ELATIONSHIP BETWEEN OUTPUT LEVEL AND MONEY SUPPLY IN NEPAL

(An Econometric Study on Rational Expectations Proposition)

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By
ARJUN KUMAR BARAL
(Lecturer in Economics, Tribhuvan University, Nepal)

Under the Supervision of-
Prof. Chandan Kumar Mukhopadhyay, Ph.D. (Illinois, USA)

DEPARTMENT OF ECONOMICS
UNIVERSITY OF NORTH BENGAL
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Dedicated

To my father

Late Punya Prasad Baral

Who inspired me to work hard

And taught me the value of time

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ACRONYMS

ACF	Autocorrelation Function
ADF	Augmented Dickey-Fuller
AIC	Akaike Info Criterion
ARIMA	Autoregressive Integrated Moving Average
CRDW	Durbin-Watson Cointegrating Regression
DF-GLS	Dickey-Fuller Generalized Least Squares
ERS	Elliott-Rothenberg-Stock
GDP	Gross Domestic Product
GNP	Gross National Product
IFS	International Financial Statistics
IMF	International Monetary Fund
IP	Industrial Production
KPSS	Kwiatkowski-Phillips-Schmidt-Shin
LDCs	Least Developed Countries
lnM1	Natural Log of Narrow Money Supply
lnM2	Natural Log of Broad Money Supply
lnNY	Natural Log of Nominal Output
lnY	Natural Log of Real Output
LSW	Lucas, Sargent and Wallace
M1	Narrow Money Supply
M2	Broad Money Supply
MAXLAG	Maximum Lag
NRB	Nepal Rastra Bank
NY	Nominal Output
OLS	Ordinary Least Squares
PACF	Partial Autocorrelation Function
PP	Phillips-Perron
RE	Rational Expectations
SIC	Squartz Info Criterion
UVAR	Unrestricted Vector Auto regression
VAR	Vector Auto regression

CHAPTER –I

Introduction

1.1 Nepalese Economy: A Scenario

1.1.1 General Characteristics

Nepal is one of the least developed countries of the world having a per capita income of less than $ 300 per annum. It extends for 500 miles along the Himalayas between $26^0\,25'$ and $30^0\,27'$ north latitudes and $80^0\,4'$ and $88^0\,12'$ east longitudes. Its northern boundary merges with the Tibet region of the People's Republic of China. On the east, it borders with the state of Sikkim and the North Bengal division of the state of West Bengal of India. It touches the Indian states of Uttar Pradesh (U.P.) and Bihar on the southern side and the state of Uttaranchal on the western side of Nepal.

Hence geographically, Nepal is a landlocked country sandwiched between two giant neighbors China and India, and has a very small economy compared with that of these two neighboring countries. Mountainous topography with the highest Himalayan range in the north bordering China compared to a strip of plain land bordering India has compelled the country to seek her access to the sea and international markets via India only. For that matter, the country is totally India-locked and her dependence on the Indian economy for a smooth supply of essential goods into the country as well as for export of primary commodities has become a persistent feature in spite of stringent measures designed to insulate the economy from the dominance of the Indian economy (Khatiwada 1994:1-2).

Human development index below 0.50 indicates low level of development. Poverty (30.8 %) is the intrinsic problem which has come up due to traditional farming, unequal distribution of holdings and high population growth and poor development of industrial sector. It is obvious from the sluggish growth of GDP, compared to other developing countries the growth rate of GDP in 2004/05 remained 2.3 percent and in 2005/06, it again increased only by 2.3 percent, with agriculture and non-agriculture sector remaining 1.7 percent and 2.8 percent respectively. Rugged topography and landlocked-ness have always limited the socio economic and infrastructure development. Capital formation is the key factor, which requires very high rate of growth to increase the quality of life of the people. For the large share of resource should go for productive investment. Since investment is the function of saving, due to poor economic base saving is quite low. The saving investment gap in Nepal has ascended to two digits. It presents poor economic domestic resource generation through internal source.

The structure of the economy is still dependent on agriculture. It contributes about 40% of the GDP and engages 81% of the people. About 89% of the people live in the rural areas of the country. The diversification in the economy has not taken place leading to over concentration of economy in agriculture. Agriculture has been facing the problem of underemployment. The productivity of the agriculture sector could not be increased. The industrial sector is contributing about 10% of the GDP. The trading, construction and services have been contributing about 50% of the GDP and these sectors are providing employment to a large section of the population.

1.1.2 Global and National Economy: A Glance

Global economy, which had suffered slowdown as a result of crisis of confidence created by non-economic events of the past, steadily recovered and grew by 4.1 percent in 2003. This was possible with the expansion in the trade of goods and services and efficient macroeconomic management during this period. Similarly, the global economy in 2004, as compared to 2003, further grew by 1.2 percent point and 5.3 percent. This growth is attributable to the adoption and thereby effective implementation of expansionary fiscal and monetary policies by the United States and the East Asian Countries.

The economic growth rate of Developing Asian Countries which was 8.6 % in 2005, according to IMF estimates, will grow by 8.2 percent in 2006 and 8.0 percent in 2007. On the regional level, the economic growth rate of emerging Asian countries has also been higher during all years in review. The growth rate of this region was 8.2 percent in 2005 and the projections for 2006 and 2007 are 7.9 percent and 7.6 percent respectively. The South Asian Economy, which grew at an increasing rate of 7.7 percent in 2003 and 7.9 percent in 2005, is estimated to grow by 7.1 percent and 6.9 percent respectively in 2006 and 2007. In India and China, the neighboring countries of Nepal, economic growth rate was 8.3 percent and 9.9 percent respectively in 2005. The economy in India in 2006 and 2007 is projected to grow at 7.3 percent and 7.0 percent respectively, whereas for China the growth rate is projected to hover around 9.5 percent and 9.0 percent respectively during the same period. At the same time Nepalese economy suffered from several economic and non-economic factors and got very low growth rate (3.3%) in 2003, (3.8%) in 2004 and (2.7%) in 2005 in comparison to China, India, Pakistan and Bangladesh. The IMF has estimated that the growth of Nepalese economy will be increased at a constant rate by 3.0 percent in 2006 and 2007, which is the slight improvement over that of previous year (Economic Survey: 2006). A glance on economic growth rates of the World has been presented in the following table (Table 1.1).

Table 1.1: World Economic Growth Rates (in percent)

	2003	2004	2005	Projection	
				2006	2007
World Production	4.1	5.3	4.8	4.9	4.7
Developed Economies	2.0	3.3	2.7	3.0	2.8
Major Developed Economies*	1.9	3.1	2.6	2.8	2.6
Other Developed Economies	2.5	4.6	3.7	4.1	3.7
Developing Economies	6.7	7.6	7.2	6.9	6.6
Developing Asia	8.4	8.8	8.6	8.2	8.0
Emerging European Countries	4.6	6.6	5.4	5.3	4.8
African Countries	4.6	5.5	5.2	5.7	5.5
Middle East Countries	6.6	5.4	5.9	5.7	5.4
Petroleum Product Exporting Countries**	6.9	5.7	6.2	5.8	5.5
Emerging Asia***	7.5	8.4	8.2	7.9	7.6
New Industrial Asian Economies****	3.2	5.8	4.6	5.2	4.5
Asian-4*****	5.4	5.8	5.2	5.1	5.7
China	10.0	10.1	9.9	9.5	9.0
South Asia******	7.1	7.7	7.9	7.1	6.9
Bangladesh	5.8	5.9	5.8	6.0	6.3
India	7.2	8.1	8.3	7.3	7.0
Nepal	3.3	3.8	2.7	3.0	3.0
Pakistan	5.7	7.1	7.0	6.4	6.3

* USA, Japan, Germany, France, UK, Italy and Canada ** Bahrain, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Saudi Arabia, Syria and Yemen. *** Developing Asia, New Industrialized Asian Countries and Mongolia ****Korea, Taiwan, Hong Kong and Singapore *****Indonesia, Malaysia, the Philippines and Thailand ******Bangladesh, India, Maldives, Nepal, Pakistan and Sri Lanka.

Source: - World Economic Outlook, IMF, Washington D.C., September 2005, April 2006, pp. 2, 16, 35, 43, 52, 177 and 186

1.1.3 Monetary Perspective

The monetary system of Nepal shows the dualistic nature of monetary economy. The urban is merged in organized industries, trade and service sector. The rural economy, where the majority of people languish at subsistence level without any surplus of exchange, does not show any improvement in the process of monetization.

When we look historically in the monetary system of Nepalese economy, it seems the two commercial banks viz. Nepal Bank Ltd. (1936) and the Rastriya Banijya Bank (1965) played an important role in the Nepalese money market. Though those two banks were different in origin, they are now operating under the same rule and regulation of Commercial Bank Act 1974(Sharma, 1987:53). The Nepal Rastra Bank as a central bank of country took entirely a decade since its establishment in 1956, to consolidate its power as banker's bank and to regulate operations of banking. By the same token, the Nepal Industrial Development Corporation (NIDC) was set up in 1959 with the objective of providing financial outgoing of new industries in country. The Agricultural Development Bank (ADB) was also established in 1968 with a view to financing in agricultural sector.

Gaudel (2000) has presented some propositions regarding monetary perspective of Nepalese economy which are as follows:

i. The monetary structure of the Nepalese economy is dualistic in nature. It implies that the banking and financial intermediaries have no significant influence on unorganized rural sector vis-à-vis with the urban sector.

ii. The economy is open and liberalized. This suggests foreign capital has been a constant source of financing savings investment gap and foreign exchange deficits.

iii. Excessive liquidity prevails in the economy and creates price hike inflation.

iv. Timely improvement in the interest rate structure seems to be advisable for promoting savings and investment.

v. The aggregate demand generated by the monetary expansion in the economy has been absorbed by higher imports. This reflects the situation of instability in balance of payments.

1.1.4 A Bird's Eye view On Some Macroeconomic Variables

1.1.4.1 Gross Domestic Product (GDP)

The Gross Domestic Product, under the National Income Accounting, provides a broad view of economic development. The national income statistics reveal the basic changes in the past and suggests the trend of the future.

Table-1.2: Average Annual Growth Rate of GDP and Population (FY 1985/86 to 1996/97)

Year	Nominal GDP (%)	Real GDP At 1984/85 Price (%)	Population (%)
1986-88	18.01	4.55	2.66
1989-91	16.64	5.60	2.66
1992-94	18.26	5.27	2.08
1995-97	12.07	4.45	2.07
Total Average	16.25	4.97	2.37

Sources: Statistical Pocket Book, CBS, Nepal, 1998, Economic Survey, Ministry of Finance, HMG,Nepal, 1999.

1.1.4.2 Savings and Investment

In the context of low per capita income along with pressure of the population, national consumption as a ratio of GDP has increased up to 90.5% (in FY 1997/98). This has resulted in the low level of gross domestic savings and investment in the economy.

Table-1.3: Percentage Ratio of Gross Domestic Savings and Investment to GDP (FY 1985/86 to 1996/97)

Year	Average Annual savings	As a percentage of GDP at producers Prices	Average annual investment	As a percentage of GDP	Average annual Savings gap (%)
1986-88	7.53	10.64	14.63	19.68	24.89
1989-91	18.37	9.60	19.04	20.34	21.12
1992-94	36.61	13.00	21.37	20.22	4.73
1995-97	10.30	14.20	17.12	25.96	30.06
Total Average	18.20	11.86	18.04	22.05	20.21

Source: Economic Survey, Ministry of Finance, HMG, Nepal, 1999. The Year represents fiscal Year

1.1.4.3 Price and Inflation

In order to reflect the price situation, the National Urban Consumer Price Index (CPI) has been used. A general view of the price level, as measured by the change in consumer price index, shows on an average, a progressive escalation from 1991(1990/1991) to 2002(2001/2002).

Table-1.4: Average Consumer Price Index and Inflation (1991-2002)

Year	Average Consumer Price Index(1996=100)	Average Inflation Rate (%)
1991-1993	70.33	6.33
1994-1996	92.8	4.7
1997-1999	118.43	7.43
2000-2002	138.33	2.43

Source: NRB, Quarterly Economic Bulletin Vol.37 (No.3), Mid-April 2003, p.49

1.1.4.4 Money Supply

The total money stock comprises of narrow money and broad money. The narrow money (M1) consists of currency in circulation plus demand deposits, whereas broad money (M2) includes M1 plus time deposits or quasi money.

While reviewing the monetary situation of the economy, an attempt has been made here to evaluate the growth rate of money supply from 1991 onwards.

Table-1.5: Average Annual Growth Rate of Money Stock and Their Ratio to GDP (1991-2002)

Year	Real GDP (%) (1990=100 Price)	Narrow Money M1 (%)	Ratio M1/GDP	Broad Money M2 (%)	Ratio M2/GDP
1990-1992	5.05	16.87	3.34	17.08	3.38
1993-1995	2.83	15.13	5.35	16.23	5.74
1996-1998	4.42	9.56	2.16	14.62	3.31
1999-2001	5.27	14.22	2.69	14.64	2.78
Total Average	4.39	13.95	3.385	15.64	3.80

Source: IMF, International Financial Statistics, Various Issues (1996 & August 2002)

1.1.5 History of Monetary Policy:

Nepal has been an independent country governed by monarchy ranging from absolute monarchy to constitutional monarchy. After the Nepal-British war (1814-16) which led to the Treaty of Sugauli with British East India Company in March 1816, the country was absolutely closed for protecting itself from expanding British rule. The modern era started from 1951 following the end of Rana hereditary prime-ministerial rule in the country. From 1951 to 1965, the country hovered around the multiparty system with constitutional monarchy. In 1960, King Mahendra Bir Bikarm Shah Dev dissolved the elected parliament and the government to form a single party Panchayat System. Then, the absolute monarchy continued until 1992 when popular up rise reestablished the multiparty parliament. During those years, Nepal indulged in planned economy. The first economic plan laid out goals for the period 1956-61. The subsequent economic plans were for 5 year period in which economic goals of the country were clearly stated. These planning dictate fiscal policies and monetary policies of the government. The planning commission and the government dictated the monetary policies of Nepal Rastra Bank (NRB), the Central Bank.

According to NEPAL RASTRA BANK SAMACHAR (2006) published by Nepal Rastra Bank (Central Bank of Nepal), the NRB conducted its monetary policy depending on the "money-multiplier theory." Therefore, the monetary policy of NRB has been targeting M1 monetary aggregate based on the money multiplier and the reserve requirement. Since the NRB has more control over reserve requirement, it mainly manipulated the reserve to achieve the desired level of the monetary aggregate. This implies that NRB is implicitly assuming that the multiplier is stable over time.

The major determinants of money supply being the size of monetary base and the components that determines the money multipliers, such as income level, deposit rate, various interest rate, liquidity preferences of the people, the theory suggests that the NRB's policy has been a steady growth money supply which is reflected in the publication, the Periodic Economic Planning, of the planning commission and the Economic Review published by NRB. According to Thapa (1997), the highest growth was recorded in 1960, and the lowest growth was recorded in 1971. In 1960, the M1 and M2 monetary aggregates grew by 40.9% and reserve money (monetary base) grew by 48.8%. In 1971, the growth of M1 was 3.9% while reserve money declined by almost 1%.

1.2 Objectives Of The Study

The present study has tried to test empirically the issue using a hybrid of methods of Invariance Proposition of Rational Expectations for least developed country (LDC) in South Asia, namely Nepal. The results will be of interest as LDCs are not as much monetized as Developed Countries. Recently, LDC's have emphasized on monetary policies to curb inflation, and to have stable and sound economic growth. Therefore, the purpose of this study is to investigate empirically the effects of anticipated and unanticipated monetary policies on real output for Nepal.

The main purpose of the present study is to analyze the relationship between output level and money supply in the line of Rational Expectations Proposition in Nepal. For this purpose several Econometric tests have to be examined. In the event of such relationship being present, we seek to see how far and to what extent the variation in output is related to changes in anticipated and unanticipated part of money supply.

1.2.1 Conceptual Background of the Rational Expectations Hypothesis

The policy effectiveness has been a continuing debate in macroeconomics between the Classical and the Keynesians. The introduction of the rational expectation hypothesis in macroeconomics elevated the debate by differentiating policies into anticipated and unanticipated. The rational expectation hypothesis suggests that economic agents use all available information to form the future expectation. Therefore, any expected policy change will not have any impact on real macro-variables as the economic agents fully incorporate the information into their expectation formation. The policy implication of this hypothesis is that the change in policy should be a surprise to have a real impact in the economy. However, there are disagreements among economists over the policy implications of the rational expectations macro models.

There are two competing hypotheses. One model, so called the neutrality theory, developed by Lucas (1972), and Sargent and Wallace (1975) often referred to as LSW proposition, stated that the anticipated monetary shocks would have no effect on real economic variables neither in short run nor in long run; whereas unanticipated monetary shocks should have profound impact on real economic variables. The alternate model developed by Fischer (1977) and Phelps and Taylor (1977), established that due to the rigidities in the wage contracts, anticipated monetary polices, at least in the short run, have strong impact on real economic variables, which is often termed as non-neutrality of monetary policies. This contest between these hypotheses breaded tremendous theoretical and empirical literature. The empirical literature has been indecisive, some supported LSW proposition while others advocated for non-neutrality theory. For example, Barro (1977), Barro and Rush (1980), Attfield et al. (1981), Canarella and Garston (1983), Chen and Steindl (1987), Marashdeh (1993) found empirical support for LSW proposition while Gordon(1982), Mishkin (1982a, b), McGee and Stasiak (1985), Choudhary and Parai (1991) supported the non-neutrality theory.

Most of these empirical studies have been on developed countries. There are handful of studies on oil producing countries and Asian countries. Beladi and Samanta (1988, on India), Choudary and Parai (1991, on Latin American countries), and Marashdeh (1993, on Malaysia) did empirical test on the hypotheses. Beladi and Samanta (1988), Choudary and Parai (1991) found evidence for non-neutrality while Marashdeh (1993) found mixed result, but mainly supporting LSW proposition. Most of empirical studies tested the hypotheses on anticipated and unanticipated monetary shocks. However, Cover (1992) distinguished between unanticipated positive and negative shocks. He found that negative money supply shocks affect output.

1.2.2 Two Main Tests of Hypotheses

Since the work has been focused on Rational Expectations Proposition, we have to quantify the notions of anticipated and unanticipated part of money supply. Once this is done, there are two tests to be conducted:

i. Testing whether anticipated money does not matter.

ii. Testing whether unanticipated money matters.

Both these propositions have to be tested separately as the presence of one does not necessarily imply the absence of the other, i.e. non-neutrality of monetary policy does not imply that the agents are non-rational.

1.2.3 Study of Causality

Besides these, the present study endeavors to identify the causal relationship between output level and money supply using Granger Causality test. Finally, the study concentrates to investigate the structural changes in the relationship between output level and money supply. For this purpose, the crucial task is to examine if the relationship is stable over the period of study. If not, the period of study, may consist of several sub-periods embodying structural changes. We seek to identify such sub-periods where structural changes have occurred in such relationship. We then seek to examine, under different sub-periods, the relation between output variation and variation in different parts (anticipated and unanticipated) of money supply.

The objectives of the present study have been summarized as follows:

i. To assess the applicability of the policy ineffectiveness theorem in Nepalese economy.

ii. To identify the effectiveness of monetary policies to influence the output level in Nepalese context.

iii. To analyze the nature of the time series data whether they are stationary or not.

iv. To explore whether there is cointegrating relationships between the variables.

v. To investigate whether there is causal relationships between the variables.

vi. To examine the structural changes in the relationship between output level and money supply in Nepal.

1.3 The Plan Of The Study

The present work has accordingly been divided into the following chapters:

Chapter II presents the literature survey. In this chapter conclusion and findings of several works related to the present study have been reviewed. The conceptual background of several relevant literatures has also been reviewed in this chapter.

Chapter III deals with source and nature of the data. methodological issues and period of the study. The introductions of some econometric methods, which are applied in the present study, have also been mentioned in this chapter.

Chapter- IV is devoted to study of testing for stationarity of Macroeconomic variables which are used in the present work. In order to test the stationarity of the log – transformed series as well as first differences of these series; Augmented Dickey Fuller, Phillips-Perron, DF-GLS (ERS), KPSS, ERS Point- Optimal and Ng-Perron modified unit root tests have been applied. Stationarity of the variables have also been checked on the basis of correlogram (ACF & PACF) and nature of line graphs of these series.

In Chapter- V, Unrestricted Vector Auto regression (UVAR) model. Cointegration and Vector Error Correction Modeling of the series have been presented. For this purpose CRDW, Engle-Granger (1987) and Johansen (1988) method of cointegration have been used. Conventional Granger Causality test is also subject for the study.

Chapter –VI estimates the anticipated and unanticipated parts of money supply. ARIMA structures of the series have been applied for this purpose. This chapter is also devoted to study the relationship of output variation with the anticipated and unanticipated parts of money supply over the period (1959-2003).

Chapter –VII identifies several sub-periods in which structural changes in output – money supply relations have occurred. The structural changes have been identified on the basis Chow breakpoint test. It also presents the relationship between output level and money supply (anticipated and unanticipated parts) over the different sub- periods.

In Chapter-VIII, observations in different chapters have been presented for review along with a discussion on public policy implications of the findings.

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CHAPTER –II

Survey of the Literature

2.1 The Rational Expectations Hypothesis:

The rational expectations hypothesis is the hypothesis that, when forming expectations about any variable, people will make optimal use of the available information. This information includes the actual value of certain variables and, more widely, the nature or structure of the world in which people are operating.

