.2552	-2.647319	0.2621
Critical Value (1%)	-4.140858			
Critical Value (5%)	-3.496960			
Critical Value (10%)	-3.177579			

Thus it can be concluded with 95% confidence that all four series; LBD, LER, LGNP, and LMS are not stationary but only LINF is stationary.

4.4 Stationary of Log Series

For Granger Causality test, it is necessary that all series should be stationary at the same level. Thus the 1st differences of the series were checked for stationary. Results are shown in Table 4.3.

Table 4.3: Results of Augmented Dickey-Fuller (Unit root test) and P-P Tests for Log Transformation of 1st Difference Series

Series	ADF		P-P	
	Test	P - Value	Test	P - Value
D(LINF)	-7.954449	0.0000	-18.47987	0.0000
D(LBD)	-10.37014	0.0000	-10.38620	0.0000
D(LER)	-7.241877	0.0000	-7.290319	0.0000
D(LGNP)	-3.768967	0.0263	-3.657171	0.0345
D(LMS)	-3.529139	0.0466	-3.533012	0.0462
Critical Value (1%)	-4.144584			
Critical Value (5%)	-3.498692			
Critical Value (10%)	-3.178578			

As can be seen in the Table 4.2 null hypothesis that the series contain a unit root can be rejected at 1%, 5% and 10% significance level. Because, both P-Values are less than the significance levels, it can be concluded that both series are stationary at its 1st difference suggesting that these series are integrated of order one, I(1).

Time series plots for log transformation of 1st difference series of inflation, gross national products, budget deficit, exchange rate and money supply are shown in Figures 4.6 - 4.10.

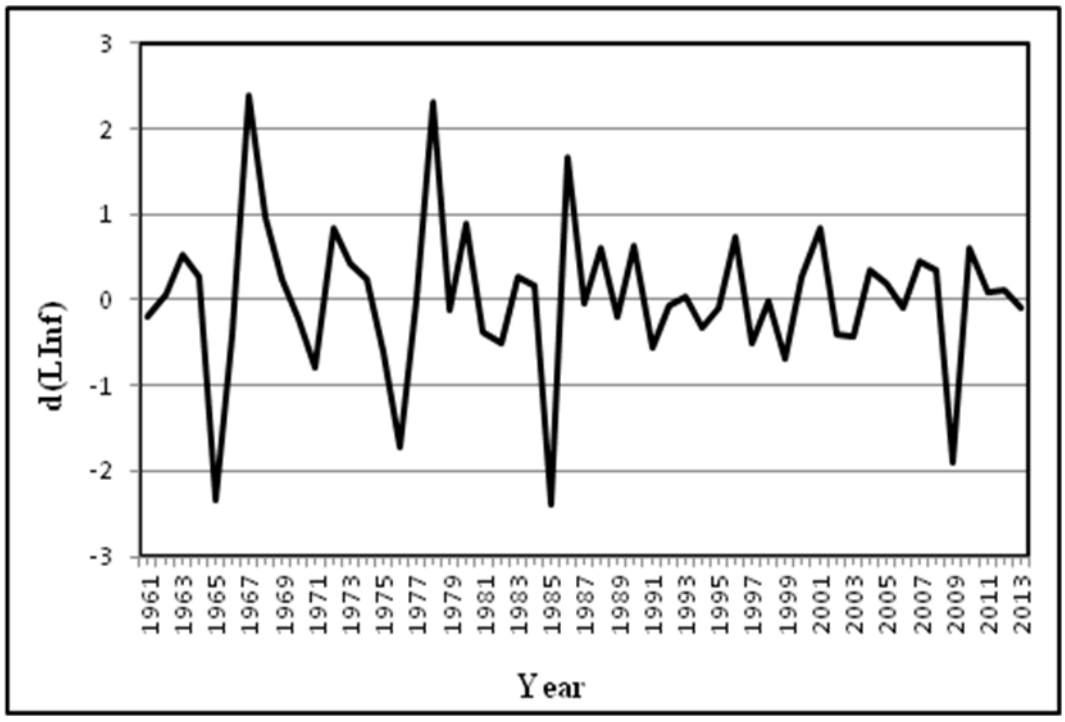

Figure 4.6: Time Series Plot for Log Transformation of the 1st Difference Series of Inflation

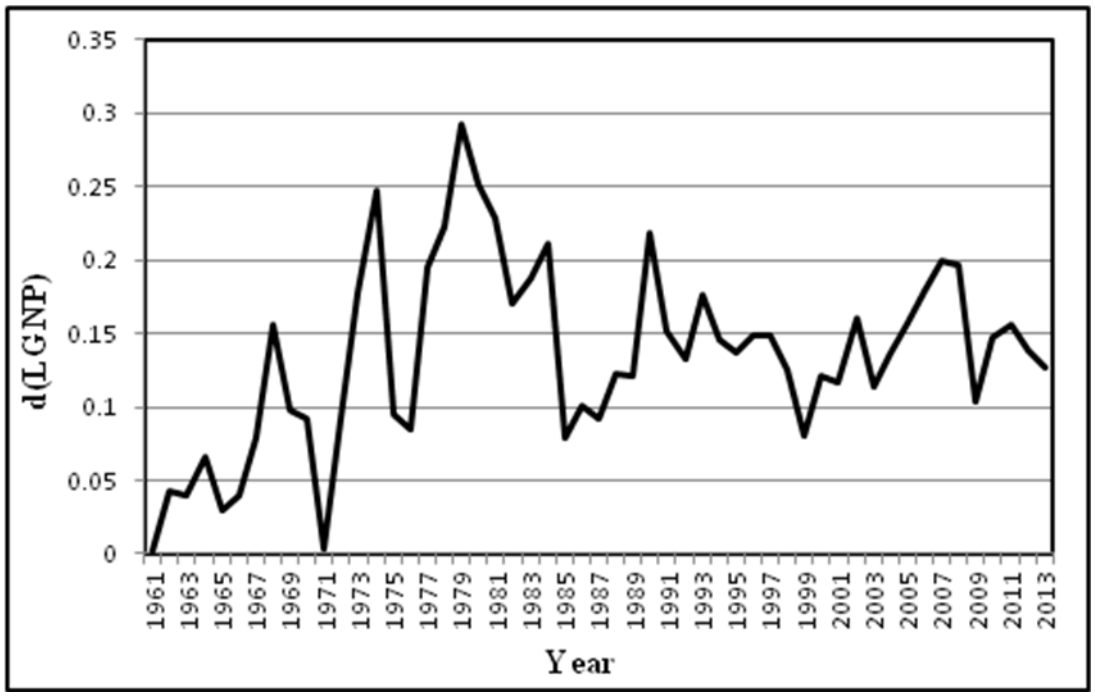

Figure 4.7: Time Series Plot for Log Transformation of the 1st Difference Series of Gross National Product

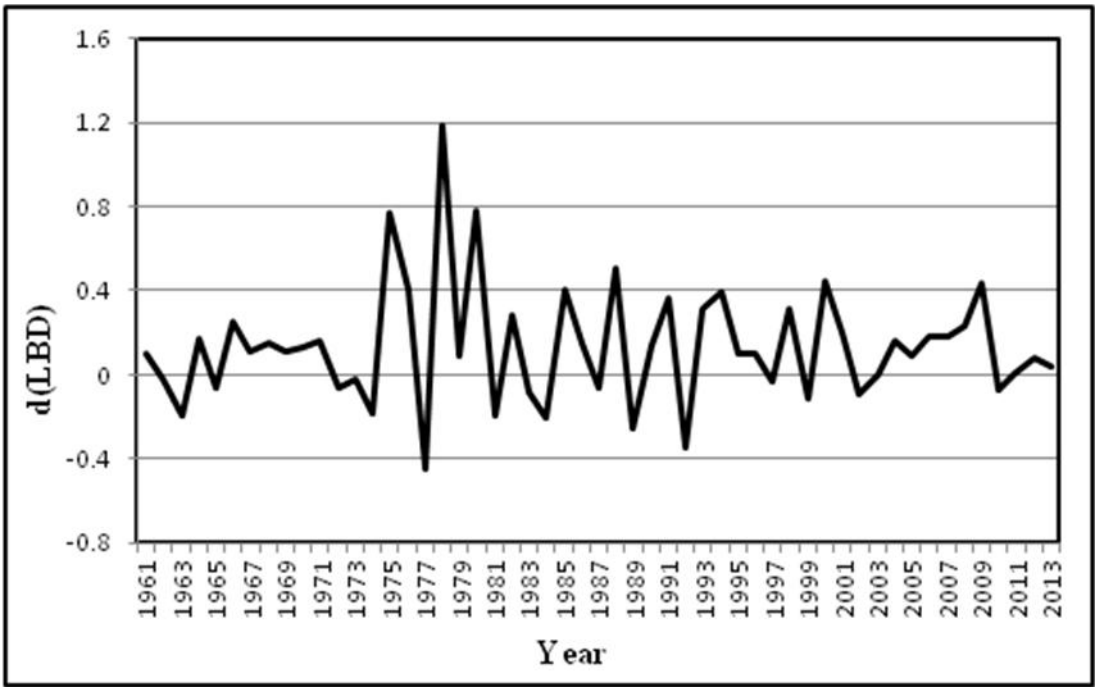

Figure 4.8: Time Series Plot for Log Transformation of the 1st Difference Series of Budget Deficit