Let the value a variable 'y' takes in period t depend upon, or be a function f (.) of, the value of other variables, x_1, x_2 and x_3 have taken in some previous periods. But let y also be influenced by a random event, u. So the true nature of the world is the following:

$$y_t = f\,(x_{1t-1} \text{-----} x_{1t-n},\, x_{2t-1} \text{-----} x_{2t-n},\, x_{3t-1} \text{-----} x_{3t-n}) + u_t \qquad (2.1)$$

Here the state of the world is represented by the actual value of all the variables and the nature of the f(.) function. Assuming the nature of the function and values of all the variables in period't-1'then the rational forecast of y_t will be:

$$Ey_t/I_{t-1} = f\,(x_{1t-1} \text{-----} x_{1t-n},\, x_{2t-1} \text{-----} x_{2t-n},\, x_{3t-1} \text{-----} x_{3t-n}) + Eu_t/I_{t-1} \qquad (2.2)$$

Where Ey_t/I_{t-1} means the expectation of y_t formed on the basis of information (I) available in period t-1.The distribution of u is another element of the 'state of the world' which people are assumed to know. What they do not know is the actual value 'u' will take in period t. Usually this distribution is assumed to be normal around zero so that u has a mean of zero and the best guess one can form of u_t in period t-1 is that it will be zero. Hence,

$$Ey_t/I_{t-1} = f(x_{1t-1} \text{-----} x_{1t-n}, x_{2t-1} \text{-----} x_{2t-n}, x_{3t-1} \text{-----} x_{3t-n}) \qquad (2.3)$$

And the forecast error is,

$$y_t - Ey_t/I_{t-1} = u_t \qquad (2.4)$$

There are two important implications of this:

- Only u_t appears in the forecast error, the terms in the f(.) function do not appear. This is a more formal illustration of the implication of rational expectations that only the inherently unpredictable element affecting y_t will fool rational people; the predictable element will be predicted by them.

- If the process driving the predictable component were to change, then the process would drive people's expectations. So, if, for example, the process driving y_t changed to,

$$y_t = f(z_{1t-1} \text{-----} z_{1t-n}, z_{2t-1} \text{-----} z_{2t-n}, z_{3t-1} \text{-----} z_{3t-n}) + u_t \qquad (2.5)$$

Where the 'z's are other variables, expectations would be given by,

$$Ey_t/I_{t-1} = f(z_{1t-1} \text{-----} z_{1t-n}, z_{2t-1} \text{-----} z_{2t-n}, z_{3t-1} \text{-----} z_{3t-n}) \qquad (2.6)$$

The forecast error in any period would still be the unpredictable event, u_t.

2.2 The Lucas Critique

A key macroeconomic question in the late 1970s was whether the aggregate supply curve was best thought of as a new classical formulation or an alternative type. Consider the following example. Suppose the aggregate supply function is defined as,

$$y_t = \alpha m_t + \beta m_{t-1} + \chi y_{t-1} + \varepsilon_t \qquad (2.7)$$

Where m_t is the money supply, y_t is output, and ε_t is an error term. By lagging this relationship and repeatedly substituting it back into the equation to eliminate lagged output terms, output can be shown to be a function of past money supply.

$$y_t = \alpha m_t + (\beta + \alpha\chi) m_{t-1} + \text{-----------} + \varepsilon_t \qquad (2.8)$$

A systematic money supply rule based on the previous level of money supply, m_{t-1}, and a random component u_t, such as

$$m_t = \delta\, m_{t-1} + u_t \qquad (2.9)$$

The random component 'u_t' would be influenced on output.

Consider now the equation above rating output to lagged money supply, we know that

$$E_{t-1}\, m_t = \delta m_{t-1} \qquad (2.10)$$

and by adding and subtracting the terms of $E_{t-1}\, m_t$, $E_{t-2}\, m_{t-1}$ from the equation we can rewrite the relationship between output and lagged money supply as relationship between output and unanticipated money supply stocks:

$$y_t = \phi(m_t - E_{t-1} m_t) + \gamma(m_{t-1} - E_{t-2} m_{t-1}) + \ldots\ldots + \chi y_{t-1} + \varepsilon_t \qquad (2.11)$$

This model shows that unsystematic 'surprise' in money stock affect output, but this has been derived from exactly the same equation as the model which purported to show the *systematic* monetary policy can affect output. With the additional assumption, that the public make rational expectations about monetary policy, the two models can be said to be observationally equivalent. The general implication is that any estimated reduced-form equation which an econometrician discovers in the data is compatible with many different structural models with different theoretical priorities and policy implications. (Lewis and Mizen 2000:229)

Lucas (1972) introduced a rider to this debate which became a turning point in relation to the econometric estimation of economic models involving expectations, known as the 'Lucas Critique'. His observation was that many reduced-form models treat the expectational terms in the same way as they treat the structural parameters of the model, that is, as if they are given and unchanging. He made a substantive and a methodological contribution in his paper, 'Expectations and the Neutrality of Money'. The substantive contribution is to develop and analyze a specific mechanism by which monetary instability leads to fluctuations in output and inflation. In this mechanism, people with limited information confuse monetary disturbances with relative price movements, so that monetary fluctuations lead to aggregate output fluctuations. The methodological contribution is to illustrate how one goes about constructing dynamic, stochastic general equilibrium models to shed light on questions of substantive economic interest. In order to test the proposition that, where nominal aggregate demand shocks are highly volatile, the effect of any particular nominal aggregate demand shock is less. Lucas got data on nominal and real output/ expenditure covering the years 1951-1967 for 18 countries. He then assumed that, for each country, the mean value of the growth in their nominal expenditure over the whole period was a reasonable estimate of what people were expecting nominal spending growth to be in any particular year. The difference between the actual growth in nominal spending and this mean in any year was used by Lucas as his measure of unpredictable nominal spending growth in that year which is denoted by 'pyr_t'. The variance of this series can be taken as a measure of the volatility of nominal aggregate demand shocks. For each of his 18 countries Lucas then carried out the regression:

$$y_t = \beta_0 + \beta_1 \, pyr_t \qquad (2.12)$$

Actually Lucas has estimated a more complex equation which allows for natural rate and lagged effects on y. Using the above equation Lucas has had 18 estimates of 'β_1'- one for each country-and 18 measures of the volatility of nominal aggregate demand shocks-again, one for each country. But 'β_1' estimates the influence an aggregate demand shock has on real output or unemployment. If the misperceptions model of the business cycle were true then countries with high volatility should be those countries with low estimates values of 'β_1'. Lucas' results did appear to reveal such a negative relationship. One criticism of this test is that there are only 18 countries in the data set, and only two of these had markedly high volatility measures. So the result was rather dependent upon two observations. However, later studies used more countries and found the same relationship.

2.3 The Policy Ineffectiveness Theorem: The Invariance Proposition

Sargent and Wallace (1973, 1975) used tests of the direction of causality between economic variables to try to validate Lucas's new classical model on econometric grounds, concluding that the new classical approach was not inconsistent with the data. They first proposed the strong conclusion of Policy Ineffectiveness Theorem in a simple model made up of aggregate supply and aggregate demand equations, a money demand function and a monetary policy rule. The aggregate supply function is the Lucas 'surprise' function. Aggregate demand depends on the expected real interest rate, that is, the nominal interest rate, R_t, and the expected change in the general price level (inflation) given by ($E_{t-1}p_{t+1}$-$E_{t-1}p_t$):

$$y_t^D = \{ R_t - (E_{t-1}p_{t+1} - E_{t-1}p_t) \} \tag{2.13}$$

The demand for money depends on income, y_t, prices, p_t, and nominal interest rates, R_t, that affects nominal money balances, m_t^D, according to a fixed parameter, χ, and is written as

$$m_t^D = pt + yt - \chi R_t \tag{2.14}$$

$$m_t^S = \eta(y_{t-1} - y^*) + \varepsilon_t \tag{2.15}$$

Equation (2.15) provides the information that the money supply is the function of the difference between output last period and its natural rate. 'η' is the systematic part of monetary policy. Solving the system, Sargent and Wallace assume that markets clear, and by equating the money demand and supply, $m_t^D = m_t^S$, the interest rate can be determined as a function of prices and output, since

$$pt + yt - \chi R_t = \eta(y_{t-1} - y^*) + \varepsilon_t \qquad (2.16)$$

Hence,

$$Rt = 1/\chi \ \{\eta\,(y_{t-1} - y^*) + \varepsilon_t - p_t - y_t\} \qquad (2.17)$$

Equating the aggregate demand and aggregate supply, $y_t^S = y_t^D$, gives

$$y^* + \alpha(p_t - E_{t-1}p_t) = \{ R_t - (E_{t-1}p_{t+1} - E_{t-1}p_t)\} \qquad (2.18)$$

and substituting for the interest rate they are able to derive an expression entirely in terms of prices, the natural rate of output, expectations of prices and coefficients of the model η, α and χ given as

$$(\chi+1)\, y^* + \alpha\,(\chi+1)\,[p_t - E_{t-1}p_t] = \varepsilon_t - p_t - \chi[E_{t-1}p_{t+1} - E_{t-1}p_t] + \alpha\eta\,[p_{t-1} - E_{t-2}p_{t-2}] \qquad (2.19)$$

From this equilibrium expression, the system can be closed by assuming that expectations are formed rationally.

2.4 The New Keynesian Economics: Alternative to Invariance Proposition

Fischer (1977) constructed a model in the spirit of Sargent and Wallace. It was assumed in the model that expectations were rational but replacing the market-clearing hypothesis in the labor market by the assumption of multi- period contracts negotiated in nominal terms. These contracts inject an element of short-run wage stickiness in the model. In this context the policy ineffectiveness proposition is found to be invalid. Monetary policy can affect output and employment if the length of the period of the labor contracts is larger than the time it takes the monetary authority to react to changing economic circumstances. For instance, if the monetary authority increases the money supply (reacting to some recent economic disturbances) during the negotiated time period, this will affect the price level and therefore, the real wage (for the contract period) and in turn employment and real output will be affected. In this model public and private agents have the same information set at any time but the public agent has the larger opportunity set. The Fischer's model has been explained using the following equations.

The nominal wage in period t+1 is given by

$$W_{t+1} = 1/2\left({}_{t-1}W_t + {}_{t}W_{t+1}\right) \tag{2.20}$$

Where, ${}_{t}W_{t+1}$ indicates a wage negotiated in time t+1 on the basis of information available up to time t. Wages are based on the achievement of the level of real wages and are therefore dependent on price expectations, hence

$${}_{t-1}W_t = E_{t-1}p_{t+1} \tag{2.21}$$

$$ {}_{t}W_{t+1} = E_{t}p_{t+1} \qquad (2.22) $$

By substituting,

$$ W_{t+1} = 1/2\,(E_{t-1}p_{t+1} + E_{t}p_{t+1}) \qquad (2.23) $$

If we define the aggregate supply function as dependent on the real wage rate,

$$ y_{t+1} = 1/2\alpha\,(W_{t+1} - p_{t+1}) + y^{*} \qquad (2.24) $$

Then substituting for nominal wage rate gives

$$ y_{t+1} = \alpha/2\,(p_{t+1} - E_{t-1}p_{t+1}) + \alpha/2\,(p_{t+1} - E_{t}p_{t+1}) + y^{*} \qquad (2.25) $$

The equation (2.25) shows that the supply function differs from the Lucas supply function in that half the workforce is subject to a contract which is based on information from two periods ago.

Phelps and Taylor (1977) and Taylor (1979, 1980) had shown that despite the presence of rational expectations on the part of individual agents, anticipated policy could still have real effects, if nominal contracts are long term. In such models unanticipated money matters but anticipated money matters too if wages and/ or prices are not flexible.

2.5 Barro's test of the Misperceptions Model of the Business Cycle

The Misperceptions Model of the Business Cycle has two predictions:-

i. Predictable movements in variables influencing nominal aggregate demand should have no effect on real variables though unpredictable ones can.

ii. In countries where nominal aggregate demand shocks are highly volatile the effect of any particular nominal aggregate demand shock is less.

Barro(1977,1978) attempted to confirm the results by modeling directly the aggregate supply relationship. In order to do this he specified the money supply process and from it derived estimates of the unexpected changes in monetary policy. He then introduced both variables into a model to explain output and found that whilst anticipated monetary policy did not have a statistically significant effect on output the unexpected component did-seeming to confirm the new classical approach. Barro provided some initial evidence that indicated that the R.E. Hypothesis could not be dismissed simply as a theoretical curiosum. His approach was to use past values for money growth and other lagged variables to forecast money growth. These forecast equations were then identified explicitly with agents' expectations of money growth rates. Barro tested his hypothesis by entering the actual money growth rates into the equation to determine if they added significant explanatory power to the regression explaining unemployment in terms of unanticipated growth. However, it did not happen. Barro argued that he could not reject the hypothesis that only unanticipated money growth causes unemployment to deviate from its natural rate. Barro's methodology has been forwarded on the basis of following equations. Assuming the quantity of money has the main influence on nominal aggregate demand and estimating the relationship between the quantity of money and the variables X and Z.

$$\dot{M}t = a_0 + a_1X_{t-1} + a_2Z_{t-1} + dmr_t \qquad (2.26)$$

In the equation (2.26), the component 'dmr_t' is the estimate's error term. This error term presents the unpredictable part of the quantity of money on its movement. Barro argued that his estimated relationship in the equation is part of the state of the world which rational agents would have been aware of. So, their one-period-ahead forecasts of monetary growth should be consistent with this estimate. The expected change in the quantity of money can be identified as.

$$M_t^e = a_0 + a_1 X_{t-1} + a_2 Z_{t-1} \tag{2.27}$$

The unpredictable component as the equation's error term can be identified as.

$$\dot{M}t - M_t^e = dmr_t \tag{2.28}$$

Barro has obtained for each period in his data set an observation on the unpredictable and predictable components of the quantity of money, which, since the quantity of money is assumed by Barro to be the influence on nominal aggregate demand, amounts to a set of observations on unpredictable and predictable nominal aggregate demand. According to the misperceptions model of the business cycle, the first component should cause fluctuations in real output and unemployment whilst the second component should not. To test this he carried out a regression of a real variable-unemployment in his first paper, real output in his second- on dmr_t and M_t^e. So he used the regression.

$$y_t = b_0 + b_1 dmr_t + b_2 M_t^e \tag{2.29}$$

and his test is of the hypothesis that $b_1>0$, and $b_2 = 0$. In fact Barro's estimate was more complicated than this. He included terms to capture movements in the natural rates of unemployment and output, and allows for the possibility of lagged effects of movements in nominal aggregate demand. If unemployment is the dependent variable the hypothesis is that $b_1<0$. He found that neither hypothesis could be rejected. A number of other studies applied the same idea and the results are rather mixed. As time went on sufficient evidence accumulated suggesting that predictable movements in nominal aggregate demand can have real effects to cast doubt on the misperceptions model of the business cycle in its strictest form.

2.6 Theoretical and Empirical Explorations

There have been a huge theoretical and empirical explorations on effectiveness (or ineffectiveness) of monetary policies.

Sargent (1979) established from theoretical first principles that the econometric approaches could be misleading. His reasoning was to become known as the observational equivalence argument by which it is possible to show that systematic monetary policy can affect output and can be rearranged with some reasonable additional assumptions to show contrary, i.e. only unanticipated policy can affect output. The problem for the econometric work is that while these models have different assumptions which set them apart in theory, they are observationally equivalent in practice because it is not possible to specify them in such a way that they can be separated on econometric grounds when estimated in reduced form.

J. Grossman (1979) used nominal Gross National Product (GNP) as a proxy for policy instruments to test the hypothesis that only unanticipated money growth causes unemployment to deviate from its natural rate. Grossman's study used quarterly data as a contrast to Barro's original study on annual data. His study lends support to the invariance proposition.

McCallum (1980) explained the notion of rational expectations that the real sector of the model is completely independent of anticipated monetary policy. The expected rate of inflation fully reflects any change in the systematic component of the growth of the money supply and this directly raises the actual rate of inflation without any repercussions in the real sector. This result of the R.E. School is known as the "Policy Ineffectiveness" proposition and has been the subject of heated dispute. After a slow start the concept of rational expectations became widely accepted, primarily because it seems to be the 'Natural Rate Hypothesis' in the neo-classical model.

W.Buiter (1980), in surveying R.E. debate, distinguished two types of models- the walrasian model with frictionless markets and market-clearing prices and non-Walrasian model with sluggish wage and price adjustments. If the Walras type is combined with R.E., the policy ineffectiveness proposition will result. If, on the other hand, a non-Walrasian model is combined with R.E., demand management policy will have real consequences. Such policy will influence employment and output rates.

Gordon (1981) has forcefully challenged the studies claiming to have found support for the invariance proposition. He developed a model of gradual price adjustment. In it, the invariance proposition may be obtained as a special case. Money is neutral in Gordon's alternative model in the long run but anticipated money growth may be non-neutral in the short run. Gordon's empirical work on quarterly data covered the period 1890-1980. His basic finding was that prices did not move one for one with anticipated changes in nominal income as required by the invariance propositions. This finding was also true for the 1890-1930 periods during which prices of commodities were volatile than in the post-war era.

Mishkin's (1982) own empirical results somewhat support the assumption of rational expectations but generally throw doubt on the assumptions of neutrality of money. In addition, Mishkin also found that, with rise in lag-structure, tests of the invariance proposition on longer time support the hypothesis.

McGEE and Stasiak (1985) first used the VAR model to test all hypotheses involved in monetary policy and real output. Their study supported the non-neutrality theory of Rational Expectations Proposition. They introduced the methodology that focus on the stationarity and restriction issues of the variables. Their results supported the findings of Mishkin's study.

Beladi and Samanta (1988) examined the issue using the two step method for the period 1952 to 1982. They also rejected the hypothesis of neutrality of money when industrial production (IP) was used as the measures of output while the results using GDP was mix. Their argument in using IP was that GDP of India consisted of higher proportion of agriculture products which was very volatile as agriculture depended on weather. They had three different money processes. First one was standard money supply process equation, second one was recursive ex post forecast of money growth, and the final one was ARIMA model. Their argument in using recursive forecast and ARIMA model was dubious. Since, the research interest lies on the monetary authority's money supply process, the use of ARIMA model and recursive forecast in determining anticipated monetary policy seems to be dubious.

Choudhary and Parai (1991) explored the issue for Latin American countries in which they employed Mishkin's econometric procedure, i.e., two step methods, for the period starting early fifties to late eighties. This is one of the paper in which the theories were tested on LDC. They used Theil's adjusted R^2 criterion in determining the lag length. They hold "Examination of the F-statistics shows that the effect of anticipated money growth on the rate of growth of real output is significantly different from zero for 11 of 13 countries at 5% level and for all countries in our sample at 10% level." (p 584). Their results validated the non-neutrality theory of Fischer, Phelps and Taylor.

Ghani (1991) concluded that only unanticipated money matters in the Indian context. However, his study had certain stark shortcomings. For instance, he used spurious variables in the monetary growth equation, regressed I (1) series on I (0) series and so on.

Cover (1992) studied the positive and negative money shocks for the United States for the period 1951 (I) to 1987 (IV). As many empirical tests have been done on the United States, the paper mainly concentrated in testing the positive and negative NEWS. It employed two step methods. The lag length was determined using Akaike Information Criterion. He defined positive money shock as positive errors from the money supply process while negative money shock as negative errors from the money supply process.

The results concluded that the negative money supply shocks had significant effect on output.

Marashdeh (1993) studied the effect of anticipated and unanticipated money on real output of Malaysia for the period 1970 (I) to 1990 (IV). He employed a VAR model which allows interactions between monetary policy, fiscal policy, inflation, balance of payments and real output. Upon imposing restrictions on coefficients of monetary shocks and other parameters, the results showed that the null hypotheses of LSW policy ineffectiveness were rejected at 5% level. Moreover, he found that unanticipated changes in inflation do influence real output in the short run, supporting the LSW proposition. Marashdeh concludes, "However, unanticipated changes in monetary policy, balance of payments and fiscal policy did not influence real output, lending support to the classical view of the economy and rejecting the LSW proposition." (p 925)

R.Mandal(1997) concluded in the Indian context that output level is related to the anticipated part of money supply only, unanticipated part of money supply is not found to affect output level significantly during the period of 1950-1991.

R.Jha and K.Donde(2001) obtained exactly opposite results in the Indian context. in contrast to Barro's conclusion for the US economy that anticipated monetary policy has no significant effects on real variables. They hold that for the Indian economy anticipated policy matters whereas no significant influence from the unanticipated monetary policy exists. According to them, economic agents in India may have rational expectations at the micro- level, but the existing rigidities in the system do not let this 'rationality' get reflected in their behavior and consequently in the macro level data.

S. Ranjit (2004) obtained the empirical results for Nepal which supported the non-neutrality of money. Both anticipated and unanticipated money supply shocks were found to have statistically significant positive impacts on the output level in the economy. The further break-down of the unanticipated part of money showed that both of positive and negative shocks had equal positive impacts on real output.

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CHAPTER – III

Data and Methodology

3.1 Source and Nature of Data

In the present study the relationship between output level and money supply for the period 1959 to 2003(45 Years) has been analyzed. For this study, we have used the data sets of GDP (1990=100) for output and both M1 & M2 for money supply. Though the data series for GDP has been given in different bases in various issues, we have changed all bases in the same year i.e. 1990 as a base year. M1 includes currency held by non-bank public and demand deposit held at monetary sector.M2 consists of M1 and time deposits held at commercial banks. The source of the data sets of the present study is International Financial Statistics (IFS), a publication of International Monetary Fund (IMF). The line 34 of IFS represents M1 while the line 35 represents quasi money compromising time, savings and foreign currency deposits of resident sectors other than Central Govt. M2, therefore, gives a broader measure of money supply. We have used various issues of IFS for the collection of data.

3.2 Methodology Adopted

For the analysis of the study we have used various econometric tools. Several models, which are based on econometric analysis, have been used for the present work. Testing for stationarity has been applied based on unit root test and ACF / PACF (correlogram). Cointegration test, UVAR modeling, Vector Error Correction modeling, Granger

Causality Test, ARIMA structure and Chow Test are some of the examples of econometric tools used in the present study.

3.3 Unit Root Tests

When time series data are used in econometric analyses, the preliminary statistical step is to test the stationary of each individual series. Unit root tests provide information about stationarity of the data. Nonstationarity data contain unit roots. The main objective of unit root tests is to determine the degree of integration of each individual time series. Various methods for unit root tests have been used in the present study. Some of which are being stated and explained below:

3.3.1 Dickey Fuller unit root test

The test of unit root was proposed by David A. Dickey and Wayne A. Fuller in 1976. To discuss the Dickey-Fuller tests, the model has been considered as following:

$$y_t = \beta_0 + \beta_1 t + u_t \quad (3.1)$$

$$u_t = \alpha u_{t-1} + \varepsilon_t \quad (3.2)$$

Where ε_t is a covariance stationary process with zero mean. The reduced form for this model is

$$yt = \gamma + \delta t + \alpha y_{t-1} + \varepsilon_t \quad (3.3)$$

Where $\gamma = \beta_0 (1-\alpha) + \beta_1 \alpha$ and $\delta = \beta_1 (1-\alpha)$.

This equation is said to have a unit root if $\alpha=1$ (in which case $\delta=0$)

3.3.2 Augmented Dickey Fuller unit root test

In order to test for the existence of unit roots, and to determine the degree of differencing necessary to induce stationarity, we have applied the augmented Dickey-Fuller test. Dickey and Fuller (1976, 1979), Said and Dickey (1984), Phillips (1987), Phillips and Perron(1988), and others developed modifications of the Dickey-Fuller tests when ε_t is not white noise. These tests are called "augmented" Dickey-Fuller (ADF) tests. The results of the augmented Dickey-Fuller test (ADF) determine the form in which the data should be used in any subsequent econometric analyses. The test is based upon estimating the following equations:

$$\Delta y_t = \gamma + \alpha y_{t-1} + \sum_{j=2}^{k} \theta_j \Delta y_{t-j+1} + e_t \qquad (3.4)$$

$$\Delta y_t = \gamma + \delta t + \alpha y_{t-1} + \sum_{j=2}^{k} \theta_j \Delta y_{t-j+1} + e_t \qquad (3.5)$$

$$\Delta y_t = \alpha y_{t-1} + \sum_{j=2}^{k} \theta_j \Delta y_{t-j+1} + e_t \qquad (3.6)$$

Where, y_t = GDP of Nepal; Δy_t = First differenced series of y_t.

Δy_{t-j+1} = First differenced series of y_t at $(t-j+1)^{th}$ lags. (j = 2 -------- k)

The equation (3.4) is related to ADF test with constant as exogenous, equation (3.5) is based on constant and linear trend as exogenous and ADF test with no exogenous is presented in equation (3.6).

3.3.3 The D-F GLS unit root test

The DF-GLS test developed by Elliott, Rothenberg and Stock (1996), which has greater power than standard ADF test, also is employed in the present study.

The DF-GLS t-test is performed by testing the hypothesis $a_0=0$ in the regression

$$\Delta y_t^d = a_0 y_t^d + a_1 \Delta y^d_{t-1} + \text{-----} + a_p \Delta y^d_{t-p} + \text{error} \qquad (3.7)$$

Where y_t^d is the locally de-trended series y_t. The local de-trending depends on whether we consider a model with drift only or a linear trend.

(i) DF-GLS unit root test without time trends (a model with drift only)-

$$y_t^\mu = \alpha y^\mu_{t-1} + \sum_{i=1}^{k} \Psi i \, \Delta y^\mu_{t-i} + u_t \qquad (3.8)$$

(ii) DF-GLS unit root test with time trends (a model with linear trend)-

$$y_t^\tau = \alpha y^\mu_{t-1} + \sum_{i=1}^{k} \Psi i \, \Delta y^\tau_{t-i} + u_t \qquad (3.9)$$

3.3.4 Phillips –Perron Unit root test

Phillips(1987), Phillips and Perron (1988) generalized the DF tests to situations where disturbance processes, ε_t are serially correlated, other than by augmenting the initial regression with lagged dependent variables as in the ADF procedure. The PP approach is to add a correction factor to the DF test statistic.

Suppose the AR (1) model is,

$$Yt = \mu + \varphi_1 Y_{t-1} + \varepsilon_t, \ \{t = 1, \text{---------}, T\} \qquad (3.10)$$

With $Var(\varepsilon_t) \equiv \sigma_\varepsilon^2$.

If ε_t is serially correlated the ADF approach is to add lagged ΔY_t to 'whiten' the residuals. To illustrate the alternative approach the test statistic $T(\varphi_1-1)$ has been considered which is distributed as ρ_μ from the maintained regression with an intercept but no time trend. The PP modified version is,

$$Z\rho_\mu = T(\varphi_1 - 1) - CF \tag{3.11}$$

Where the correction factor CF is

$$CF = 0.5(s^2_{Tl} - s_\varepsilon^2) / \left(\sum_{t=2}^{T} (Y_{t-1} - \bar{Y}_{-1})^2 / T^2\right) \tag{3.12}$$

And,

$$s_\varepsilon^2 = T^{-1} \sum_{t=1}^{T} \varepsilon_t^2 \tag{3.13}$$

$$s^2_{Tl} = s_\varepsilon^2 + 2 \sum_{s=1}^{l} W_{sl} \sum_{t=s+1}^{T} \varepsilon_t \varepsilon_{t-s} / T \tag{3.14}$$

$W_{sl} = 1 - s/(l+1)$ and $\varepsilon_t = Y_t - \mu - \varphi_1 Y_{t-1}$

$$\bar{Y}_{-1} = \sum_{t=2}^{T} Y_t / (T-1) \tag{3.15}$$

(Patterson 2002:264)

3.3.5 The KPSS unit root test

There are many tests for unit roots with stationarity as null but the most common one is the KPSS test due to Kwiatowski et al. All the tests for moving average unit roots can be regarded as tests with stationarity as null. The KPSS test is an analog of Phillips-Perron test. The model for KPSS test is;

$$\varphi(L)y_t = \alpha_t + \beta t + \varepsilon_t \tag{3.16}$$

$$\alpha_t = \alpha_{t-1} + \eta_t \quad \alpha_0 = \alpha \quad (t = 1,2,\text{---------}T)$$

$$\text{where } \varepsilon_t \sim \text{IID}(0, \sigma_\varepsilon^2), \quad \eta_t \sim \text{IID}(0, \sigma_\eta^2)$$

ε_t and η_t are independent and $\varphi(L)$ is a p^{th}- order autoregression. The test for stationarity in this model is,

H_0: $\sigma_\eta^2 = 0$ vs. $H_1 > 0$. Under H_1 the model has been an ARIMA model.

It has been argued that tests with stationarity as null can be used to confirm the results of the usual unit root tests. The two tests are:

Test 1 (usual test)	Test 2 (KPSS test)
H_0: y_t is nonstationary (unit root) H_1: y_t is stationary	H_0: y_t is stationary H_1: y_t is nonstationary(unit root)

If both tests reject their nulls, their will be no confirmation. But if test 1 rejects the null but test 2 does not (or vice versa) the confirmation can be drawn (Maddala 2001:553).

3.3.6 ERS Point Optimal Test

The ERS Point Optimal test is based on the following quasi-differencing regression equation:

$$d(y_t/\alpha) = d(x_t/\alpha)'\delta(\alpha) + \eta_t \tag{3.17}$$

where x_t stands for either a constant or a constant along with trend and $\delta(\alpha)$ be the OLS estimates from this regression. The residual from this equation is:

$$\eta_t(\alpha) = d(y_t/\alpha) - d(x_t/\alpha)'\delta(\alpha) \qquad (3.18)$$

Let SSR (α) = $\sum \eta_t^2(\alpha)$ be the sum of squared residuals function. The ERS point optimal test statistic of the null that $\alpha = 1$ against the alternative that $\alpha = \bar{\alpha}$, is then defined as;

$$P_T = SSR(\bar{\alpha}) - \bar{\alpha}\, SSR(1)/f_0 \qquad (3.19)$$

where f_0, is an estimator of the residual spectrum at frequency zero. In order to compute the ERS test, it is necessary to specify the set of exogenous regressors x_t and a method for estimating f_0.

3.3.7 Ng and Perron (NP) Tests

Ng and Perron (2001) construct four test statistics that are based upon the GLS detrended data y_t^d. These test statistics are modified forms of Phillips and Perron Z_α and Z_t statistics, the Bhargava(1986) R_1 statistics and the ERS Point Optimal statistic. Defining the term:

$$k = \sum_{t=2}^{T} (y^d_{t-1})^2 \Big/ T^2 \qquad (3.20)$$

The modified statistics can be written as;

$$MZ^d_\alpha = [T^{-1}(y_t^d)^2 - f_0]/2k$$

$$MZ^d_t = MZ_\alpha \times MSB$$

$$MSB^d = (k/f_0)^{1/2} \qquad (3.21)$$

$$MP^{d}_{t} = \{ \bar{c}^{2}k - \bar{c}T^{-1}(y^{d}{}_{T})^{2} \Big/ f_0 \qquad \text{if } x_t = \{1\}$$

$$= \{ \bar{c}^{2}k - (1-\bar{c})T^{-1}(y^{d}{}_{T})^{2} \Big/ f_0 \quad \text{if } x_t = \{1, t\}$$

$$\text{Where, } \bar{c} = \{-7 \qquad \text{if } x_t = \{1\}$$

$$= \{-13.5 \quad \text{if } x_t = \{1, t\}$$

The NP tests require a specification for x_t and a choice of method for estimating f_0.

3.4 Correlogram

Testing for stationarity of the variables, the correlogram of the variables has also been presented. Correlogram is simply a graphical representation of Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF). The nature of stationarity can also be found tentatively with the help of Correlogram.

3.5 Cointegration test

The co- integration test presents the long run equilibrium relationships between two variables say y_t and x_t. Suppose that $y_t \sim I(1)$ and $x_t \sim I(1)$. Then y_t and x_t are said to be co-integrated if there exists a β such that $y_t - \beta x_t$ is $I(0)$.This is denoted by saying y_t and x_t are CI (1, 1). Several co-integration techniques are available for the time series analyses. These tests include the Engle and Granger test (1987), Stock and Watson procedure (1988) and Johansen's method (1988).

3.5.1 Engle-Granger Cointegration test

The Engle and Granger approach is also known as a residual test. If variables in an equation are integrated of the same order, say (1), the error term should be stationary, i.e., I (0). Let us consider M time series (Y_{t1}-----Y_{tM}), each of which is I(1), and the following two regression models, the first with drift and no trend and the second with drift and trend:

$$Y_{t1} = \beta_0 + \sum_{j=2}^{M} \sum \beta_j y_{t-j+1} + \varepsilon_t \tag{3.22}$$

$$Y_{t1} = \beta_0 + \beta_1 t + \sum_{j=2}^{M} \beta_j y_{t-j+1} + \varepsilon_t \tag{3.23}$$

A test for no cointegration is given by a test for a unit root in the estimated error terms e_t of ε_t. This can be achieved by applying ADF test to the residuals using the following equation:

$$\Delta e_t = \alpha e_{t-1} + \sum_{j=1}^{p} \Phi_j e_{t-j} + v_t \tag{3.24}$$

The null hypothesis $\alpha = 0$ is tested using the τ statistic.

3.5.2 Johansen Maximum Likelihood Cointegration Test

The Johansen procedure analyses the relationship among stationary or non-stationary variables using the following equation:

$$Xt = \sum_{i=1}^{p} \prod_i Xt - 1 + \varepsilon_t \tag{3.25}$$

This function can be presented according to the following VAR system:

$$\Delta Xt = \prod Xt-1 + \sum_{i=1}^{r-1} \phi i \Delta Xt-1 + \mu + \varepsilon_t \qquad (3.26)$$

in which Xt is an $n \times 1$ random vector, ε_t is NIID $(0, \Sigma_\varepsilon)$, and μ is deterministic terms. The long-run relationships are captured in the the coefficient matrix of $\prod$, denoted by r, is between 0 and n. Then there are r linear combinations of the variables in the system that are I (0) or cointegrated. Under Johansen (1991), and Johansen and Juselius (1990) procedures, two tests are available for the determination of cointegrating vectors and for the estimation of their values. These tests are the trace test and the eigen value test. In Johansen's method, a two-stage testing procedure has been implemented. In the first stage, the null hypothesis of no cointegration is tested against the alternative that the data are cointegrated with an unknown cointegrating vector. If the null hypothesis is rejected, a second stage test is implemented with cointegration maintained under both the null and alternative.

Gonzalo (1994) has suggested that Johansen's procedure has properties which are superior to alternative co-integration testing methods.

3.6 Vector Error Correction Modeling

Vector Error Correction modeling provides important information on the short run relationship between any two cointegrated variables. Vector Error Correction test has provided empirical evidence on the short run causality between real GDP and money supply(M1 &M2) in Nepal.

In the present study the vector error correction estimates have been specified using the following model. The model has been used in both cases i.e. involving M1 & M2.

$$\Delta \ln Y_t = \gamma_1 + \rho_1 z_{t-1} + \alpha_1 \Delta \ln Y_{t-1} + \alpha_2 \Delta \ln Y_{t-2} + \alpha_3 \Delta M_{t-1} + \alpha_4 \Delta M_{t-2} + \varepsilon_{1t} \tag{3.27}$$

$$\Delta M_t = \gamma_2 + \rho_2 z_{t-1} + \beta_1 \Delta \ln Y_{t-1} + \beta_2 \Delta \ln Y_{t-2} + \beta_3 \Delta M_{t-1} + \beta_4 \Delta M_{t-2} + \varepsilon_{2t} \tag{3.28}$$

The focus of the vector error correction analysis is on the lagged z_t terms. These lagged terms are the residuals from the previously estimated cointegration equations. In the present case the residuals from two lag specifications of the cointegrating equations have been used in the vector error correction estimates. Lagged z_t terms provide an explanation of short run deviations from the long run equilibrium for the two test equations. Lagging these terms means that disturbance of the last period impacts the current time period. Statistical significance tests are conducted on each of the lagged z_t term in equations (3.27) and (3.28). In general, finding a statistically insignificant coefficient of the z_t term implies that the system under investigation is in the short run equilibrium as there are no disturbances present. If the coefficient of the z_t term is found to be statistically significant, then the system is in the state of the short run disequilibrium. In such a case the sign of z_t term gives an indication of the causality direction between the two test variables.

3.7 Unrestricted Vector Auto regression

The model for the Unrestricted Vector Auto regression of the variables in the present study is based on the following equations:-

$$\Delta \ln Y_t = \gamma_1 + \alpha_{11} \Delta \ln Y_{t-1} + \alpha_{12} \Delta M_{t-1} + \beta_{11} \Delta \ln Y_{t-2} + \beta_{12} \Delta M_{t-2} + \varepsilon_{1t} \tag{3.29}$$

$$\Delta M_t = \gamma_2 + \alpha_{21}\Delta M_{t-1} + \alpha_{22}\Delta \ln Y_{t-2} + \beta_{21}\Delta M_{t-1} + \beta_{22}\Delta M_{t-2} + \varepsilon_{2t} \quad (3.30)$$

Where, $\Delta \ln Y_t$= first difference of output level (real & nominal).

ΔM_t = first difference of money supply (narrow & broad).

α_{ij}, β_{ij}, γ_i are the parameters to be estimated.

3.8 Conventional Granger Causality Test

The model for Conventional Granger causality test is based on the following equations:

$$Y_t = \sum_{j=1}^{m} a_j M_{t-j} + \sum_{j=1}^{m} b_j Y_{t-j} + \varepsilon_t \quad (3.31)$$

$$M_t = \sum_{j=1}^{m} a_j Y_{t-j} + \sum_{j=1}^{m} b_j M_{t-j} + \eta_t \quad (3.32)$$

Where Yt and Mt represents first difference of output level (real and nominal) and money supply (narrow and broad) respectively.

3.9 The ARIMA model

In order to identify the anticipated and unanticipated part of money supply the ARIMA structures of the series have been applied. The model has been explained as follows:

$$\Phi (L)\, Y_t = \mu + \theta (L)\, \varepsilon_t \quad (3.33)$$

Where $\Phi (L) = 1 - \sum_{i=1}^{p} \phi_i L^i$, $\theta (L) = 1 + \sum_{j=1}^{q} \theta_j L^j$ and ε_t is white noise.

This is known as an autoregressive moving average model of orders p and q or more simply an ARMA (p,q) model. A simple MA (1) model is;

$$Y_t = \mu + (1+\theta_1 L)\,\varepsilon_t \tag{3.34}$$

This has an alternative representation as an AR (∞) model provided $|\theta_1|<1$, in which case the MA model is said to be invertible. Multiplying through by the inverse of $(1+\theta_1 L)^{-1} = 1- \theta_1 L- \theta_1^2 L^2 - \theta_1^3 L^3 -.......- \theta_1^s L^s -,\ldots,$ gives

$$(1- \theta_1 L- \theta_1^2 L^2 - \theta_1^3 L^3 -.......- \theta_1^s L^s -,\ldots,)Y_t = \mu^* + \varepsilon_t \tag{3.35}$$

so that

$$Y_t = \mu^* + (\theta_1 L+ \theta_1^2 L^2 + \theta_1^3 L^3 +.......+ \theta_1^s L^s +,\ldots,)Y_t + \varepsilon_t$$

$$= \mu^* + \sum_{j=1}^{\infty} \theta_j L^j Y_t + \varepsilon_t \tag{3.36}$$

Where $\mu^* = (1+ \theta_1 L)^{-1}\,\mu$.

If Φ (L) contains a unit root, then it can be factored into $\Phi(L) = \Phi^*(L)(1-L)$, and the ARMA(p,q) model $\Phi(L)Y_t = \mu + \theta(L)\,\varepsilon_t$ can be rewritten as $\Phi^*(L)(1-L)Y_t = \mu + \theta(L)\,\varepsilon_t$. In this case Y_t is integrated of order 1, and the model is referred to as an ARIMA (p,d,q) model, with d=1 in this case. (Patterson 2002:254)

3.10 The Chow Test

In order to test for the stability of the regression equation, Chow has presented a test statistic which is based on F-statistic which can be calculated as:

$$F = \frac{(RRSS - URSS)(T - k)}{URSS(g)} \tag{3.37}$$

Where RRSS is the residual sum of squares from a restricted version of a more general model from which the unrestricted residual sum of squares, URSS, is calculated.

Equivalently RRSS comes from the regression model with the null hypothesis imposed and URSS comes from the regression model according to the alternative hypothesis. In this case the restricted model imposes just one set of regression coefficients for T observations with residual sum of squares $\sum_{t=1}^{T_1} \varepsilon_{1t}^2 = \varepsilon_1'\varepsilon_1$ and $\sum_{t=T_1+1}^{T} \varepsilon_{2t}^2 = \varepsilon_2'\varepsilon_2$

with $T_1 - k + T_2 - k = T\text{-}2k$ degrees of freedom.

Chow has used the model for test statistic as;

$$CT\,(k,\ T\text{-}2k) = \frac{\varepsilon'\varepsilon - (\varepsilon'_1\varepsilon_1 + \varepsilon'_2\varepsilon_2)(T - 2k)}{(\varepsilon'_1\varepsilon_1 + \varepsilon'_2\varepsilon_2)(k)} \tag{3.38}$$

(Patterson 2002:186)

In order to find the structural breaks in the period of study, Chow breakpoint test has been applied in the present work.

Table 3.1: DATABASE FOR GDP (Yt) & MONEY SUPPLY (M1 &M2)

(In million Rs.)

Year	Yt (1990=100)	M1	M2	ln Y	ln M1	ln M2
1959	44658	133.1	152.8	10.70679	4.891101	5.029130
1960	42695	182.2	209.6	10.66184	5.205105	5.345201
1961	44146	223.6	256.3	10.69526	5.409859	5.546349
1962	45253	227.9	266.7	10.72002	5.428907	5.586124
1963	44716	294	335.1	10.70809	5.683580	5.814429
1964	45603	378.7	418.6	10.72773	5.936744	6.036916
1965	46743	481.4	525.4	10.75242	6.176699	6.264160
1966	49413	506.3	555.9	10.80797	6.227129	6.320588
1967	48638	531.7	601.6	10.79216	6.276079	6.399593
1968	48698	595.8	718.1	10.79339	6.389905	6.576609
1969	51152	739.4	922.4	10.84256	6.605839	6.826979
1970	52470	699.2	931.1	10.868	6.549937	6.836367
1971	51844	784.3	1108.5	10.85599	6.664792	7.010763
1972	53459	841.7	1293.1	10.88667	6.735424	7.164798
1973	53204	1090.2	1663.4	10.88189	6.994116	7.416619
1974	56574	1289.8	1948.2	10.9433	7.162242	7.574661
1975	57398	1333.5	2180.1	10.95776	7.195562	7.687126
1976	59923	1635.8	2810.7	11.00082	7.399887	7.941189
1977	61731	1932.5	3400.9	11.03054	7.566570	8.131795
1978	64451	2200.2	4070	11.07366	7.696304	8.311398
1979	65978	2534.3	4712.1	11.09708	7.837673	8.457889
1980	64447	2864.4	5525.8	11.0736	7.960114	8.617183
1981	69823	3204.7	6579.9	11.15372	8.072374	8.791775
1982	72462	3704.8	7987.4	11.19082	8.217385	8.985621
1983	70304	4366	9594.4	11.16058	8.381603	9.168935
1984	77111	4942.3	10841.2	11.253	8.505586	9.291109
1985	81849	5615.9	13014.1	11.31263	8.633357	9.473789
1986	85663	6951	15542.9	11.35818	8.846641	9.651359
1987	87349	8632	19024	11.37767	9.063232	9.853457
1988	93349	9826	23219	11.4441	9.192787	10.05273
1989	98567	11720	28106	11.49849	9.369052	10.24374
1990	103416	14205	33304	11.54651	9.561349	10.41343
1991	110078	17614	40855	11.60894	9.776449	10.61778
1992	115166	20428	49316	11.65413	9.924662	10.80600
1993	118951	25320	61537	11.68647	10.13935	11.02739
1994	127600	30524	72696	11.75666	10.32627	11.19404
1995	125735	33553	84043	11.7872	10.42088	11.33908
1996	132906	35544	94288	11.8432	10.47853	11.45411
1997	139247	38596	109151	11.89179	10.56090	11.60049
1998	144031	45509	135359	11.92468	10.72567	11.81569
1999	150474	55107	164628	11.96904	10.91703	12.01144
2000	160170	63028	195578	12.02792	11.05133	12.18371
2001	169457	72161	218111	12.07376	11.18666	12.29276
2002	168227	77156	229375	12.03307	11.25358	12.34311
2003	179461	83754	255395	12.09771	11.33564	12.45057

(Source-INTERNATIONAL FINANCIAL STATISTICS YEAR BOOK 1987, 1996, AUGUST 2002, 2004 -IMF)

CHAPTER- IV

Testing for Stationarity of Money and Output

4.1 Introduction:

In order to develop models for time series data, it is necessary to know whether the data are stationary or not. Only those series are called stationary which are assumed to be invariant with respect to time. If the characteristics of the time series data change over time, the series are taken as non-stationary. A stationary time series has three basic properties.