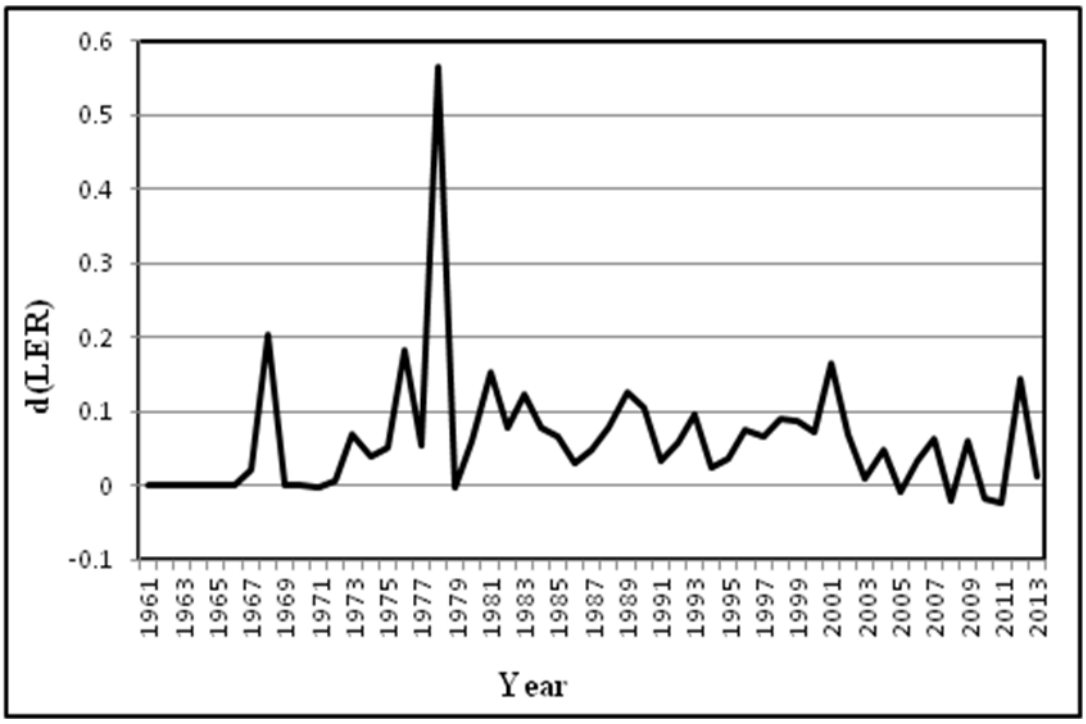

Figure 4.9: Time Series Plot for Log Transformation of the 1st Difference Series of Exchange Rate