(i) A stationary series fluctuates around a constant long run mean.

$E[Y_t]$ is independent of t.

or,

$$E[Y_t] = E[Y_{t-s}] = \mu \qquad (4.1)$$

(ii) It has a finite variance.

$$E(Y_t - \mu)^2 = E(Y_{t-s} - \mu)^2 = \sigma_y^2 \qquad (4.2)$$

$Var(Y_t)$ is a finite, positive constant and independent of t.

(iii) Cov $[Y_t, Y_s]$ is a finite function of t-s, but not of t or s.

$$E[(Y_t - \mu)(Y_{t-s} - \mu)] = E[(Y_{t-j} - \mu)(Y_{t-j-s} - \mu)] = \gamma_s$$

$$[cov(Y_t, Y_{t-s}) = cov(Y_{t-j}, Y_{t-j-s})] \qquad (4.3)$$

Where μ, σ_y^2 and all γ_s are constants.

That is, the mean, variance and co-variance of the underlying process are invariant with time. Testing for stationarity can be performed with the help of unit root test and/or correlogram.

4.2 Unit Root test

Suppose we have a series $\{Y_t\}$ which we know to have been generated by an AR (1) process, say

$$Yt = \alpha + \rho Y_{t-1} + \xi_t \tag{4.4}$$

Where $|\rho| < 1$ and ξ_t is white noise error term. We can estimate the parameters in (4.4) by OLS. Our estimator is efficient and the series is stationary since $|\rho| < 1$. If the value of $\rho = 1$, the series $\{Y_t\}$ is non-stationary. That is, if the coefficient of Y_{t-1} is equal to one, we face with unit root problem. Hence, the unit root null hypothesis is: $H_o = \rho = 1$

While testing the null hypothesis of unit root, we use the following equation-

$$\Delta Y_t = \alpha + \gamma Y_{t-1} + \xi_t \tag{4.5}$$

Where, $\gamma = \rho - 1$, ΔY_t –First difference of the series Y_t. The null hypothesis of unit root is, $Ho = \gamma = 0$. If ' γ' is in fact 0, we can write eq^n (4.5) as $\Delta Y_t = Y_t - Y_{t-1} = \xi_t$

Time series data, which we often use in practice for economic modeling, almost have a unit root at level and such series are known as non-stationary time series. They are also called random walk time series. If the series have the characteristics of non –stationarity or random walk at level, then we have to find its successive differences to test the stationarity of the series. If the models are developed from the series having non –stationarity, they produce spurious relationship between the variables.

4.2.1 Augmented Dickey-Fuller (ADF) Unit Root test: Results of Estimation

The Dickey-Fuller test was extended by, among many other authors, Said and Dickey (1984) to take into account when $\{y_t\}$ follows an AR (k) process. In the literature it is known as Augmented Dickey-Fuller (ADF) test. Lagged values of y's were introduced in (3.4), (3.5) and (3.6) to take into account of the fact that $\{y_t\}$ follows an AR (k) process. Said and Dickey approach yields test statistics with the asymptotic critical values as those tabulated by Dickey and Fuller. Data should be used in any subsequent econometric analyses. The test is based upon estimating the equations (3.4), (3.5) and (3.6).

The estimations of the parameters based on the equation (3.4) have been presented in the following table (Table 4.1).

Table 4.1: Estimations of ADF Unit Root Test Equation on Variables

Dependent variable	Explanatory variable	Coefficient	t-statistic	probability
$\Delta \ln Y_t$	$\ln Y_{t-1}$	0.021463	2.050596	0.0466
	constant	-0.209565	-1.780429	0.0822
$\Delta^2 \ln Y_t$	$\Delta \ln Y_{t-1}$	-1.140360	-7.846359	0.0000
	constant	0.037722	5.885357	0.0000
$\Delta \ln NY_t$	$\ln NY_{t-1}$	0.008140	1.185043	0.2427
	constant	0.023830	0.330283	0.7428
$\Delta^2 \ln NY_t$	$\Delta \ln NY_{t-1}$	-0.972033	-6.379611	0.0000
	constant	0.107786	5.465127	0.0000
$\Delta \ln M1_t$	$\ln M1_{t-1}$	-0.005442	-0.902658	0.3719
	constant	0.190818	3.786550	0.0005
$\Delta^2 \ln M1t$	$\Delta \ln M1_{t-1}$	-0.931458	-6.322940	0.0000
	constant	0.132429	5.442044	0.0000
$\Delta \ln M2_t$	$\ln M2_{t-1}$	-0.004114	-0.980233	0.3326
	constant	0.204716	5.400992	0.0000
$\Delta^2 \ln M2_t$	$\Delta \ln M2_{t-1}$	-0.970881	-6.623665	0.0000
	constant	0.160288	6.061265	0.0000

The 't-statistic' of the coefficients of the explanatory variable in the table presents the Augmented Dickey Fuller test statistic. The findings from the Table 4.1 and other estimations based on equations (3.5) and (3.6) have been presented in the first part (exogenous: constant), second part (exogenous: constant & linear trend) and third part (exogenous: none) respectively of the following table (Table 4.2).

Table 4.2: Augmented Dickey Fuller Unit Root Test on Variables

Exogenous: Constant Null Hypothesis: The variable has a unit root.
Lag length: (Automatic based on SIC, MAXLAG=9) [Sample: - 1959 - 2003]

Variable	ADF test statistic	Prob* value	Lag length	Test critical values 1%	5%	10%
lnY	2.050596	0.9998	0	-3.588509	-2.929734	-2.603064
Δln Y	-7.846359	0.0000	0	-3.592462	-2.931404	-2.603944
lnNY	1.185043	0.9976	0	-3.588509	-2.929734	-2.603064
Δln NY	-6.379611	0.0000	0	-3.592462	-2.931404	-2.603944
lnM1	-0.902658	0.7782	0	-3.588509	-2.929734	-2.603064
ΔlnM1	-6.322940	0.0000	0	-3.592462	-2.931404	-2.603944
lnM2	-0.980233	0.7522	0	-3.588509	-2.929734	-2.603064
ΔlnM2	-6.623665	0.0000	0	-3.592462	-2.931404	-2.603944

Exogenous: Constant, Linear trend

lnY	-2.193497	0.4807	2	-4.192337	-3.520787	-3.191277
Δln Y	-8.816670	0.0000	0	-4.186481	-3.518090	-3.189732
lnNY	-2.601538	0.2816	0	-4.180911	-3.515523	-3.188259
ΔlnNY	-6.472161	0.0000	0	-4.186481	-3.518090	-3.189732
lnM1	-2.171765	0.4929	0	-4.180911	-3.515523	-3.188259
ΔlnM1	-6.237164	0.0000	0	-4.186481	-3.518090	-3.189732
lnM2	-2.175162	0.4911	0	-4.180911	-3.515523	-3.188259
ΔlnM2	-6.542661	0.0000	0	-4.186481	-3.518090	-3.189732

Exogenous: None

lnY	6.715892	1.000	0	-2.618579	-1.948485	-1.612135
Δln Y	-0.448267	.5143	3	-2.624057	-1.949319	-1.611711
Δ^2ln Y	-8.902897	0.000	2	-2.624057	-1.949319	-1.611711
lnNY	10.54346	1.0000	0	-2.618579	-1.948485	-1.612135
ΔlnNY	-0.355329	0.5501	5	-2.627238	-1.949856	-1.611469
Δ^2lnNY	-5.273061	0.0000	4	-2.627238	-1.949856	-1.611469
lnM1	10.96791	1.000	0	-2.618579	-1.948485	-1.612135
ΔlnM1	-1.114717	0.2362	3	-2.624057	-1.949319	-1.611711
Δ^2lnM1	-5.890954	0.0000	3	-2.625606	-1.949609	-1.611593
lnM2	4.166666	1.0000	1	-2.619851	-1.948686	-1.612036
ΔlnM2	-0.954235	0.2978	3	-2.624057	-1.949319	-1.611711
Δ^2lnM2	-9.228296	0.000	0	-2.621185	-1.948886	-1.611932

*MacKinnon (1996) One-sided P-values ** Automatic based on SIC, MAXLAG=9

The findings from the above table have been summarized in following points:

(i) Comparing the test statistic with the critical values, the conclusion can be drawn whether the variable is stationary or non-stationary. From the table it can be concluded that all the variables are suffered from non-stationarity at level.

(ii) Only the first difference of such variables has the characteristics of stationarity.

(iii) The result is quite different for the case of no exogenous. The series are stationary only at the second differences in such cases.

Besides ADF unit root test on variables, the study is devoted to mention the other unit root tests also. Tables 4.3 and 4.4 are related to DF-GLS unit root test, Table 4.5 explains Phillips-Perron test, Tables 4.6, 4.7 & 4.8 are related to Kwiatkowski-Phillips-Schmidt-Shin test, ERS-Point optimal test and Ng-Perron modified test respectively.

4.2.2: Dickey-Fuller-GLS Unit Root Test: Results of Estimation

The DF-GLS unit root test, elaborated by Elliott, Rothenberg and Stock, based on the t-test of the hypothesis $a_0=0$ in the regression equation,

$$\Delta y_t^d = a_0 y_t^d + a_1 \Delta y^d_{t-1} + \text{-------} + a_p \Delta y^d_{t-p} + \text{error term} \qquad (4.6)$$

Where, y_t = GDP of Nepal (t = 1959 -------------2003)

y_t^d is the locally de-trended series y_t.

The local de-trending depends on whether we consider a model with drift only or a linear trend (Maddala, 2002:550).

The latter case is based on the following equation.

$$y_t^d = y_t - \beta_0 - \beta_1 t \qquad (4.7)$$

The DF-GLS Unit root test has been performed on the basis two equations;

(i) DF-GLS unit root test without time trends (a model with drift only)-

$$y_t^{\mu} = \alpha y^{\mu}_{t-1} + \sum_{i=1}^{k} \Psi i \, \Delta y^{\mu}_{t-i} + u_t \tag{4.8}$$

(ii) DF-GLS unit root test with time trends (a model with linear trend)-

$$y_t^{\tau} \; \alpha y^{\mu}_{t-1} + \sum_{i=1}^{k} \Psi i \, \Delta y^{\tau}_{t-i} + u_t \tag{4.9}$$

where y_t^{τ} is the GLS de-trended real output (and other variables). For the DF-GLS test with SIC lag selection, there are no additional unit root rejections.

The findings from the DF –GLS unit root test, which are based on equations (4.8) and (4.9), have been presented in the following tables (Tables 4.3 & 4.4):

Table 4.3: Dickey-Fuller-GLS Unit Root Test on Variables

Exogenous: Constant Null Hypothesis: The variable has a unit root

Variable	ERS DF-GLS test statistic	Lag*** length	Test critical values* 1%	5%	10%
lnY	-1.713881	5	-2.625606	-1.949609	-1.611593
Δln Y	-0.514962	3	-2.624057	-1.949319	-1.611711
Δ^2ln Y	0.017729	4	-2.627238	-1.949856	-1.611469
lnNY	-1.563904	6	-2.627238	-1.949856	-1.611469
ΔlnNY	-4.663495	0	-2.619851	-1.948686	-1.612036
lnM1	0.276458	4	-2.624057	-1.949319	-1.611711
ΔlnM1	-0.598926	3	-2.624057	-1.949319	-1.611711
Δ^2lnM1	-1.198784	4	-2.627238	-1.949856	-1.611469
lnM2	-0.632651	5	-2.625606	-1.949609	-1.611593
ΔlnM2	-0.118500	3	-2.624057	-1.949319	-1.611711
Δ^2lnM2	-0.935555	4	-2.627238	-1.949856	-1.611469

Table 4.4: Dickey-Fuller-GLS Unit Root Test on Variables

Exogenous: Constant, Linear trend Null Hypothesis: The variable has a unit root

Variable	ERS DF-GLS test statistic	Lag length	Test critical values** 1%	5%	10%
lnY	-1.255053	0	-3.770000	-3.190000	-2.890000
Δln Y	-7.065671	0	-3.770000	-3.190000	-2.890000
lnY	-1.532918	0	-3.770000	-3.190000	-2.890000
Δln Y	-6.220423	0	-3.770000	-3.190000	-2.890000
lnM1	-2.080509	0	-3.770000	-3.190000	-2.890000
ΔlnM1	-5.098195	0	-3.770000	-3.190000	-2.890000
lnM2	-2.347205	0	-3.770000	-3.190000	-2.890000
ΔlnM2	-5.168297	0	-3.770000	-3.190000	-2.890000

* Mackinnon (1996) ** Elliott-Rothenberg-Stock (1996, Table 1) *** Automatic based on SIC, MAXLAG=9

The outcome of the DF-GLS unit root test depicts the same conclusion as ADF test when constant and linear trend are taken as exogenous. The results have been summarized as following:

(i) The series are not stationary at level.

(ii) The null hypothesis of a unit root is rejected when the variables are in first differences.

However, the ERS DF-GLS test statistic from the Table 4.3 (i.e. exogenous- constant) doesn't explain the nature of stationarity of the variables properly except the variable – Nominal output (NY). Hence the conclusion that the variables are stationary at first differences has been drawn on the basis of second case (i.e. exogenous- constant and linear trend) in DF-GLS unit root test.

4.2.3: Phillips-Perron Unit Root Test: Results of Estimation

The results of estimations from Phillips-Perron unit root test have been presented in following table (Table 4.5):

Table 4.5: Phillips-Perron Unit Root Test on Variables

Exogenous: Constant Null Hypothesis: The variable has a unit root

Variable	Phillips-Perron test statistic	Prob* value	Band** -width	Test critical values 1%	5%	10%
lnY	2.425708	1.0000	1	-3.588509	-2.929734	-2.603064
Δln Y	-7.691083	0.0000	4	-3.592462	-2.931404	-2.603944
lnNY	1.223705	0.9979	2	-3.588509	-2.929734	-2.603064
Δln NY	-6.383283	0.0000	2	-3.592462	-2.931404	-2.603944
lnM1	-0.888079	0.7828	5	-3.588509	-2.929734	-2.603064
ΔlnM1	-6.503866	0.0000	10	-3.592462	-2.931404	-2.603944
lnM2	-1.227756	0.6541	16	-3.588509	-2.929734	-2.603064
ΔlnM2	-7.655977	0.000	27	-3.592462	-2.931404	-2.603944

Exogenous: Constant, Linear trend

lnY	-2.455896	0.3474	1	-4.180911	-3.515523	-3.188259
Δln Y	-8.816670	0.0000	0	-4.186481	-3.518090	-3.189732
lnNY	-2.602955	0.2810	1	-4.180911	-3.515523	-3.188259
Δln NY	-6.472119	0.0000	1	-4.186481	-3.518090	-3.189732
lnM1	-2.171765	0.4929	0	-4.180911	-3.515523	-3.188259
ΔlnM1	-6.356959	0.0000	9	-4.186481	-3.518090	-3.189732
lnM2	-2.281759	0.4346	4	-4.180911	-3.515523	-3.188259
ΔlnM2	-7.199580	0.0000	25	-4.186481	-3.518090	-3.189732

Exogenous: None

lnY	6.77841	1.0000	4	-2.618579	-1.948495	-1.612135
Δln Y	-4.434442	0.0000	5	-2.619851	-1.948686	-1.612036
lnNY	10.81440	1.0000	2	-2.618579	-1.948495	-1.612135
Δln NY	-2.139663	0.0326	2	-2.619851	-1.948686	-1.612036
lnM1	9.647173	1.000	2	-2.618579	-1.948495	-1.612135
ΔlnM1	-2.567971	0.0114	10	-2.619851	-1.948686	-1.612036
lnM2	10.59127	1.000	3	-2.618579	-1.948495	-1.612135
ΔlnM2	-2.323613	0.0211	42	-2.619851	-1.948686	-1.612036

* MacKinnon (1996) One-sided P-values **Newey-West using Bartlett Kernel

The test statistic, as presented in the table, supports the hypothesis of a unit root on variables when they are in level. The hypothesis is rejected when the variables are in first differences. Hence it can be concluded that the variables are stationary when they are in first differences and non-stationary at level in all the above mentioned cases. However, the null hypothesis is rejected only at 5% level of significance for the first difference of nominal output and money supplies (M1 & M2) in the case of 'None Exogenous'.

4.2.4: KPSS Unit Root Test: Results of Estimation

The results of estimation from the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root test on variables, which are based on equation (3.16), have been presented in the following table (Table 4.6).

Table 4.6: KPSS Unit Root Test on Variables

Exogenous: Constant Null Hypothesis: The variable is stationary

Variable	KPSS test statistic (LM-stat.)	Band width**	Residual variance (no correction)	HAC Corrected Variance (Bartlett kernel)
lnY	0.834315	5	0.208555	
Δln Y	0.659738	4	0.000996	0.001070
lnNY	0.848113	5	2.415740	12.83501
Δln NY	0.380810	3	0.004744	0.005225
lnM1	0.861027	5	3.592854	18.75985
ΔlnM1	0.108757	5	0.005367	0.005401
lnM2	0.860010	5	4.975932	26.12488
ΔlnM2	0.260549	18	0.003623	0.001646
Asymptotic critical Values*		1%	5%	10%
		0.739000	0.463000	0.347000

Exogenous: Constant, Linear Trend

lnY	0.219421	5	0.007622	
Δln Y	0.096673	1	0.000858	0.000624
lnNY	0.191930	5	0.030380	0.139468
Δln NY	0.172666	1	0.004506	0.004429
lnM1	0.130366	5	0.013635	0.053861
ΔlnM1	0.091383	5	0.005292	0.005455
lnM2	0.135267	4	0.006198	
ΔlnM2	0.149561	17	0.003553	
Asymptotic critical Values*		1%	5%	10%
		0.216000	0.146000	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table-1) **Newey-West using Bartlett kernel

The KPSS test statistic of the variables supports the null hypothesis that the variable is stationary when they are in first differences. However, the KPSS test statistic shows that the null hypothesis is accepted even in level form of nominal output and both money supplies in later case (i.e. constant and linear trend as exogenous), the conclusion has been drawn on the basis of former case (i.e. constant as exogenous).

4.2.5: ERS Point-Optimal Unit Root Test: Results of Estimation

The findings from this unit root test are presented in following table (Table 4.7)

Table 4.7: ERS Point-Optimal Unit Roots Test on Variables

Exogenous: Constant Null Hypothesis: The variable has a unit root

Variable	Elliott-Rothenberg-Stock test statistic (P-statistic)	Lag length**	HAC Corrected Variance (Spectral OLS auto regression)
lnY	568.1185	0	0.000906
ΔIn Y	5.187157	0	0.000860
lnNY	1406.628	0	0.004590
ΔlnNY	2.275993	0	0.004594
lnM1	2232.308	0	0.005265
ΔlnM1	4.534211	0	0.004799
lnM2	4449.400	0	0.003542
ΔlnM2	5.142870	0	0.003187
Test critical values*	1%	5%	10%
	1.8700	2.9700	3.9100

Exogenous: Constant, Linear Trend

lnY	275.0271	2	0.000189
ΔIn Y	6.745437	0	0.000730
In NY	51.42926	0	0.003868
ΔIn NY	4.985337	0	0.004456
lnM1	13.50041	0	0.004746
ΔlnM1	6.677749	0	0.004796
lnM2	9.879003	0	0.003185
ΔlnM2	7.051560	0	0.003181
Test critical values*	1%	5%	10%
	4.220000	5.72000	6.770000

*Elliott-Rothenberg-Stock (1996, Table 1) ** Spectral OLS AR based on SIC, MAXLAG = 9

According to the ERS Point-Optimal test statistic in Constant & Linear Trend as exogenous, the variables (Real output, nominal output and narrow money supply) are stationary at first differences except for broad money supply. But such conclusion cannot be drawn in former case (i.e. constant as exogenous) except for nominal output.

4.2.6: Ng-Perron Modified Unit Root Test: Results of Estimation

The results of estimation from this unit root test are presented in the following table:

Table 4.8: Ng-Perron Modified Unit Root Test on Variables

Exogenous: Constant Null Hypothesis: The variable has a unit root

Variable	Lag length*	Ng-Perron test statistics MZa	MZt	MSB	MPT	HAC corrected variance
lnY	5	0.77750	0.44104	0.56726	26.0363	0.015535
Δln Y	3	-0.00071	-0.00048	0.68200	29.6276	8.87E-05
lnNY	6	-0.39142	-0.17986	0.45950	16.0590	0.298344
Δln NY	0	-16.8813	-2.90466	0.17206	1.45363	0.005365
lnM1	4	-0.14009	-0.06817	0.48664	17.9945	0.445607
ΔlnM1	3	-2.58165	-0.98042	0.37976	8.81358	0.001486
lnM2	5	-20.7767	-3.08369	0.14842	1.65869	6.546833
ΔlnM2	3	-3.12491	-1.08258	0.34644	7.59050	0.001266
Asymptotic	1%	-13.8	-2.58	0.174	1.78	
Critical	5%	-8.1	-1.98	0.23	3.17	
Values**	10%	-5.7	-1.62	0.275	4.45	

Exogenous: Constant, Linear Trend

lnY	0	-1.69614	-0.79354	0.46785	43.5421	0.000961
Δln Y	0	-16.2092	-2.84677	0.17563	5.62235	0.000766
lnNY	0	-2.55220	-1.12530	0.44091	35.5393	0.004520
ΔlnNY	0	-20.5155	-3.17037	0.15454	4.63762	0.004615
lnM1	0	-7.16344	-1.85119	0.25842	12.7838	0.004876
ΔlnM1	0	-16.8945	-2.90471	0.17193	5.40404	0.005071
lnM2	0	-9.89734	-2.04593	0.20672	9.97327	0.003217
ΔlnM2	0	-16.1313	-2.83714	0.17588	5.66618	0.003326
Asymptotic	1%	-23.8	-3.42	0.143	4.03	
Critical	5%	-17.3	-2.91	0.168	5.48	
Values**	10%	-14.2	-2.62	0.185	6.67	

** Ng-Perron (2001, Table 1) * Spectral GLS-detrended AR based on SIC, MAXLAG = 9

Ng-Perron modified unit root test statistics as given in the Table (4.8) present the same conclusion that the variables are stationary at first differences. But the conclusion can be drawn only on the basis of later case; the former case cannot explain the nature of stationarity properly.