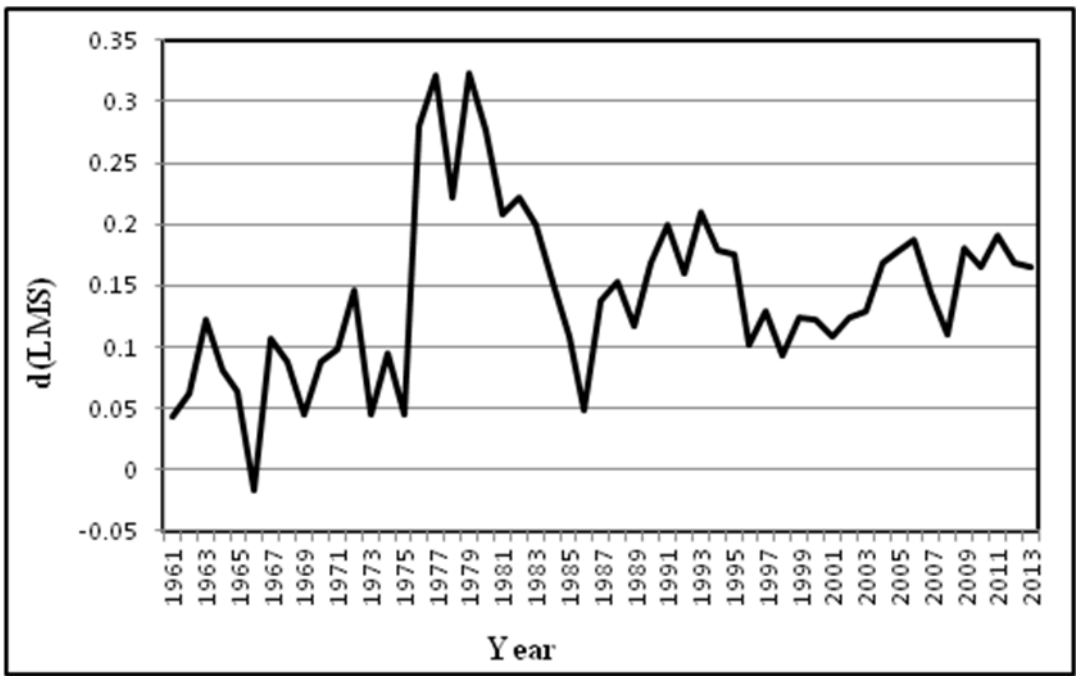

Figure 4.10: Time Series Plot for Log Transformation of the 1st Difference Series of Money Supply

As can be seen in the above figures, it can be concluded that the heterogeneity of the variance was reduced by the taking log transformation of 1st difference of the series separately. Augmented Dicky Fuller test (ADF) under Schwartz Information Criteria and the Philip Perron test (PP) under Bartlett Kernel and newly west bandwidth were conducted to test the stationary of the series.

4.5 Estimation of Long - Run Equation

Since the INF, LD, BMS, GNP and ER are integrated of the same order I(1) it is required to estimate the long-run equilibrium relationship between these series. For this purpose, the simple regression was carried out taking LINF as the response variable and other variables as explanatory variables. Summary result of the model and residuals are shown in Table 4.4 below.

Table 4.4: Results of the Estimated Simple Linear Regression model

Dependent Variable – LINF (Inflation)		
Variable	**Coefficient**	**P-Value**
LBD	0.756325	0.1019
LER	1.897816	0.0397
LGNP	2.798742	0.0902
LMS	-4.136621	0.0147
Constant	-0.397712	0.8961
R-Squared	0.438760	
Adjusted R-Squared	0.392945	
DW Statistic	1.212036	
Sum sq. residuals	30.62471	
S.E. of equation	0.790566	
F-statistics	9.576674	

Results in Table 4.4 indicate that, all parameters are statistically significant at 10% significance level with exceptional to LBD. It can be seen that both R-Squared and Adjusted R-Squared are very law. Furthermore, DW statistics is not close to two

confirming errors are not randomly distributed. Thus it can be concluded there is not a possible evidence of the spurious regression.

4.6 Identification of Optimal Lag Length

As the series are stationary, the co-integration relationship between these series was tested using Johansen approach. The important step in the Johansen co integration method is the selecting appropriate lag length of the model of the various indicators. Minimum AIC, SIC and HQ values were considered to decide the optimal lag length. Results of selecting appropriate lag length are given below in Table 4.5.

Table 4.5 : Results of Selecting Appropriate Lag Length

Lag	AIC	SIC	HQ
0	-5.245356	-5.050439	-5.171696
1	-6.521516*	-5.352016*	-6.079560*
2	-6.256525	-4.112440	-5.446272
3	-6.457207	-3.338539	-5.278658
4	-6.349157	-2.255905	-4.802311
5	-6.009064	-0.941228	-4.093922

Results indicate that minimum value of AIC, SIC and HQ indicators were obtained at Lag 1. Therefore it can be concluded that the optimal lag order one for Johasen co-integration model. However, to apply Johasen co-integration test, variables should be non stationary at level and to be stationary at the first differences of each series.

4.7 Tests for Causality between Series

The next step of analysis is to test for causality between inflation and it's determinants in the long run. According to the results of VAR lag order selection criteria (Table. 4.5), it was decided to use lag length 1 for the Granger Causality test. The results are shown below in Table 4.6.