4.2.7 The Overview of the Results

Hence, transforming all the variables in natural logarithmic form, first differences of the transformed series are free from non-stationarity (i.e. unit roots).If the variable is stationary at level, the variable is said to be integrated of order zero, I (0). If the variable is differenced once and differenced series is stationary, it is said that the original series is integrated of order 1, denoted by I (1). Similarly, if the original series has to be differenced twice before it becomes stationary, the original series is integrated of order 2, or I (2). From all the above mentioned unit root tests, it can be concluded that all the variables are I (1), i.e. the variables are stationary at first differences.

4.3: Graphical Representation of the series

The following figures (Figure 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7 and 4.8) present the nature of stationarity of the variables (Real output, nominal output, narrow money supply and broad money supply) with the help of line graphs of the series. The Figures (4.1, 4.3, 4.5 and 4.7) show the line graph of the variables at level which are non-stationary; the Figures (4.2, 4.4, 4.6 and 4.8) show the line graph of the variables at first difference which are stationary. The nature of stationarity (or non-stationarity) can be compared with the help of line graphs and difference between such series can easily be seen. The line graph of non-stationary series (Real output, nominal output, narrow money supply and broad money supply) starts from the left corner of the box and moves upward almost out with fluctuations towards right corner of the box while the line graph of stationary series generally begins from middle part of left vertical axis of the box and moves rightward with fluctuations towards the middle part of right vertical axis of the box.

Figure 4.1: Line Graph of Real Output at Level

(Non-stationary Series)

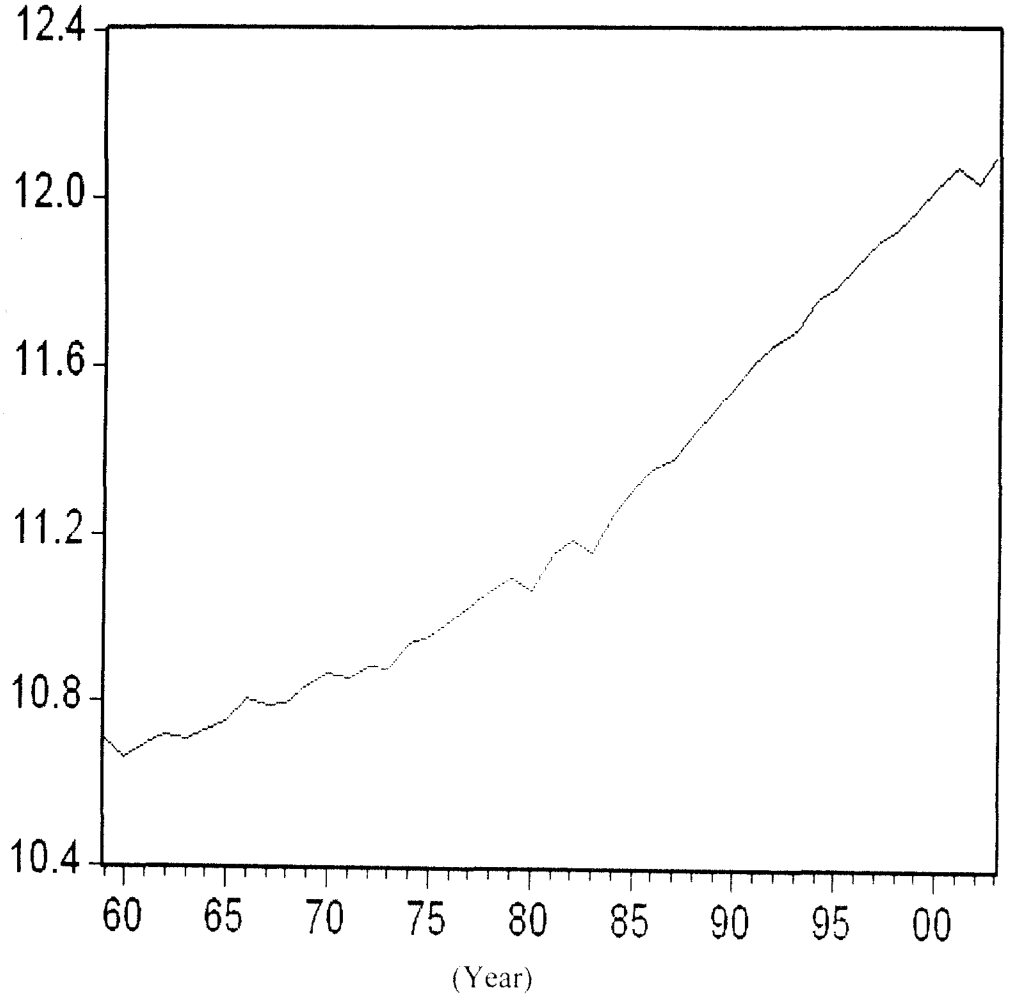


Figure 4.2: Line Graph of Real Output at First Difference

(Stationary Series)

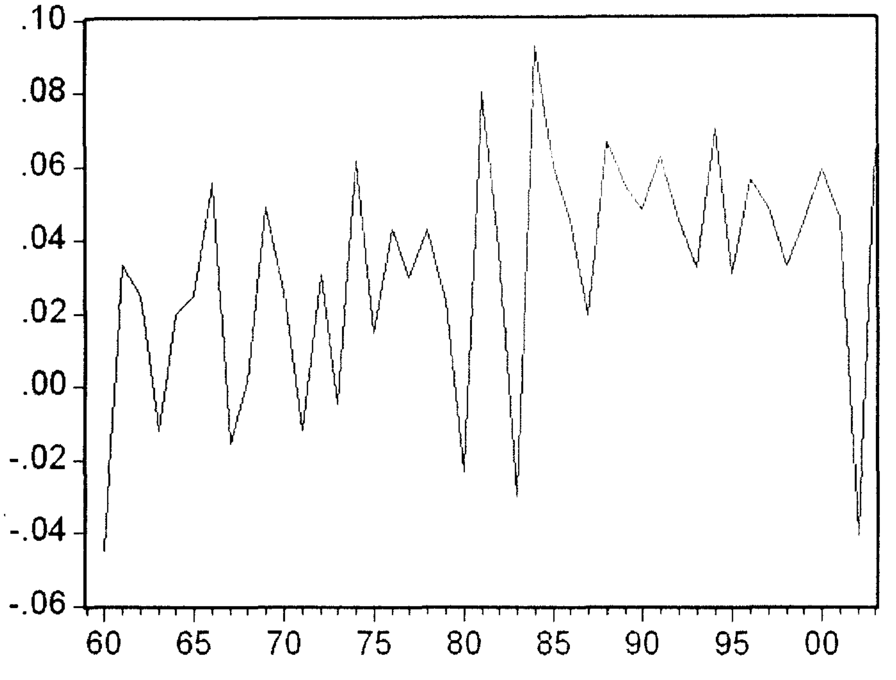


Figure 4.3: Line Graph of Nominal Output at Level

(Non-stationary Series)

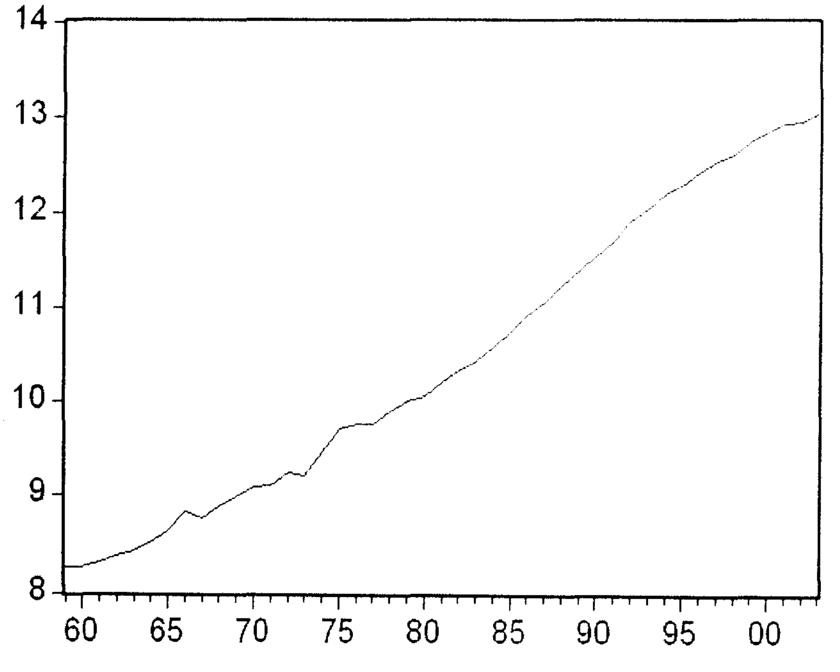


Figure 4.4: Line Graph of Nominal Output at First Difference (Stationary Series)

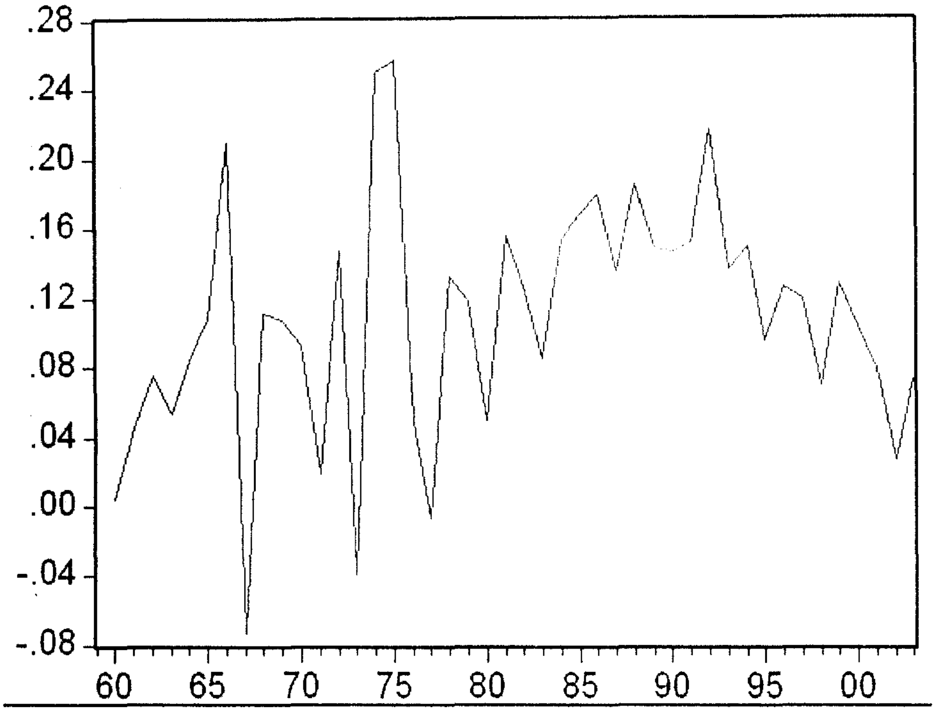


Figure 4.5: Line Graph of Narrow Money Supply at Level (Non-stationary Series)

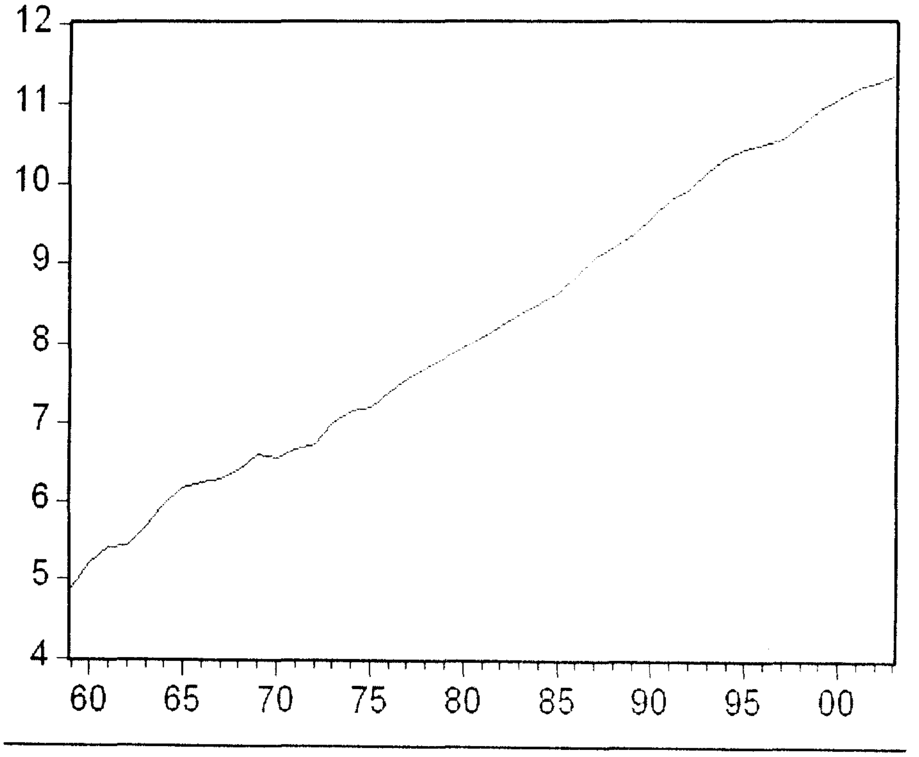


Figure 4.6: Line Graph of Narrow Money Supply at First Difference (Stationary Series)

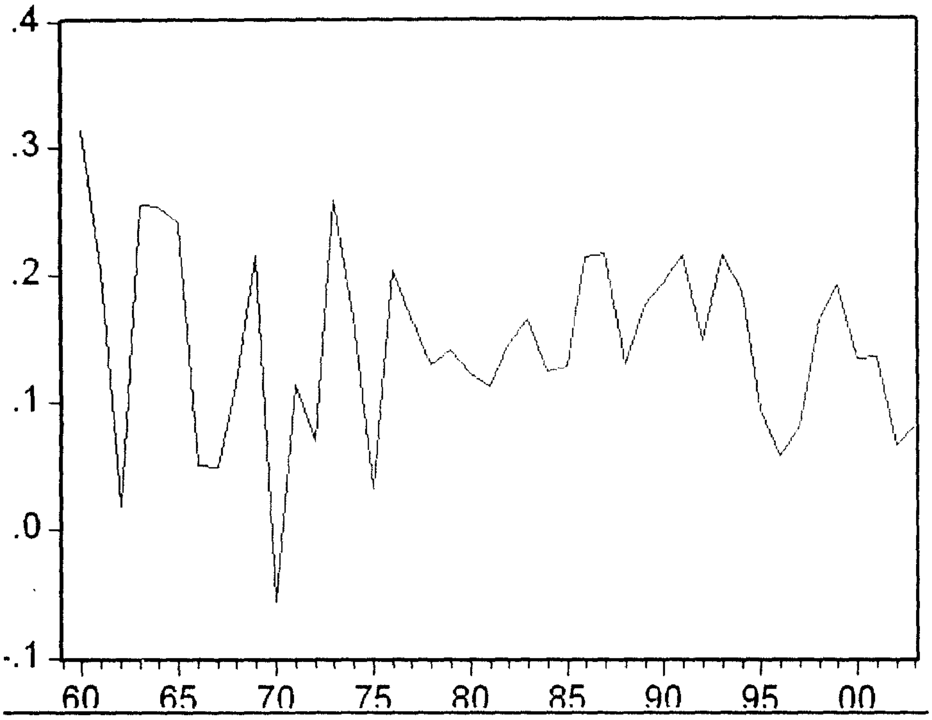


Figure 4.7: Line Graph of Broad Money Supply at Level (Non-Stationary Series)

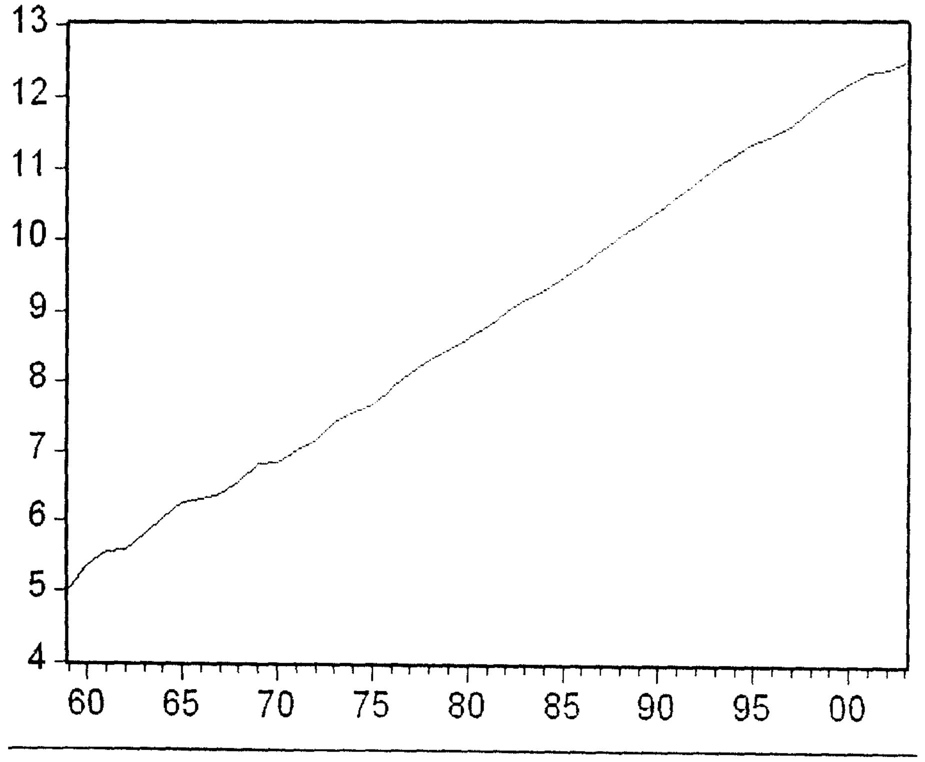
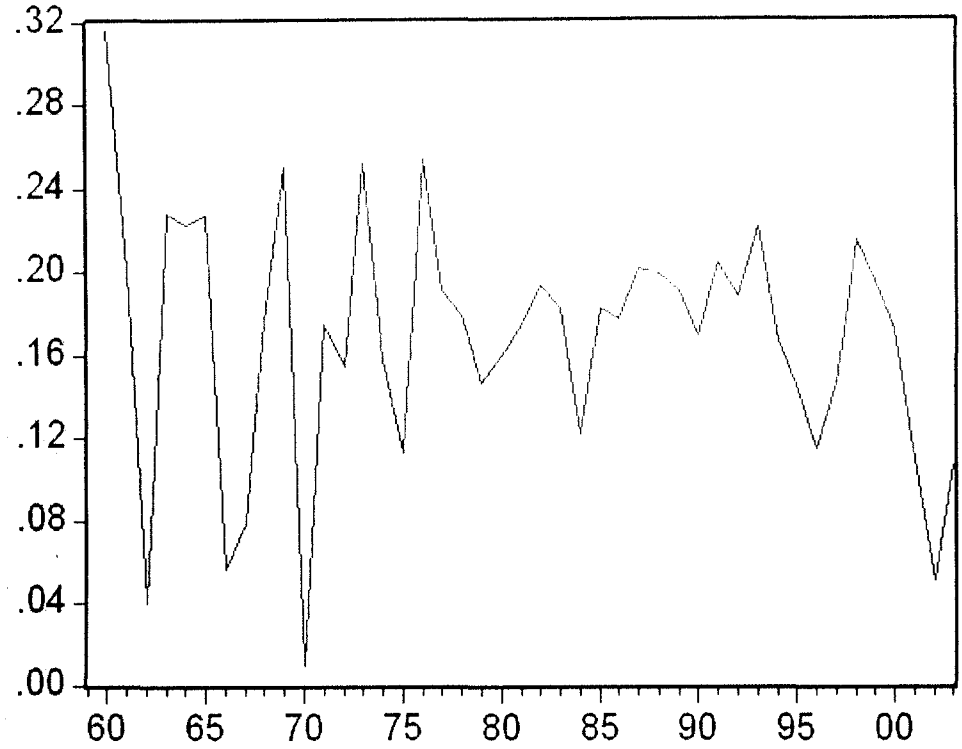


Figure 4.8: Line Graph of Broad Money Supply at First Difference

(Stationary Series)



4.4 Correlogram: Graphs of ACF & PACF

Correlogram is a graphical representation of Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) at different lags. Plotting the values of ACF and PACF in a graph, it gives the informal idea whether the series is stationary or not. The visual graphs of ACF and PACF should lie between the lines of confidence interval for almost all the lags for stationarity; otherwise the series can be taken as non-stationary series. The 95% confidence interval for sample autocorrelation coefficients (ρ_k) = $\pm$ 1.96 (1/$\sqrt{45}$) = $\pm$0.2922. Hence, the autocorrelation coefficient should lie between -0.2922 to +0.2922 for the data when they are in level for stationarity. For the first difference of the series the confidence interval is (ρ_k) = $\pm$ 1.96 (1/$\sqrt{44}$) =0.2955 on either side of zero. The coefficient of ACF should lie between -0.2955 to +0.2955. If an estimated ρ_k falls inside the interval, the hypothesis that the true ρ_k is zero is not rejected. But if it lies outside this confidence interval, then the hypothesis that the true ρ_k is zero can be rejected. The 95% confidence interval has been shown as two dashed lines in the correlogram of different series on the following figures (Figure 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15 and 4.16). From these correlogram, it can be held that -

(i) All the series at level suffer from non-stationarity.

(ii) All the first differenced series are stationary.

For example, the Figure 4.9 shows the sample correlogram of the real output, which is obtained from E-VIEWS 4.1 software package. The correlogram up to 20 lags has been shown. One striking feature of this sample correlogram is that it starts at a very high value (0.942 at lag 1) and tapers off very gradually. Even at lag 7 the autocorrelation coefficient is still a sizable 0.548. From this figure, two facts stand out: First, the ACF declines very slowly; ACF up to 10 lags are individually statistically significantly different from zero, for they all are outside the 95% confidence bounds. Second, after the first lag, the PACF drops dramatically, and all PACFs after lag 1 are statistically insignificant. This type of pattern is generally an indication that the time series is non-stationary. Again for all the first differenced series, ACF and PACF are free from any significant spike at any lag. Again the spikes cross the base at the second or third lag.

Figure 4.9: Correlogram of Real Output at Level (Non-Stationary)

Included observations: 45 **Correlogram of YT** Sample: 1959 2003

	AC	PAC	Q-Stat	Prob
1	0.942	0.942	42.610	0.000
2	0.882	-0.038	80.882	0.000
3	0.816	-0.088	114.44	0.000
4	0.750	-0.041	143.45	0.000
5	0.682	-0.045	168.07	0.000
6	0.615	-0.037	188.59	0.000
7	0.548	-0.040	205.31	0.000
8	0.483	-0.024	218.65	0.000
9	0.418	-0.049	228.90	0.000
10	0.351	-0.061	236.33	0.000
11	0.288	-0.009	241.50	0.000
12	0.227	-0.038	244.81	0.000
13	0.164	-0.066	246.59	0.000
14	0.105	-0.022	247.34	0.000
15	0.048	-0.037	247.50	0.000
16	-0.005	-0.020	247.50	0.000
17	-0.055	-0.024	247.73	0.000
18	-0.102	-0.038	248.55	0.000
19	-0.146	-0.025	250.28	0.000
20	-0.185	-0.018	253.18	0.000

Figure 4.10: Correlogram of Real Output at First Difference (Stationary)

Included observations: 44 **Correlogram of D(YT)** Sample: 1959 2003

	AC	PAC	Q-Stat	Prob
1	-0.138	-0.138	0.8980	0.343
2	-0.038	-0.058	0.9661	0.617
3	0.318	0.311	5.9492	0.114
4	0.216	0.339	8.3060	0.081
5	0.055	0.215	8.4646	0.132
6	-0.035	-0.093	8.5317	0.202
7	0.244	0.034	11.775	0.108
8	0.100	0.011	12.337	0.137
9	0.011	0.047	12.344	0.195
10	0.163	0.135	13.927	0.176
11	-0.094	-0.202	14.471	0.208
12	0.196	0.044	16.910	0.153
13	0.018	-0.039	16.930	0.203
14	-0.267	-0.352	21.752	0.084
15	0.196	0.007	24.420	0.058
16	0.021	0.012	24.452	0.080
17	-0.178	-0.103	26.832	0.061
18	-0.178	-0.188	29.297	0.045
19	0.149	0.008	31.106	0.039
20	0.066	0.172	31.470	0.049

Figure 4.11: Correlogram of Nominal Output at Level (Non-Stationary)

Correlogram of LNNY

Included observations: 45 Sample: 1959 2003

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.944	0.944	42.834	0.000
		2	0.885	-0.056	81.355	0.000
		3	0.823	-0.060	115.44	0.000
		4	0.759	-0.048	145.15	0.000
		5	0.693	-0.050	170.57	0.000
		6	0.628	-0.034	191.97	0.000
		7	0.562	-0.050	209.54	0.000
		8	0.498	-0.017	223.72	0.000
		9	0.432	-0.068	234.67	0.000
		10	0.365	-0.046	242.73	0.000
		11	0.300	-0.035	248.34	0.000
		12	0.237	-0.039	251.92	0.000
		13	0.175	-0.035	253.94	0.000
		14	0.115	-0.029	254.85	0.000
		15	0.056	-0.061	255.06	0.000
		16	0.001	-0.008	255.06	0.000
		17	-0.047	0.004	255.23	0.000
		18	-0.093	-0.045	255.91	0.000
		19	-0.139	-0.047	257.47	0.000
		20	-0.180	-0.021	260.22	0.000

Figure 4.12: Correlogram of Nominal Output at First Difference (Stationary)

Correlogram of D(LNNY)

Included observations: 44 Sample: 1959 2003

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.028	0.028	0.0374	0.847
		2	-0.015	-0.016	0.0483	0.976
		3	0.148	0.149	1.1323	0.769
		4	0.241	0.237	4.0649	0.397
		5	-0.101	-0.111	4.5956	0.467
		6	0.260	0.273	8.2064	0.223
		7	0.053	-0.043	8.3607	0.302
		8	-0.118	-0.151	9.1407	0.331
		9	0.109	0.135	9.8337	0.364
		10	0.130	-0.046	10.838	0.370
		11	-0.098	-0.021	11.429	0.408
		12	-0.074	-0.097	11.776	0.464
		13	0.051	-0.059	11.948	0.532
		14	-0.182	-0.132	14.187	0.436
		15	-0.152	-0.168	15.790	0.396
		16	0.029	0.025	15.850	0.464
		17	-0.023	0.037	15.888	0.532
		18	-0.013	0.173	15.902	0.599
		19	-0.083	-0.092	16.463	0.626
		20	-0.001	0.065	16.463	0.687

Figure 4.13: Correlogram of Narrow Money Supply at Level (Non- Stationary)

Correlogram of M1T

Included observations: 45 Sample: 1959 2003

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.932	0.932	41.758	0.000
		2	0.866	-0.017	78.685	0.000
		3	0.801	-0.033	111.01	0.000
		4	0.733	-0.055	138.75	0.000
		5	0.668	-0.023	162.34	0.000
		6	0.606	-0.011	182.26	0.000
		7	0.548	-0.009	198.97	0.000
		8	0.488	-0.051	212.58	0.000
		9	0.425	-0.064	223.20	0.000
		10	0.362	-0.050	231.11	0.000
		11	0.302	-0.016	236.78	0.000
		12	0.241	-0.053	240.50	0.000
		13	0.181	-0.042	242.67	0.000
		14	0.122	-0.046	243.69	0.000
		15	0.068	-0.014	244.01	0.000
		16	0.017	-0.024	244.03	0.000
		17	-0.034	-0.053	244.12	0.000
		18	-0.081	-0.019	244.63	0.000
		19	-0.123	-0.020	245.86	0.000
		20	-0.163	-0.032	248.11	0.000

Figure 4.14: Correlogram of Narrow Money Supply at First Difference (Stationary)

Correlogram of D(M1T)

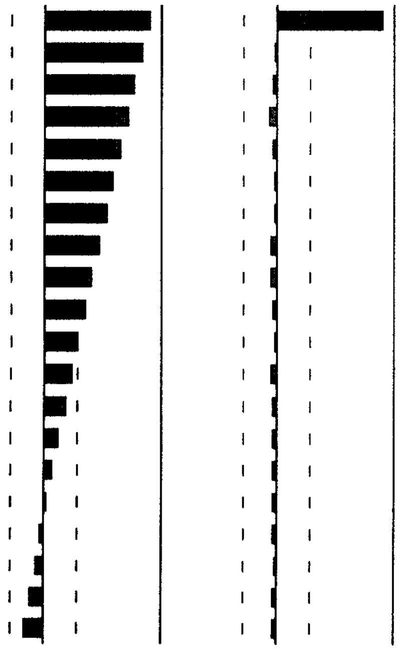
Included observations: 44 Sample: 1959 2003

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.066	0.066	0.2066	0.649
		2	-0.191	-0.196	1.9683	0.374
		3	-0.061	-0.034	2.1512	0.542
		4	0.244	0.223	5.1623	0.271
		5	0.147	0.104	6.2901	0.279
		6	-0.219	-0.177	8.8347	0.183
		7	-0.253	-0.191	12.349	0.090
		8	0.124	0.071	13.214	0.105
		9	-0.001	-0.153	13.214	0.153
		10	-0.135	-0.070	14.300	0.160
		11	-0.171	-0.041	16.104	0.137
		12	-0.107	-0.172	16.825	0.156
		13	0.211	0.151	19.720	0.102
		14	0.003	-0.013	19.721	0.139
		15	-0.128	-0.044	20.863	0.141
		16	-0.070	-0.066	21.218	0.170
		17	-0.012	-0.145	21.229	0.216
		18	0.031	-0.113	21.306	0.264
		19	-0.112	-0.147	22.322	0.269
		20	-0.098	-0.015	23.135	0.282

Figure 4.15: Correlogram of Broad Money Supply at Level (Non-Stationary)

Correlogram of M2T

Included observations: 45 Sample: 1959 2003

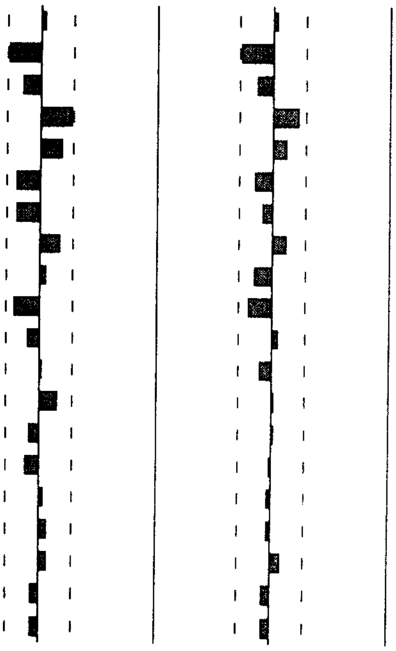


Autocorrelation / Partial Correlation	AC	PAC	Q-Stat	Prob
1	0.935	0.935	42.050	0.000
2	0.872	-0.020	79.477	0.000
3	0.808	-0.041	112.39	0.000
4	0.742	-0.058	140.77	0.000
5	0.676	-0.028	164.95	0.000
6	0.613	-0.024	185.31	0.000
7	0.552	-0.017	202.26	0.000
8	0.490	-0.050	215.96	0.000
9	0.426	-0.056	226.61	0.000
10	0.363	-0.040	234.56	0.000
11	0.302	-0.023	240.24	0.000
12	0.241	-0.050	243.97	0.000
13	0.182	-0.036	246.16	0.000
14	0.124	-0.038	247.21	0.000
15	0.070	-0.025	247.55	0.000
16	0.018	-0.034	247.57	0.000
17	-0.033	-0.040	247.66	0.000
18	-0.080	-0.022	248.16	0.000
19	-0.124	-0.030	249.42	0.000
20	-0.165	-0.029	251.73	0.000

Figure 4.16: Correlogram of Broad Money Supply at First Difference (Stationary)

Correlogram of D(M2T)

Included observations: 44 Sample: 1959 2003



Autocorrelation / Partial Correlation	AC	PAC	Q-Stat	Prob
1	0.027	0.027	0.0346	0.852
2	-0.275	-0.276	3.6808	0.159
3	-0.152	-0.147	4.8271	0.185
4	0.275	0.225	8.6567	0.070
5	0.196	0.129	10.658	0.059
6	-0.219	-0.150	13.203	0.040
7	-0.216	-0.091	15.762	0.027
8	0.175	0.118	17.477	0.026
9	0.048	-0.157	17.608	0.040
10	-0.225	-0.207	20.611	0.024
11	-0.106	0.056	21.306	0.030
12	0.022	-0.111	21.338	0.046
13	0.156	0.011	22.929	0.043
14	-0.087	0.018	23.445	0.053
15	-0.125	-0.015	24.532	0.057
16	0.040	-0.040	24.647	0.076
17	0.071	-0.036	25.028	0.094
18	0.058	0.088	25.291	0.117
19	-0.077	-0.081	25.777	0.137
20	-0.070	-0.081	26.186	0.160

4.5 Summary

The present chapter is devoted to the analysis of the nature of macroeconomic variables which are used in the present work. Testing for stationarity of the variables has been presented for identifying the nature of variables. For this purpose unit root tests, Correlogram of the variables and nature of line graphs have been presented. Testing for unit root has been applied on the basis of Augmented Dickey-Fuller unit root test, Phillips-Perron unit root test, DF-GLS unit root test, KPSS unit root test, ERS Point optimal unit root test and Ng-Perron modified unit root test. It has been found from these tests that all the variables i.e. real output, nominal output, narrow money supply (M1) and broad money supply (M2) are non-stationary at level whereas they are stationary at first differences.

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NOTE (CHAPTER- IV)

In order to test the joint hypothesis that all the autocorrelation coefficients (ρ_k) are simultaneously equal to zero, the 'Q statistic' developed by Box and Pierce can be used, which has been defined as,

$$Q = n \sum_{k=1}^{m} \rho_k^2 \qquad \text{where, } n = \text{sample size} \qquad m = \text{lag length}$$

The Q statistic is approximately distributed as a chi-square variate with m df. If the computed Q exceeds the critical Q value from the chi-square table at the chosen level of significance, the null hypothesis that all ρ_k are zero can be rejected; at least some of them must be nonzero. The probability value of the corresponding Q statistic from the Figures (4.9, 4.11, 4.13 & 4.15) rejected the null hypothesis that all ρ_k are zero while second part of the Figures supported the hypothesis that all ρ_k are zero. Although the probability values at lag 18, 19 & 20 of the Figures (4.10, 4.12, 4.14 & 4.16) show that the Q-stat. exceeds the critical Q value at 5% level of significance, the Q-stat. of other lags present the idea that the acceptance of the null hypothesis that all ρ_k are zero.

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CHAPTER - V

Cointegration, Vector Error Correction and Causal Relationships

5.1 Introduction

In econometric analysis, it is necessary to integrate short-run dynamics of the time series data with long-run equilibrium. The analysis of short-run dynamics is often done by first eliminating trends in the variables, usually by differencing. The concept of co-integration was developed by Granger in 1981 and elaborated by Engle and Granger in 1987. They addressed the issue of integrating short run dynamics with long run equilibrium. If separate economic series are stationary only after differencing but a linear combination of their levels is stationary, it can be said that the variables are co-integrated. When variables are cointegrated, it is possible to test for the existence of a long run relationship among a group of economic variables. It means that the variables track each other over time and even though there may be deviations from the long run path, they only last for a finite time. When the variables are co-integrated the long run relationship is best represented by an error correction model. The idea is simply that a proportion of the disequilibrium from one period is corrected in the next period.

The seminal papers of Phillips (1957) and Sargan (1964) have opened new ground in economic modeling and the foundation for what are now called error correction models. The pioneering efforts of Phillips and Sargan have been followed by a number of studies, notably the paper by Davidson, Hendry, Srba and Yoo

(1978).Engle and Granger (1987) introduced co-integration based error correction modeling. If there exists a co-integrating relationship between some variable Yt and a vector of related explanatory variables Xt, then by the Granger Representation Theorem (Granger and Weiss, 1983), there exists a valid error correction model for that variable Yt.

The cointegrating relationship between the variables can be achieved from CRDW, Engle-Granger or from Johansen's method.

5.2 Engle-Granger method of Cointegration: Relation between Output and Money Supply

The Engle-Granger method, which is also called residual test of the cointegration, has been explained as follows:

Suppose two series of the variables Y_t and X_t which are integrated of order 1 or I (1) and the relationship between Y_t and X_t is,

$$Y_t = \alpha + \beta X_t + \mu_t \qquad \text{or,} \qquad \mu_t = Y_t - \alpha - \beta X_t \qquad (5.1)$$

If the residual term (μt) is stationary at level or I (0), then it can be said that the variables Yt and Xt are co-integrated, so to speak, they are on the same wavelength.

5.2.1 The Model

The estimable cointegration models (5.2, 5.3, 5.4 and 5.5) for the present study of the long run relationship between GDP (Real & Nominal) and Money Supply (M1 & M2) are given below:

$$\ln Y_t = \alpha_1 + \beta_1 \ln M1_t + \mu_{1t} \quad \text{or,} \quad \mu_{1t} = \ln Y_t - \alpha_1 - \beta_1 \ln M1_t \qquad (5.2)$$

$$\ln Y_t = \alpha_2 + \beta_2 \ln M2_t + \mu_{2t} \quad \text{or,} \quad \mu_{2t} = \ln Y_t - \alpha_2 - \beta_2 \ln M2_t \qquad (5.3)$$

$$\ln NY_t = \alpha_3 + \beta_3 \ln M1_t + \mu_{3t} \quad \text{or,} \quad \mu_{3t} = \ln Y_t - \alpha_3 - \beta_3 \ln M1_t \qquad (5.4)$$

$$\ln NY_t = \alpha_4 + \beta_4 \ln M2_t + \mu_{4t} \quad \text{or,} \quad \mu_{4t} = \ln Y_t - \alpha_4 - \beta_4 \ln M2_t \qquad (5.5)$$

Where, Y_t= Real output, NY_t = Nominal output, $M1_t$ = Narrow money supply,

$M2_t$ = Broad money supply: μ_{1t}, μ_{2t}, μ_{3t} & μ_{4t} = Residual terms

5.2.2 Estimation of the Models

Equations (5.2, 5.3, 5.4 and 5.5) have been estimated. The corresponding estimated equations are given by equations (5.6, 5.7, 5.8 and 5.9) below.

$$\ln Y_t = 9.302611 - 0.237618 \ln M1_t \qquad (5.6)$$

S.E. =(0.051067) (0.006053) R^2=0.972858 Adj. R^2= 0.972227

t-stat. = [182.1659] [39.25885] Durbin-Watson stat.= 0.245629

$$\ln Y_t = 9.474255 - 0.201495 \ln M2_t \qquad (5.7)$$

S.E. = (0.050394) (0.005525) R^2= 0.968678 Adj. R^2= 0.967950

t-stat. = [188.0023] [36.46702] Durbin-Watson stat.= 0.181409

$$\ln NY_t = 3.736079 - 0.816837 \ln M1_t \qquad (5.8)$$

S.E. = (0.092335) (0.010945) R^2= 0.992339 Adj. R^2= 0.992161

t-stat. = [40.46208] [74.63235] Durbin-Watson stat.= 0.508229

$$\ln NY_t = 4.316805 - 0.693649 \ln M2_t \quad (5.9)$$

S.E. = (0.091593) (0.010043) R^2= 0.991067 Adj. R^2= 0.990860

t-stat. = [47.13044] [69.07126] Durbin-Watson stat.= 0.326543

From the estimated equations (5.6, 5.7, 5.8 &5.9) the residual series have been estimated. Testing Stationarity of the residual series has been tested for assessing the cointegration between the variables concerned.

5.2.3 Tests of Stationarity of Residuals

Stationarity of the residuals (μ_{1t} ------ μ_{4t}) have been tested through ADF and Phillips-Perron methods. The results of the tests are being presented through the Tables 5.1 and 5.2.

Table 5.1: Augmented Dickey Fuller Unit Root Test on Residuals

(Null Hypothesis: The residual has a unit root)

Exogenous: Constant Lag length :-(Automatic based on SIC, MAXLAG=9)

Variable	ADF test statistic	Prob* value	Lag length	Test critical values 1%	5%	10%
μ_{1t}	-1.576357	0.4856	2	-3.596616	-2.933158	-2.604867
μ_{2t}	-1.330444	0.6068	1	-3.592462	-2.931404	-2.603944
μ_{3t}	-4.776468	0.0003	0	-3.588509	-2.929734	-2.603064
μ_{4t}	-3.447093	0.0144	0	-3.588509	-2.929734	-2.603064
Exogenous: None						
μ_{1t}	-3.285493	0.0016	0	-2.618579	-1.948495	-1.612135
μ_{2t}	-2.533729	0.0125	0	-2.618579	-1.948495	-1.612135

- MacKinnon (1996) One-sided P-values

The ADF unit root test on residuals shows that the null hypothesis (Ho: The residual has a unit root) has been accepted for the residuals (μ_{1t} & μ_{2t}) of the regression equation of real output and both money supplies (M1 & M2) when exogenous as constant. But the result is quite different in the case of 'None Exogenous'. Here both residuals are stationary at 1% and 5% level respectively. Consequently, on the basis of the second case it can be concluded that there is cointegration between real output and money supplies even though first case does not support this statement.

The null hypothesis has been rejected for the residuals (μ_{3t} & μ_{4t}) of the regression of nominal output and money supplies (M1 & M2). This indicates that there is cointegrating relationship between nominal output and both money supplies.

The Phillips-Perron unit root test on residuals has been presented in Table 5.2.

Table 5.2: Phillips-Perron Unit Root Test on Residuals

(Null Hypothesis: The residual has a unit root)

Exogenous: Constant Lag length :-(Automatic based on SIC, MAXLAG=9)

Variable	P-P test statistic	Prob* value	Band** Width	Test critical values 1%	5%	10%
μ_{1t}	-3.293422	0.0212	3	-3.588509	-2.929734	-2.603064
μ_{2t}	-2.547112	0.1117	4	-3.588509	-2.929734	-2.603064
Exogenous: None						
μ_{1t}	-3.273232	0.0016	4	-2.618579	-1.948495	-1.612135
μ_{2t}	-2.554266	0.0118	4	-2.618579	-1.948495	-1.612135

* MacKinnon (1996) One-sided P-values **Newey-West using Bartlett kernel

The PP unit root test on residuals depicts that the test statistic is insignificant at 5% level of significance for 'μ_{1t}' but it is significant for 'μ_{2t}' even at 10% level of significance in the first case (i.e. exogenous-constant). This mean there is cointegration between real output and narrow money supply and no cointegration between real output and broad money supply on the basis of first case. The second case (exogenous-none) presents slightly different result from the first case. Both residuals are stationary at 1% and 5% level respectively. Hence it can be concluded that there is cointegration between real output and both money supplies on the basis of second case.