Table 4.6: Pair wise Granger Causality Test

Null Hypothesis	F-Statistic	Probability	Decision
DLBD does not Granger Cause DLINF	0.67640	0.41481	Do not Reject
DLINF does not Granger Cause DLBD	0.04082	0.84072	Do not Reject
DLER does not Granger Cause DLINF	0.00966	0.92212	Do not Reject
DLINF does not Granger Cause DLER	0.65373	0.42269	Do not Reject
DLGNP does not Granger Cause DLINF	1.21825	0.27509	Do not Reject
DLINF does not Granger Cause DLGNP	0.50112	0.48236	Do not Reject
DLMS does not Granger Cause DLINF	0.92623	0.34057	Do not Reject
DLINF does not Granger Cause DLMS	0.51080	0.47818	Do not Reject
DLER does not Granger Cause DLBD	0.26999	0.60568	Do not Reject
DLBD does not Granger Cause DLER	1.25617	0.26784	Do not Reject
DLGNP does not Granger Cause DLBD	8.86490	0.00451	Reject
DLBD does not Granger Cause DLGNP	0.85090	0.36082	Do not Reject
DLMS does not Granger Cause DLBD	2.73524	0.10455	Do not Reject
DLBD does not Granger Cause DLMS	8.64570	0.00499	Reject

Table 4.6 (Contd.): Pair wise Granger Causality Test

Null Hypothesis	F-Statistic	Probability	Decision
DLGNP does not Granger Cause DLER	2.74180	0.10415	Do not Reject
DLER does not Granger Cause DLGNP	7.41721	0.00893	Reject
DLMS does not Granger Cause DLER	9.39170	0.00354	Reject
DLER does not Granger Cause DLMS	5.69267	0.02094	Reject
DLMS does not Granger Cause DLGNP	14.0312	0.00047	Reject
DLGNP does not Granger Cause DLMS	0.19107	0.66394	Do not Reject

The results of Table 4.6 indicate that the null hypothesis of inflation does not granger cause budget deficit, exchange rate, gross national product, money supply do not reject at 5% level of significance. Granger causality test also indicates that there is a causal relationship exists between gross national product and budget deficit, money supply and budget deficit, exchange rate and money supply, exchange rate and gross national product and also money supply and gross national product. Moreover, the results revealed that there is a bidirectional causal relationship exists between money supply and exchange rate.

4.8 Estimation of the Johansen Co-integration Model

Since the variables are integrated of order one to test for co-integration, Johansen Co integration test was applied at the predetermined lag 1 to estimate the long run equilibrium relationship among the variables. In this test, maximum eigen value statistics (Table 4.8) and trace statistics (Table 4.7) was compared to the corresponding critical values. Co-integration test for log transformation series of inflation, gross national products, budget deficit, exchange rate and money supply are shown in Table 4.7.

Table 4.7: Results of Trace Test for Log Transformation Series

Unrestricted Co-integration Rank Test(Trace)				
Number of Co-integrating equation	Trace test			
	Eigen Value	Statistic	Critical Value (5%)	P-Value
None*	0.468560	82.83143	69.81889	0.0032
At most 1*	0.389517	49.95885	47.85613	0.0313
At most 2	0.336471	24.29656	29.79707	0.1882
At most 3	0.049127	2.967064	15.49471	0.9684
At most 4	0.006662	0.347585	3.841466	0.5555

Table 4.8: Results of Maximum Eigen Value Test for Log Transformation Series

Unrestricted Co-integration Rank Test (Maximum Eigen Test)				
Number of Co-integrating equation	Maximum Eigen Value Test			
	Eigen Value	Statistic	Critical Value (5%)	P-Value
None	0.468560	32.87258	33.87687	0.0655
At most 1	0.389517	25.66228	27.58434	0.0863
At most 2	0.336471	21.32950	21.13162	0.0469
At most 3	0.049127	2.619478	14.26460	0.9688
At most 4	0.006662	0.347585	3.841466	0.5555

Results in Table 4.7 indicate that trace statistics is greater than critical value at 5% level only for the 1st two eigen values. Confirming H_0 is rejected at 5% significant level. Thus there is no co-integration among the series. However according to results in maximum eigen test (Table 4.8) all test statistics are non significant. Both tests cannot indicate that there exists a long run relationship among the variables. That is

both variables do not move together. Co-integration test for original series of inflation, gross national products, budget deficit, exchange rate and money supply are shown in table 4.9 and 4.10.

Table 4.9: Results of Trace Test for Original Series

Unrestricted Co-integration Rank Test(Trace)				
Number of Co-integrating equation	Trace test			
	Eigen Value	Statistic	Critical Value (5%)	P-Value
None*	0.752524	171.0385	69.81889	0.0000
At most 1*	0.670323	98.42357	47.85613	0.0000
At most 2*	0.408975	40.72221	29.79707	0.0019
At most 3	0.207077	13.37560	15.49471	0.1017
At most 4	0.024879	1.310077	3.841466	0.2524

Table 4.10: Results of Maximum Eigen Value Test for Original Series

Unrestricted Co-integration Rank Test (Maximum Eigen Test)				
Number of Co-integrating equation	Maximum Eigen Value Test			
	Eigen Value	Statistic	Critical Value (5%)	P-Value
None*	0.752524	72.61497	33.87687	0.0000
At most 1*	0.670323	57.70136	27.58434	0.0000
At most 2*	0.408975	27.34660	21.13162	0.0059
At most 3	0.207077	12.06553	14.26460	0.1082
At most 4	0.024879	1.310077	3.841466	0.2524

The trace statistics and maximum eigen value statistics are greater than the critical value at 5% significance level (p-value < 0.05) up to at most 2. Therefore, trace

statistics confirm three co-integrating equations at 5% level of significance and maximum eigen value statistics test also indicate three co-integrating equations at 5% level of significance. This indicates that there exists a long run relationship among the series and thus vector error correction model (VECM) can be explored.

4.9 Determination of Vector Error Correction Model

Since the variables are co-integrated, restricted VAR model known as vector error correction model (VECM) was applied to determine the short run relationship among series. Results are shown in Table 4.11.

Table 4.11: Co-integrating Results for Error Correction Model

Co-integrating Eq:	**CointEq1**
LINF(-1)	1.000000
LGNP(-1)	-8.324878
	(1.90758)
	[-4.36410]
LER(-1)	-1.627243
	(1.06181)
	[-1.53252]
LBD(-1)	-2.306819
	(0.62826)
	[-3.67177]
LMS(-1)	10.84223
	(1.99282)
	[5.44063]
C	8.262526

Coefficient estimated of the VEC model is presented in Table 4.11 and Table 4.12. Table 4.11 contains the detail of the co-integration vector which is derived by normalizing the inflation rate. The long run equation is given as follows:

LINF(-1) = 8.262526 - 8.324878* LGNP(-1) - 1.627243* LER(-1) - 2.306819* LBD(-1) + 10.84223* LMS(-1)

Table 4.12: Coefficients of the Error Correction Terms

Error Correction	D(LINF)	D(LBD)	D(LER)	D(LGNP)	D(LMS)
CointEq1	-0.345663	-0.034532	-0.026830	-0.004192	-0.035549
	(0.17258)	(0.05330)	(0.01681)	(0.00829)	(0.00911)
	[-2.00288]	[-0.64793]	[-1.59615]	[-0.50591]	[-3.90273]
D(LINF(-1))	0.187066	-0.012340	0.031279	0.011483	0.017942
	(0.16905)	(0.05220)	(0.01646)	(0.00812)	(0.00892)
	[1.10658]	[-0.23638]	[1.89973]	[1.41478]	[2.01099]
D(LBD(-1))	-1.007159	-0.421292	-0.088951	-0.014069	0.003671
	(0.52449)	(0.16197)	(0.05108)	(0.02518)	(0.02768)
	[-1.92027]	[-2.60105]	[-1.74130]	[-0.55869]	[0.13263]
D(LER(-1))	0.080226	-0.156972	-0.138146	0.164706	0.068915
	(1.60873)	(0.49680)	(0.15669)	(0.07724)	(0.08491)
	[0.04987]	[-0.31597]	[-0.88168]	[2.13235]	[0.81166]
D(LGNP(-1))	-5.277055	2.037675	-0.058135	0.217653	0.129616
	(2.61877)	(0.80872)	(0.25506)	(0.12574)	(0.13821)
	[-2.01509]	[2.51964]	[-0.22793]	[1.73101]	[0.93779]
D(LMS(-1))	5.286330	-0.159712	0.612294	0.417522	0.567024
	(2.21530)	(0.68412)	(0.21576)	(0.10637)	(0.11692)
	[2.38628]	[-0.23346]	[2.83780]	[3.92535]	[4.84967]
C	0.117456	-0.049134	0.004006	0.039605	0.041129
	(0.30414)	(0.09392)	(0.02962)	(0.01460)	(0.01605)
	[0.38619]	[-0.52313]	[0.13523]	[2.71212]	[2.56224]
R-squared	0.223759	0.287492	0.251146	0.609614	0.637089
Adj. R-squa.	0.120260	0.192491	0.151299	0.557563	0.588700
Sum sq. resids	31.74621	3.027529	0.301149	0.073186	0.088431
S.E. equation	0.839923	0.259381	0.081806	0.040328	0.044330
F-statistic	2.161951	3.026205	2.515301	11.71176	13.16620