5.3 Durbin-Watson method of Cointegrating Regression (CRDW)

An alternative and quicker method of finding out whether the variables are cointegrated is the CRDW test, whose critical values were first provided by Sargan and Bhargava (Gujarati, 1995:727). In CRDW, the Durbin-Watson statistic (d value) obtained from the cointegrating regression is used. Here the null hypothesis is that d=0 rather than the standard d=2. The findings of CRDW test which are based on along with critical values have been presented in Table 5.3.

Table 5.3: Durbin-Watson test for Cointegrating Regression (CRDW)

Null hypothesis	D-W statistic	Critical values 1%	5%	10%
No cointegration between lnY&lnM1	0.245629	0.511	0.386	0.322
No cointegration between lnY&lnM2	0.181409	0.511	0.386	0.322
No cointegration between lnNY&lnM1	0.508229	0.511	0.386	0.322
No cointegration between lnNY&lnM2	0.326543	0.511	0.386	0.322

From the table it is observed that the null hypothesis of no cointegration between real output and both money supplies have been accepted. But this hypothesis has been rejected between nominal output and narrow money supply at 5% level of significance and nominal output and broad money supply at 10% level of significance.

5.4: Johansen's method of Cointegration

The Johansen method of cointegration is quite different from Engle-Granger and CRDW method. This test is based on trace statistic and max-eigen statistic (λ_{-max}). The results, which have been obtained from E-views 4.1 software package, have been presented in Table 5.4.

Table 5.4: Johansen Cointegration Test

Unrestricted Cointegration Rank Test — Lags interval (in first differences): 1 to2

Series: lnY lnM1 — Trend assumption: Linear deterministic trend

Null Hypothesis.	Alternative Hypo. λ_{max}-tests	Alternative Hypo. Trace tests	Eigen value	Trace statistic	5% critical value	1% critical value	Max-eigen statistic	5% critical value	1% critical value
r=0**	r =1	r≥1	0.4266	23.553	15.41	20.04	23.360	14.07	18.63
r≤1	r =2	r≥2	0.0046	0.1926	3.76	6.65	0.1926	3.76	6.65
Series: lnY lnM2									
r=0**	r =1	r≥1	0.3588	21.894	15.41	20.04	18.666	14.07	18.63
r≤1	r =2	r≥2	0.0739	3.2278	3.76	6.65	3.2278	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5 %(1%) level. Trace & Max-eigen value tests indicate 1 cointegrating equation at both 5% and 1% levels.

Hence, according to Johansen's method cointegrating relationship can be achieved in both series (real output and both money supplies) when they are in level like the Engle-Granger method in 'None Exogenous' case. The null hypothesis of no cointegration (i.e. r =0) has been rejected on the basis of trace statistic and max-eigen statistic because in this case both statistic levels are greater than critical values of these statistic.

5.5 Vector Error Correction Modeling

Error-correction modeling involves regression of the first difference of each variable in the cointegrating equation onto lagged values of the first differences of all the variables plus the lagged value of the error correction term. Suppose that two I (1) variables y_t and z_t are cointegrated and that the cointegrating vector is [1, -θ]. Then all three variables $\Delta y_t = y_t - y_{t-1}$, Δz_t, and $(y_t - \theta z_t)$ are I (0). The error correction model is,

$$\Delta y_t = \beta' x_t + \gamma (\Delta z_t) + \lambda (y_t - \theta z_t) + \varepsilon_t \tag{5.10}$$

The model describes the variation in y_t around its long-run trend in terms of a set of I(0) exogenous factors x_t, the variation of z_t around its long-run trend, and the error correction ($yt- \theta z_t$), which is the equilibrium error in the model of cointegration. There is a tight connection between models of cointegration and models of error correction. The model in this form is reasonable as it stands, but in fact, it is only internally consistent if the two variables are cointegrated. If not, then the third term, and hence the right-hand side, cannot be I (0), even though the left-hand side must be.

5.5.1 VEC and the Estimable Models

In the present study the estimable Vector Error Correction models are as following:

$$\Delta \ln Y_t = \gamma_1 + \rho_1 z_{t-1} + \alpha_1 \Delta \ln Y_{t-1} + \alpha_2 \Delta \ln Y_{t-2} + \alpha_3 \Delta M_{t-1} + \alpha_4 \Delta M_{t-2} + \varepsilon_{1t} \quad (5.11)$$

$$\Delta M_t = \gamma_2 + \rho_2 z_{t-1} + \beta_1 \Delta \ln Y_{t-1} + \beta_2 \Delta \ln Y_{t-2} + \beta_3 \Delta M_{t-1} + \beta_4 \Delta M_{t-2} + \varepsilon_{2t} \quad (5.12)$$

Where, $\Delta \ln Y_t$:- first difference of output level (real & nominal).

ΔM_t :- first difference of money supply (narrow & broad).

z_{t-1} :- first lag of error term of cointegrating equation.

ε_{1t} and ε_{2t} are white noise errors.

α_1 --------- α_4 are the coefficients of lagged ($\Delta \ln Y_t$, ΔM_t) in equation (5.11) and β_1 ------- β_4 are the coefficients lagged ($\Delta \ln Y_t$, ΔM_t) in equation (5.12). In the estimation of vector error correction model at least one of ρ_1 and ρ_2 should be nonzero. γ_1 and γ_2 are intercepts of equations (5.11) and (5.12).

5.5.2 Vector Error Correction Estimates for Real Output and Narrow Money Supply

The vector error correction estimates for real output and narrow money supply based on equations (5.11) and (5.12) have been presented in Table 5.5.

Table 5.5: Vector Error Correction Estimates ($\ln Y_t$ & $\ln M1_t$)

Dependent variable	Explanatory variables	Coefficient	't' statistics
$\Delta \ln Y_t$	Constant (γ_1)	0.038700	2.89489^{**}
	z_{1t-1}	-0.176737	-4.91940^{**}
	$\Delta \ln Y_{t-1}$	-0.412791	-3.03055^{**}
	$\Delta \ln Y_{t-2}$	-0.358243	-2.51381^{*}
	$\Delta \ln M1_{t-1}$	0.082036	1.52950
	$\Delta \ln M1_{t-2}$	0.053466	1.00950
$\Delta \ln M1_t$	Constant (γ_2)	0.131745	3.20819^{**}
	Z_{1t-1}	0.092874	0.84156
	$\Delta \ln M1_{t-1}$	0.093302	0.56629
	$\Delta \ln M1_{t-2}$	-0.199732	-1.22767
	$\Delta \ln Y_{t-1}$	0.184459	0.44086
	$\Delta \ln Y_{t-2}$	0.609102	1.39139

*(**) Indicates statistical significance at the 5% (1%) level

The significant value of the coefficient of cointegrating equation (ρ_1) in the table indicates that the system is in the state of the short run dynamics. The negative sign shows that the change in the value of real output level depend inversely on the past error (deviation of actual value from its long run equilibrium path). The insignificant value of the coefficient of cointegrating equation (ρ_2) in second equation indicates that short run disequilibrium is insignificant in second equation. The estimates of the model also present the Granger causality between output and money supply. In the present case z_t Granger causes real output since lagged value of the z_t entering equation (5.11) is statistically significant. The't'-statistic of the coefficient of explanatory variables depicts that the real output has also been affected significantly by its own first and second lag at

1% and 5% respectively despite the effectiveness of lagged value of z_t. The significance of the coefficients of the constants (γ_1 & γ_2) is significant at 1% level.

5.5.3 Vector Error Correction Estimates for Real Output and Broad Money Supply

The estimates of VEC model for real output and broad money supply have been presented in Table 5.6.

Table 5.6: Vector Error Correction Estimates ($\ln Y_t$ & $\ln M2_t$)

Dependent variable	Explanatory variables	Coefficient	't' statistics
$\Delta \ln Y_t$	constant(γ_1)	0.027719	1.48447
	Z_{2t-1}	-0.111065	-4.46998**
	$\Delta \ln Y_{t-1}$	-0.424678	-2.93877**
	$\Delta \ln Y_{t-2}$	-0.342278	-2.32644*
	$\Delta \ln M2_{t-1}$	0.148654	2.21488*
	$\Delta \ln M2_{t-2}$	0.034169	0.48366
$\Delta \ln M2_t$	constant(γ_2)	0.214207	4.64346**
	Z_{2t-1}	1.79E-05	-0.00029
	$\Delta \ln M2_{t-1}$	-0.010975	-0.06619
	$\Delta \ln M2_{t-2}$	-0.335276	-1.90559
	$\Delta \ln Y_{t-1}$	0.173622	0.48633
	$\Delta \ln Y_{t-2}$	0.118463	0.32592

*(**) Indicates statistical significance at the 5% (1%) level

The table presents the same findings as in previous table (Table 5.5). Short run deviation is significant and Z_t Granger causes real output since its lagged value is statistically significant. Real output has been affected by its own first and second lag at 1% and 5% respectively. This level is also affected by first lag of broad money supply at 5% level of significance.

5.5.4 Vector Error Correction Estimates for Nominal Output and Money Supply

The estimates of VEC model for nominal output and money supply (M1 &M2) have been presented in Tables 5.7 and 5.8.

Table 5.7: Vector Error Correction Estimates ($\ln NY_t$ & $\ln M1_t$)

Dependent variable	Explanatory variables	Coefficient	't'-statistics
$\Delta\ln NY_t$	Constant (γ_1)	0.058432	1.80670
	z_{1t-1}	-0.278311	-3.17980**
	$\Delta\ln NY_{t-1}$	0.020618	0.14733
	$\Delta\ln NY_{t-2}$	-0.079649	-0.61445
	$\Delta\ln M1_{t-1}$	0.344601	2.58833*
	$\Delta\ln M1_{t-2}$	0.072646	0.54312
$\Delta\ln M1_t$	Constant (γ_2)	0.128131	3.28611**
	z_{1t-1}	0.204062	1.93387
	$\Delta\ln M1_{t-1}$	0.155745	0.97032
	$\Delta\ln M1_{t-2}$	-0.314019	-1.94731
	$\Delta\ln NY_{t-1}$	0.248257	1.47147
	$\Delta\ln NY_{t-2}$	0.088770	0.56803

*(**) Indicates statistical significance at the 5% (1%) level

Table 5.8: Vector Error Correction Estimates ($\ln NY_t$ & $\ln M2_t$)

Dependent variable	Explanatory variables	Coefficient	't' statistics
$\Delta\ln NY_t$	Constant (γ_1)	0.056608	1.23447
	z_{1t-1}	-0.178726	-2.62504*
	$\Delta\ln NY_{t-1}$	-0.004993	-0.03438
	$\Delta\ln NY_{t-2}$	-0.115672	-0.82960
	$\Delta\ln M2_{t-1}$	0.414386	2.41140*
	$\Delta\ln M2_{t-2}$	0.000936	0.00537
$\Delta\ln M2_t$	Constant (γ_2)	0.202879	4.74900**
	z_{1t-1}	0.011237	0.17716
	$\Delta\ln M2_{t-1}$	0.003674	0.02295
	$\Delta\ln M2_{t-2}$	-0.395683	-2.43617*
	$\Delta\ln NY_{t-1}$	0.235657	1.74180
	$\Delta\ln NY_{t-2}$	0.027000	0.20786

*(**) Indicates statistical significance at the 5% (1%) level

5.5.5 Overall Findings from Tables (5.7 & 5.8)

Tables 5.7and 5.8 present the estimations of error correction modeling related to nominal output and money supply (M1& M2). Both tables present the same result that the coefficient value (ρ_1) of cointegrating equation is significant while the coefficient (ρ_2) is insignificant in both cases. This result indicates that there is unidirectional Granger causality from money supply to nominal output. The negative sign shows that the first difference of nominal output inversely related with past error correction term. From the table 5.7, it is shown that the coefficient of first lag of money supply is significant. The same case is in table 5.8 i.e. the first lag of broad money supply has the significant role to influence the nominal output at 5% level of significance.

5.6 Unrestricted Vector Auto regression Model (UVAR) of the Variables

The vector auto regression (VAR) is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach sidesteps the need for structural modeling by treating every endogenous variable in the system as a function of the lagged values of all the endogenous variables in the system. The mathematical representation of a VAR is,

$$Y_t = A_1 Y_{t-1} + \text{------} + A_p Y_{t-p} + Bx_t + \varepsilon_t \qquad (5.13)$$

Where Yt is a k vector of endogenous variables, x_t is a d vector of endogenous variables, A_1, ----, A_p and B are matrices of coefficients to be estimated. ε_t is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables.

5.6.1 The UVAR Model under Study

The UVAR model of the variables in the present study is based on the following equations:

$$\Delta \ln Y_t = \gamma_1 + \alpha_{11}\Delta \ln Y_{t-1} + \alpha_{12}\Delta M_{t-1} + \beta_{11}\Delta \ln Y_{t-2} + \beta_{12}\Delta M_{t-2} + \varepsilon_{1t} \quad (5.14)$$

$$\Delta M_t = \gamma_2 + \alpha_{21}\Delta M_{t-1} + \alpha_{22}\Delta \ln Y_{t-2} + \beta_{21}\Delta M_{t-1} + \beta_{22}\Delta M_{t-2} + \varepsilon_{2t} \quad (5.15)$$

Where, $\Delta \ln Y_t$:- first difference of output level (real & nominal).

ΔM_t :- first difference of money supply (narrow & broad).

α_{ij}, β_{ij}, γ_i are the parameters to be estimated.

5.6.2 The UVAR Estimates of the Variables under Study

The UVAR estimates of the variables in the present study, which are based on equations (5.14 and 5.15), have been presented in four different parts. The first part is related to the estimations of real output and narrow money supply. The second part is related to the real output and broad money supply. The third and the fourth parts have presented the estimations of nominal output - narrow money supply and nominal output – broad money supply respectively. The variables have been regressed with its own first two lags and first two lags of corresponding second variable. The estimations have been presented in the following table (Table 5.9)

Table 5.9: Unrestricted Vector Auto regression Estimates of the Series

Estimable variables	Dependent variable	Explanatory variables	Coefficient	't'-statistics
(I) ΔlnY_t & $\Delta lnM1_t$	ΔlnY_t	Constant (γ_1)	0.016514	[1.02873]
		ΔlnY_{t-1}	- 0.19964	[-1.21201]
		ΔlnY_{t-2}	- 0.00646	[-0.04111]
		$\Delta lnM1_{t-1}$	0.140862	[2.11205]**
		$\Delta lnM1_{t-2}$	0.022152	[0.33030]
	$\Delta lnM1_t$	Constant (γ_2)	0.143408	[3.72452]***
		ΔlnY_{t-1}	0.072451	[0.18338]
		ΔlnY_{t-2}	0.424227	[1.12480]
		$\Delta lnM1_{t-1}$	0.062372	[0.38988]
		$\Delta lnM1_{t-2}$	-0.183285	[-1.13932]
(II) $\Delta lnYt$ & $\Delta lnM2_t$	$\Delta lnYt$	Constant	0.002647	[0.12082]
		ΔlnY_{t-1}	-0.210260	[-1.25401]
		ΔlnY_{t-2}	0.002448	[0.01588]
		$\Delta lnM2_{t-1}$	0.212747	[2.63787]***
		$\Delta lnM2_{t-2}$	0.012041	[0.13891]
	$\Delta lnM2t$	Constant	0.214215	[4.93579]***
		ΔlnY_{t-1}	0.173570	[0.52254]
		ΔlnY_{t-2}	0.118415	[0.38785]
		$\Delta lnM2_{t-1}$	-0.011000	[-0.06885]
		$\Delta lnM2_{t-2}$	-0.332574	[-1.93667]**
(III) $\Delta lnNYt$ & $\Delta lnM1_t$	$\Delta lnNYt$	Constant	0.041752	[1.17191]
		$\Delta lnNY_{t-1}$	0.022665	[0.14508]
		$\Delta lnNY_{t-2}$	-0.043651	[-0.30280]
		$\Delta lnM1_{t-1}$	0.025609	[0.17256]
		$\Delta lnM1_{t-2}$	0.041752	[1.17191]
	$\Delta lnM1t$	Constant	0.140363	[3.52010]***
		$\Delta lnNY_{t-1}$	0.246753	[1.41124]*
		$\Delta lnNY_{t-2}$	0.062376	[0.38660]
		$\Delta lnM1_{t-1}$	0.056450	[0.35817]
		$\Delta lnM1_{t-2}$	-0.279528	[-1.68292]*
(IV) $\Delta lnNYt$ & $\Delta lnM2_t$	$\Delta lnNYt$	Constant	0.029139	[0.60619]
		$\Delta lnNY_{t-1}$	0.016961	[0.10865]
		$\Delta lnNY_{t-2}$	-0.059960	[-0.40412]
		$\Delta lnM2_{t-1}$	0.539105	[3.03197]***
		$\Delta lnM2_{t-2}$	-0.010378	[-0.05531]
	$\Delta lnM2t$	Constant	0.204610	[4.98504]***
		$\Delta lnNY_{t-1}$	0.234275	[1.75764]**
		$\Delta lnNY_{t-2}$	0.023494	[0.18544]
		$\Delta lnM2_{t-1}$	-0.004182	[-0.02754]
		$\Delta lnM2_{t-2}$	-0.394976	[-2.46506]***

*, **, *** Indicates statistical significance at the 10%, 5% and 1% level respectively.

5.6.3 Findings

The first part of the above table presents the findings that the real output has been affected only by first lag of narrow money supply at 5% level of significance, while this variable (Narrow money supply) has not been influenced significantly by any lags of other variables. Only the autonomous part (constant) has affected it at 1% level of significance.

The second part of the table expresses the effectiveness of real output and broad money supply to influence each other. The real output has been influenced by first lag of broad money supply at 1% level of significance, while the broad money supply is affected only by autonomous part(constant) at 1% level of significance like first case.

The third part of the table presents the relationship between nominal output and narrow money regarding the effectiveness of these variables to influence each other. No variable has affected significantly the nominal output at any lags; even the autonomous part has no significant effect to influence nominal output. The narrow money supply has been influenced by first lag of nominal output and second lag of its own level at 10% level of significance. The autonomous part (constant) has also significant role to influence the narrow money supply.

The fourth part has presented the findings that the nominal output level has been affected significantly by first lag of broad money supply at 1% level of significance, while the broad money supply has been influenced by its own second lag at 1% level of significance and first lag of nominal output at 5% level of significance. This is also affected by autonomous part (constant) at 1% level of significance.

5.7 Conventional Granger Causality Tests:

Conventional Granger Causality Tests present the causal relationships between the variables (Real / Nominal output and Narrow/Broad money supply). The estimations for the model of Granger Causality tests, which are based on equations (3.31 and 3.32), have been presented in following table (Table 5.10).

Table 5.10: Estimations of Conventional Granger Causality Tests

Null Hypothesis	Observation	lags	F-statistics	Probability
DM1T does not Granger Cause DYT DYT does not Granger Cause DM1T	42	2	2.29647 0.64124	0.11478 0.53239
DM1T does not Granger Cause DYT DYT does not Granger Cause DM1T	41	3	1.34064 0.20546	0.20546 0.89190
DM1T does not Granger Cause DYT DYT does not Granger Cause DM1T	40	4	2.19225* 0.44036	0.09297 0.77845
DM1T does not Granger Cause DYT DYT does not Granger Cause DM1T	39	5	1.94460 0.49046	0.11847 0.78050
DM2T does not Granger Cause DYT DYT does not Granger Cause DM2T	42	2	3.48455** 0.21100	0.04107 0.81075
DM2T does not Granger Cause DYT DYT does not Granger Cause DM2T	41	3	3.01981** 0.06999	0.04309 0.97557
DM2T does not Granger Cause DYT DYT does not Granger Cause DM2T	40	4	3.47416** 0.26985	0.01862 0.89512
DM2T does not Granger Cause DYT DYT does not Granger Cause DM2T	39	5	2.79778** 0.36940	0.03589 0.86521
DM1T does not Granger Cause DNYT DNYT does not Granger Cause DM1T	42	2	5.95442*** 1.14262	0.00573 0.32998
DM1T does not Granger Cause DNYT DNYT does not Granger Cause DM1T	41	3	4.66556*** 0.49556	0.00778 0.68778
DM1T does not Granger Cause DNYT DNYT does not Granger Cause DM1T	40	4	7.07859*** 1.01413	0.00036 0.41529
DM1T does not Granger Cause DNYT DNYT does not Granger Cause DM1T	39	5	5.81947*** 1.90675	0.00083 0.12498
DM2T does not Granger Cause DNYT DNYT does not Granger Cause DM2T	42	2	4.59646** 1.60479	0.01648 0.21460
DM2T does not Granger Cause DNYT DNYT does not Granger Cause DM2T	41	3	5.74546*** 1.17956	0.00272 0.33197
DM2T does not Granger Cause DNYT DNYT does not Granger Cause DM2T	40	4	5.86748*** 1.31562	0.00123 0.28597
DM2T does not Granger Cause DNYT DNYT does not Granger Cause DM2T	39	5	5.51747*** 1.60018	0.00117 0.19261

*, **, *** Indicates statistical significance at the 10%, 5% and 1% level respectively

Source: author's calculations based on data from various issues of International Financial Statistics, IMF.