Table 4.12 contains the coefficients of the error correction terms (cointEq1) for the co-integration vector. These coefficients are called the adjustment coefficients. This measures the short-run adjustments of the deviations of the endogenous variables from their long- run values. Thus, using the error correction term as another independent variable in the restricted VAR model the following Vector Error Correction Model can be recommended.

D(LINF) = - 0.345663*(LINF(-1) - 8.324878*LGNP(-1) - 1.627243*LER(-1) - 2.306819*LBD(-1) + 10.84223*LMS(-1) + 8.262526) + 0.187066*D(LINF(-1)) - 5.277055*D(LGNP(-1)) + 0.080226*D(LER(-1)) - 1.007159*D(LBD(-1)) + 5.286330*D(LMS(-1)) + 0.117456

4.10 Check Long Run and Short Run Causality

D(LINF) = C(1)*(LINF(-1) - 2.306819387*LBD(-1) - 1.62724258*LER(-1) - 8.324877889*LGNP(-1) + 10.84222772*LMS(-1) + 8.262525797) + C(2)*D(LINF (-1)) + C(3)*D(LBD(-1)) + C(4)*D(LER(-1)) + C(5)*D(LGNP(-1)) + C(6)*D(LMS(-1)) + C(7)

Table 4.13: Error Correction Terms to Determine Long Run Causality

	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
C(1)	-0.345663	0.172583	0.304143	0.0512
C(2)	0.187066	0.169048	1.106584	0.2744
C(3)	1.007159	0.524488	-1.920272	0.0612
C(4)	0.080226	1.608732	0.049869	0.9604
C(5)	-5.277055	2.618772	-2.015088	0.0499
C(6)	5.286330	2.215303	2.386279	0.0213
C(7)	0.117456	0.304143	0.386186	0.7012

According to the results of Table 4.13, Error Correction term (C(1)) is statistically significant at 10% significance level indicating that independent variables have long run causality on dependant variable.

Table 4.14: Error Correction Terms to Determine Short Run Causality (Wald Test)

Test Statistics	Value	Probability
F-statistic	2.536755	0.0530
Chi-square	10.14702	0.0380

A result of Table 4.14 indicates that Chi-square value is significant (P value < 0.05) and thus H_0 is rejected. It means all the coefficients of independent variables jointly influence in dependant variable. There is short run causality on dependant variable.

4.11 Model Checking

In order to ascertain whether the model provides an appropriate representation, a test for misspecification should be performed.

Table 4.15: Test of Residual Autocorrelation

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
.*| . |	.*| . |	1	-0.073	-0.073	0.2929	0.588
**| . |	**| . |	2	-0.193	-0.199	2.3744	0.305
.*| . |	.*| . |	3	-0.114	-0.152	3.1168	0.374
.*| . |	**| . |	4	-0.131	-0.210	4.1223	0.390
. | . |	.*| . |	5	-0.001	-0.111	4.1223	0.532
. |** |	. |*. |	6	0.230	0.135	7.3643	0.288
.*| . |	.*| . |	7	-0.120	-0.157	8.2630	0.310
. | . |	. | . |	8	0.039	0.058	8.3577	0.399
.*| . |	**| . |	9	-0.169	-0.209	10.233	0.332
.*| . |	.*| . |	10	-0.097	-0.118	10.860	0.368

Table 4.15 presents the results of the Correlogram Q-statistic test for VEC model residual serial correlation. These tests are used to test for the overall significance of the residual autocorrelations. Both results suggest that there is no obvious residual autocorrelation problem up to lag 2 because all p-values are larger than the 0.05 level of significance.

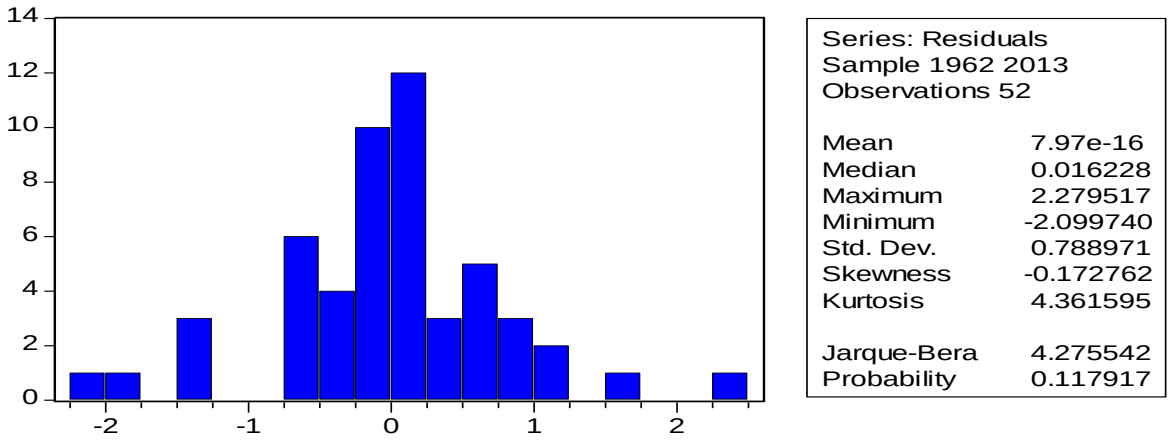

Figure 4.11: Normality Test

A result of Figure 4.16 it implied that Jarque-Bera value is 4.275 and the corresponding P value is 0.117 greater than 0.05. Confirming that residuals are normally distributed at 5% level.

Table 4.16: Test of Serial Correlation

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	7.822179	Probability	0.001267
Obs*R-squared	13.87186	Probability	0.000972

Result of Table 4.16, indicate that P value is less than 5%, indicating that H_0 is rejected. Thus it can conclude that this model has any serial correlation.

Table 4.17: ARCH LM Test

ARCH Test:

F-statistic	0.761985	Probability	0.472418
Obs*R-squared	1.570327	Probability	0.456045

Results of Table 4.17 in implied that fitted model does not have any ARCH effect since P value is 0.75%.

Table 4.18: White Heteroscedasticity Test

F-statistic	1.324887	Probability	0.235178
Obs*R-squared	23.96411	Probability	0.243963

Results of table 4.18, indicates that residuals are not heteroskedasticity ($p > 0.05$) confirming that fitted model has homoxedasticity.

4.12 Summary

Over the time period considered, all the five series showed an increasing pattern and as results of all series are non stationary. Unit root tests also confirmed that all series are non stationary at level, but stationary at first difference, at 5% significant level. In order to develop a VAR (either resticted or unresticted) model, the unit root tests (ADF and Phillips-Perron tests), identification of the number of lags and co-integration analyses were carried out. The Johansen co-integration test suggests that there are three co-integration vectors, which describes the long run short run relationship between Inflation rate, Gross National Product, Money Supply, Budget Deficit and Exchange Rate. The appropriate number of lag identified was one. Since the series are cointegrated, Granger causality test are applied to explore the long run relationships using unresticted vector autoregressive model. Granger causality test indicates that there is no causal relationship exists between inflation and other variables.

CHAPTER FIVE

CONCLUSION

Inflation rate is one of the important indicators of economic well-being. Low inflation indicates positive effect on the economy while high inflation gives negative signals. Therefore the prediction of future rate of inflation in a given country helps to outline relevant policy measures. The aim of this study is therefore to develop a multivariate time series model for inflation and its determinants which can be used to forecast the rate of inflation in Sri Lanka. The analysis was based on the annually data from 1960 to 2013. The series used in this study are inflation rate, gross national product, broad money supply, budget deficit and exchange rate. As the series are cointegrated restricted vector autoregressive model (VECM) was developed. The model was significant at 10% level and the residuals of the fitted model was white noise.

The analysis indicates that increasing broad money supply, gross national product, rising government budget deficit and exchange rate depreciation appear to be the major determinants of inflation as they play a significant role in the long run inflation equation. The results also reveal that there is a stable inflation function in the long run in Sri Lanka and indicates the reliability of forecasting inflation using gross national product, money supply growth, budget deficit and exchange rate depreciation as key determinants. Furthermore, the results of this study emphasize the need to put in place a stable macroeconomic policy environment relating to these variables in an effort to maintain price stability, since low inflation would enhance economic growth in Sri Lanka.

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