5.7.1 Findings

The F-statistic and its corresponding probability value show that the null hypothesis has not been rejected at all lags (2, 3, 4, and 5) for the series DYt and DM1t. Only at lag 4 the null hypothesis that DM1t does not Granger Cause DYt has been rejected at 10% level of significance. This mean there is unidirectional causality from narrow money supply to real output at lag 4. For the series real output (DYt) and broad money supply (DM2t), the null hypothesis that DM2t does not Granger Cause DYt has been rejected at all lags at 5% level of significance but the null hypothesis has not been rejected at all lags. This indicates there is strong unidirectional causality from broad money supply to real output level. The finding is same for the series nominal output (DNYt) and both money supplies (DM1t and DM2t) that is there is strong unidirectional causality from DM1t to DNYt and DM2t to DNYt.

5.8 Summary

The present chapter is devoted to the analysis of the cointegration test, vector error correction modeling, unrestricted vector auto-regression modeling and conventional Granger causality test. The Cointegration test has been performed with the help of Durbin -Watson test, Engle-Granger's method and Johansen's Cointegration test. The summary of the present chapter has been presented in following points:

(i) The Durbin-Watson test (CRDW) has provided the result that there is no cointegration between real output and both forms of money supplies but the long run relationship has been found between nominal output and both money supplies.

(ii) The Engle-granger's method of cointegration, which is based on the stationarity test of the residual series from the OLS regression equation between two variables, has provided mixed findings from the different cases.

(iii) The ADF unit root test on the residual between real output and money supplies with exogenous as constant shows that there is no cointegration between these variables even though there is cointegration between nominal output and both level of money supplies. The same unit root test with no exogenous provides the result that there is cointegration between the real output and money supplies (M1 & M2).

(iv) The Phillips- Perron unit root test on residual with constant as exogenous provides the finding that there is cointegration between real output and narrow money supply (M1) at 5% level of significance but there is no cointegration between real output and broad money supply. The same unit root test on residual with no exogenous presents the finding that there is cointegration between real output and both level money supplies. The residual is stationary at 1% level for real output and M1 while it is stationary at 5% level for real out and M2.

(v) The Johansen's method of cointegration test is quite different method than earlier two methods. It is based on trace statistic and max-eigen statistic. Comparing these statistic values with critical values, the finding shows that there is long run relationship between real output and both money supplies (M1 and M2).

(vi) Vector Error Correction modeling and Conventional Granger Causality test provided the result that there is unidirectional causality from money to output.

(vii) The unrestricted vector auto regression (UVAR) modeling has provided the finding that the real output has been affected by first lag of both money supplies. The broad money supply has also been affected by its own second lag. In the case of nominal output and money supplies, the narrow money supply (M1) has been influenced by first lag of nominal output and its own second lag at 10% level of significance. Again nominal output has been affected by first lag of broad money supply (M2) at 1% level and M2 has also been influenced by first lag of nominal output (at 5 %) and its own second lag (at 1%).

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CHAPTER – VI

Study of Invariance Proposition of Rational Expectations

6.1 Introduction

The concept of Invariance proposition of rational expectations, developed by Lucas, Sargent and Wallace in early seventies, presents the idea that the anticipated part of money supply doesn't affect output level while it is affected only by unanticipated part of money supply. Since the present work is devoted to study the relationship between output level and money supply in the line of Invariance proposition which is also called Policy Ineffectiveness theorem or LSW proposition, the initial task for the present study to identify the anticipated and unanticipated part of money supply. Though there are several procedures to estimate the anticipated and unanticipated part of money supply; the present study has applied ARIMA structures of narrow and broad money supply for the estimation of anticipated and unanticipated part of money supply. After identifying such parts of money supply, a regression equation has been estimated where output level appears as dependent variable while both parts of money supply appear as explanatory variables.

6.2 The ARIMA Model

In order to quantify anticipated and unanticipated part of money supply, the ARIMA structures of the variable concerned have been identified and estimated. The following equation (Equation 6.1) presents ARIMA structures of M1 and M2, on the basis of which the anticipated and unanticipated parts of both money supplies have been estimated.

$$\Delta lnM_t = \alpha + \beta_1 \Delta lnM_{t-1} + \beta_2 \Delta lnM_{t-2} + \text{---} \beta_k \Delta lnM_{t-k} + \theta_1 u_{t-1} + \theta_2 u_{t-2} + \text{---} \theta_k u_{t-k} + \varepsilon_t \qquad (6.1)$$

Where, ΔlnM_t, ΔlnM_{t-1}--ΔlnM_{t-k} represent first difference of money supply at different lags; $\theta_1 u_{t-1}$ ----- $\theta_1 u_{t-k}$ represent error terms at different lags after regressing money supply over its own past lags.

The fitted part of the above model provides the quantity of anticipated part while residuals depict the unanticipated part of money supply.

6.2.1 Estimation of Alternative ARIMA structures for M1

The following tables present the estimated ARIMA structures for M1 from four different alternative models. The estimations from the different alternative ARIMA models for narrow money supply (M1) are being presented in the tables (Table 6.1 and 6.2).

Table 6.1: Estimation of ARIMA Models for M1

ARIMA (2, 1, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.143492	0.010086	14.22625	0.0000
AR(2)	-0.762485	0.102504	-7.438595	0.0000
MA(2)	0.795976	0.123271	6.457126	0.0000
Akaike info criterion :- -2.575537			R^2 :- 0.202584	
Schwarz criterion :- -2.451418			Adj. R^2:- 0.161691	
Durbin-Watson stat:- 1.861791			RSS :- 0.162252	

ARIMA (1, 1, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.141650	0.011438	12.38408	0.0000
AR(1)	0.166086	0.402813	0.412316	0.6823
MA(1)	-0.146172	0.432742	-0.337781	0.7373
Akaike info criterion :- -2.365691			R^2 :- 0.008909	
Schwarz criterion :- -2.242816			Adj. R^2:- -0.040646	
Durbin-Watson stat:- 1.931968			RSS :- 0.205584	

Table 6.2: Estimation of Alternative ARIMA Models for M1

ARIMA (1, 1, 2)

Constant(α)	0.142678	0.010573	13.49461	0.0000
AR(1)	0.064251	0.150470	0.427005	0.6717
MA(2)	-0.100464	0.160897	-0.624400	0.5359
Akaike info criterion :- -2.373109			R^2 :- 0.016235	
Schwarz criterion :- -2.250235			Adj. R^2:- -0.032954	
Durbin-Watson stat:- 2.064099			RSS :- 0.204064	

ARIMA (2, 1, 1)

Constant(α)	0.142350	0.009654	14.74546	0.0000
AR(2)	-0.191625	0.149555	-1.281300	0.2077
MA(1)	0.052190	0.161732	0.322692	0.7487
Akaike info criterion :- -2.395981			R^2 :- 0.045748	
Schwarz criterion :- -2.271862			Adj. R^2:- -0.003188	
Durbin-Watson stat:- 1.940753			RSS :- 0.194165	

Among the alternative models, the first model i.e. ARIMA (2, 1, 2) has been taken as more appropriate model because it has minimum value of AIC and SC. The't-statistic' of both explanatory variables seem significant at 1% level. On the basis of this model the anticipated and unanticipated part of M1 has been estimated.

6.2.2 Estimation of Alternative ARIMA structures for M2

The ARIMA model has been applied for the estimation of anticipated and unanticipated part of M2 also. The following tables present the estimated ARIMA structures for M2 from four different alternative models. The estimations of different ARIMA models for M2 have been presented in Tables 6.3 and 6.4.

Table 6.3: Estimation of ARIMA Model for M2

ARIMA (2, 1, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.166909	0.007928	21.05245	0.0000
AR(2)	-0.772584	0.054061	-14.29102	0.0000
MA(2)	0.916684	0.036956	24.80451	0.0000
Akaike info criterion :- -3.191317			R^2 :- 0.354759	
Schwarz criterion :- -3.067198			Adj. R^2:- 0.321670	
Durbin-Watson stat:- 1.956532			RSS :- 0.087652	

Table 6.4: Estimation of Alternative ARIMA Models for M2

ARIMA (1, 1, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.164873	0.008783	18.77229	0.0000
AR(1)	0.102512	0.387904	0.264272	0.7929
MA(1)	-0.130972	0.418719	-0.312791	0.7561
Akaike info criterion :- -2.774446			R^2 :- 0.004070	
Schwarz criterion :- -2.651572			Adj. R^2:- -0.045726	
Durbin-Watson stat:- 1.912859			RSS :- 0.136606	

ARIMA (2, 1, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.166601	0.006271	26.56659	0.0000
AR(2)	-0.317073	0.149786	-2.116839	0.0407
MA(1)	-0.052520	0.165579	-0.317193	0.7528
Akaike info criterion :- -2.858134			R^2 :- 0.099629	
Schwarz criterion :- -2.734015			Adj. R^2:- 0.053457	
Durbin-Watson stat:- 1.896510			RSS :- 0.122310	

ARIMA (1, 1, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.166324	0.007381	22.53556	0.0000
AR(1)	-0.010302	0.153932	-0.066928	0.9470
MA(2)	-0.169366	0.169639	-0.998394	0.3241
Akaike info criterion :- -2.800107			R^2 :- 0.029301	
Schwarz criterion :- -2.677233			Adj. R^2:- -0.019234	
Durbin-Watson stat:- 2.059093			RSS :- 0.133145	

Like M1, the ARIMA (2, 1, 2) model from Table 6.3 is more appropriate model than other models because the value of AIC and SC is minimum. The estimations of AR (2) and MA (2) are significant at 1% level of significance. The fitted part of this model provides the anticipated part of M2 while the residual part presents the unanticipated part of M2. The alternative models from Table 6.4 have not been used to quantify the anticipated and unanticipated parts of M2.

The anticipated and unanticipated parts of M1 & M2, which are taken from fitted and residual part of the ARIMA (2, 1, 2) models (Table 6.1 and 6.3), have been presented in the following table (Table 6.5).

Table 6.5: Actual, Anticipated and Unanticipated Parts of Money Supply (M1 and M2)

Sample (adjusted):- 1962- 2003

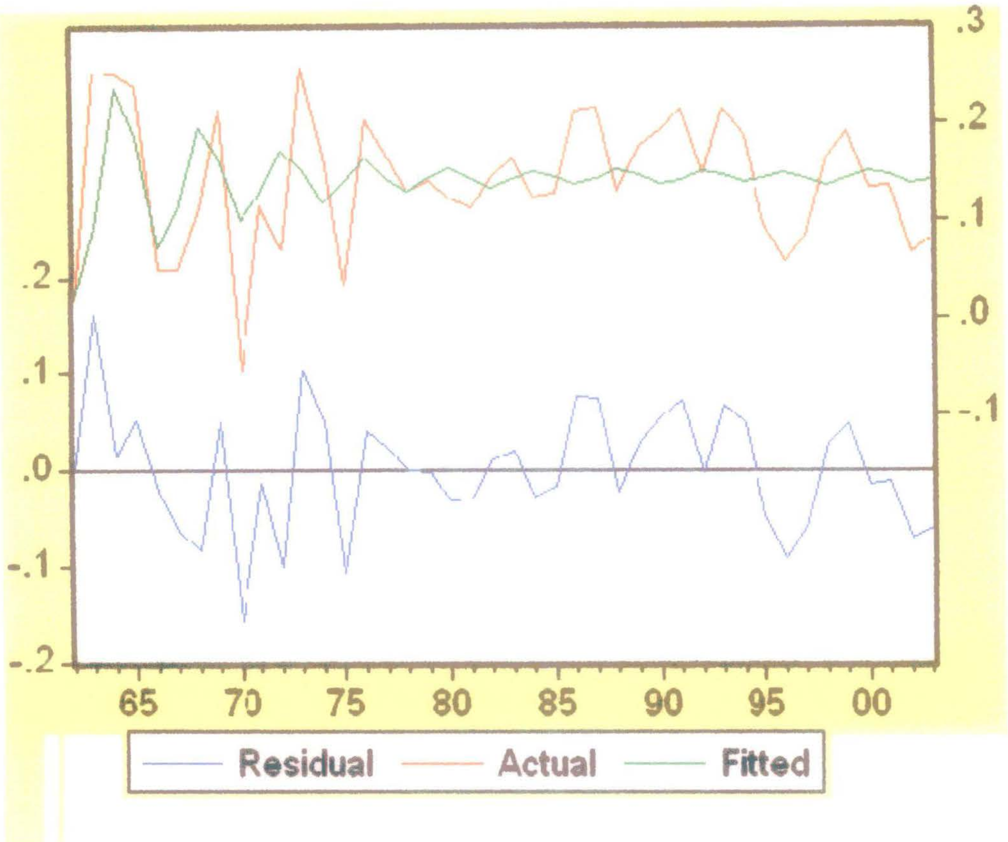
Year	Actual M1	Anticip. M1	Unantic. M1	Actual M2	Anticip. M2	Unantic. M2
1962	0.01905	0.01917	-0.00012	0.03977	0.03647	0.00331
1963	0.25467	0.09323	0.16144	0.22831	0.09935	0.12896
1964	0.25316	0.23828	0.01488	0.22249	0.26816	-0.04568
1965	0.23995	0.18722	0.05273	0.22724	0.23769	-0.01045
1966	0.05043	0.07171	-0.02128	0.05643	0.08210	-0.02567
1967	0.04895	0.11192	-0.06297	0.07901	0.11072	-0.03172
1968	0.11383	0.19751	-0.08368	0.17702	0.22873	-0.05172
1969	0.21593	0.16546	0.05047	0.25037	0.20575	0.04462
1970	-0.05590	0.09950	-0.15540	0.00939	0.11169	-0.10231
1971	0.11485	0.12843	-0.01358	0.17440	0.14333	0.03106
1972	0.07063	0.17183	-0.10120	0.15404	0.19482	-0.04079
1973	0.25869	0.15452	0.10417	0.25182	0.18960	0.06222
1974	0.16813	0.11850	0.04963	0.15804	0.13946	0.01858
1975	0.03332	0.13857	-0.10525	0.11246	0.15834	-0.04588
1976	0.20432	0.16421	0.04011	0.25406	0.19079	0.06327
1977	0.16668	0.14372	0.02296	0.19061	0.16692	0.02369
1978	0.12973	0.12904	0.00070	0.17960	0.15758	0.02203
1979	0.14137	0.14409	-0.00272	0.14649	0.17032	-0.02383
1980	0.12244	0.15454	-0.03210	0.15929	0.17729	-0.01800
1981	0.11226	0.14295	-0.03069	0.17459	0.16084	0.01375
1982	0.14501	0.13400	0.01102	0.19385	0.15629	0.03755
1983	0.16422	0.14288	0.02134	0.18331	0.17358	0.00974
1984	0.12398	0.15110	-0.02712	0.12217	0.18052	-0.05835
1985	0.12777	0.14467	-0.01690	0.18268	0.16316	0.01952
1986	0.21328	0.13678	0.07650	0.17757	0.14798	0.02959
1987	0.21659	0.14203	0.07456	0.20210	0.17262	0.02948
1988	0.12956	0.15117	-0.02162	0.19927	0.18579	0.01348
1989	0.17626	0.14711	0.02916	0.19101	0.16675	0.02426
1990	0.19230	0.13691	0.05538	0.16969	0.15426	0.01543
1991	0.21510	0.14171	0.07339	0.20435	0.17053	0.03382
1992	0.14821	0.15036	-0.00215	0.18822	0.17890	0.00932
1993	0.21469	0.14731	0.06738	0.22139	0.16898	0.05241
1994	0.18692	0.13818	0.04874	0.16665	0.15898	0.00767
1995	0.09461	0.14284	-0.04823	0.14504	0.17286	-0.02782
1996	0.05765	0.14917	-0.09153	0.11503	0.17414	-0.05911
1997	0.08238	0.14237	-0.06000	0.14638	0.15830	-0.01192
1998	0.16476	0.13609	0.02867	0.21520	0.15281	0.06239
1999	0.19137	0.14234	0.04903	0.19575	0.17184	0.02391
2000	0.13430	0.15009	-0.01579	0.17227	0.18679	-0.01452
2001	0.13532	0.14602	-0.01070	0.10905	0.16655	-0.05750
2002	0.06693	0.13793	-0.07100	0.05035	0.14945	-0.09910
2003	0.08205	0.14121	-0.05915	0.10746	0.15890	-0.05144

Source: author's calculations based on data from various issues of International Financial Statistics, IMF.

6.2.3 Time Plots of Actual, Anticipated and Unanticipated Parts of M1

The time plots of actual and anticipated as well as unanticipated parts of narrow money (M1) based on ARIMA (2, 1, 2) are being presented through the Figure 6.1 below:

Figure 6.1: Anticipated and Unanticipated Part of M1 based on ARIMA (2, 1, 2) structure

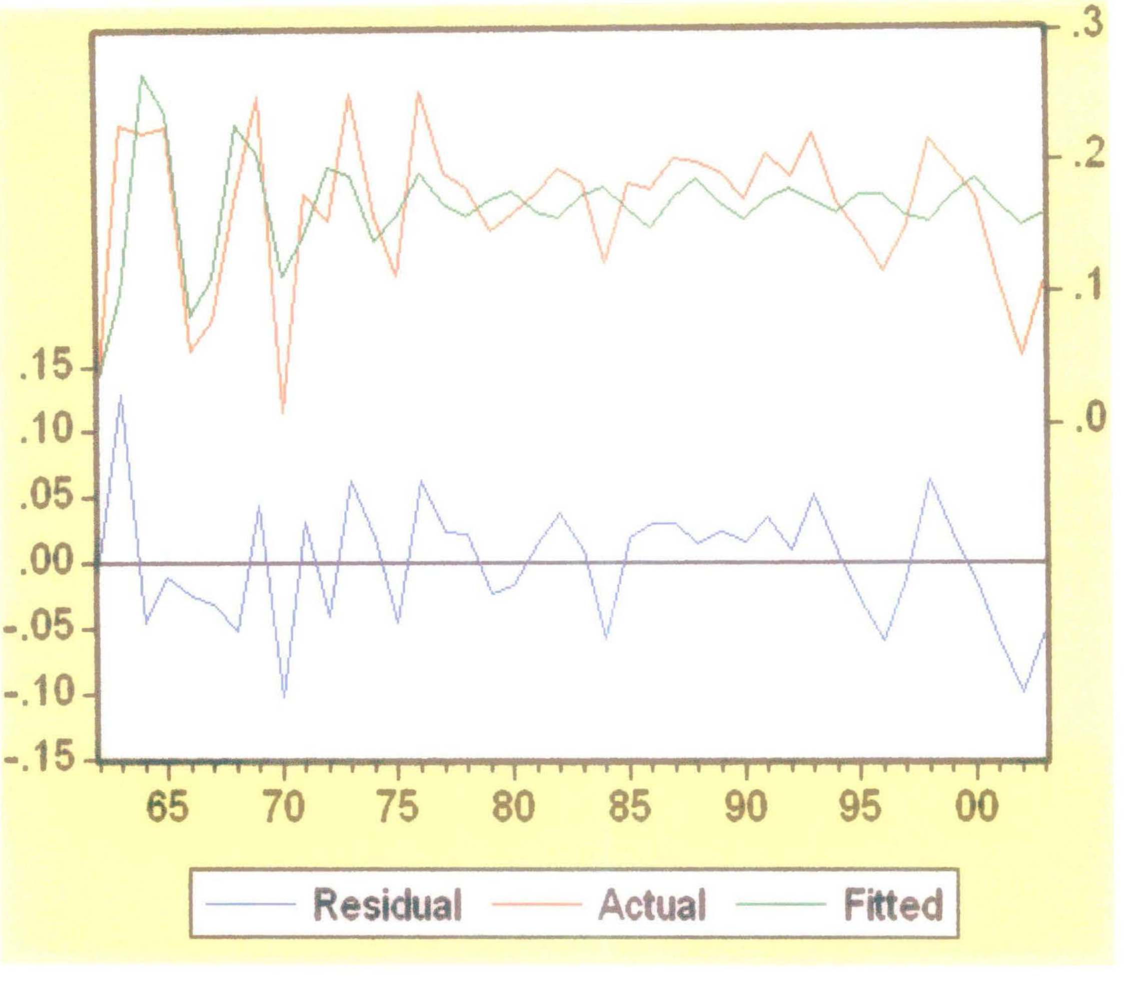


In the figure, the fitted part of the model has been presented through the line having green color. This line is showing the anticipated part of M1. Similarly, the unanticipated part of M1 is being presented through the line of residual part of the model having blue color. The actual supply of M1 has been presented through red line. The movement of all the three series is fluctuating. However, the fluctuations of fitted part (i.e. anticipated part of M1) have been dampening after 1975. The fluctuations of residual part are generally between -0.1 to +0.1, except 1963, 1970, 1973 and 1996.

2.3 Time Plots of Actual, Anticipated and Unanticipated Parts of M2

The time plots of actual and anticipated as well as unanticipated parts of broad money supply (M2) based on ARIMA (2, 1, 2) are being presented through the Figure 6.2.

Figure 6.2: Actual, Anticipated and Unanticipated Part of Broad Money Supply (M2) based on ARIMA (2, 1, 2) from the table 6.5



In the figure, the fitted part of the model has been presented through the line having green color. This line is showing the anticipated part of M2. Similarly, the unanticipated part of M2 is being presented through the line of residual part of the model having blue color. The actual supply of M2 has been presented through red line. The movement of all the three series is fluctuating like M1.

6.3: Relationship between Output Level and Anticipated & Unanticipated Parts of Money Supply (M1)

The main objective of the present study is to establish the relationship between output level and money supply in Nepalese economy based on Rational Expectations hypothesis. The above table (Table 6.5) and figures (Figure 6.1 & 6.2) provide the anticipated and unanticipated parts of money supply on the basis of which the relationships with output level have been established. The estimations from the OLS regression between first difference of real output and first lag of anticipated and unanticipated parts of money supply (M1) have been presented in the following table (Table 6.6).

Table 6.6: Estimation of the Model for Invariance Proposition for M1

($\Delta Yt = \alpha + \beta_1 AntM1_{(-1)} + \beta_2\, UnantM1_{(-1)} + \varepsilon_t$) Sample (adjusted):- 1963 2003

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	-0.014494	0.020054	-0.722764	0.4743
$AntM1_{(-1)}$	0.339936	0.138484	2.454693	0.0188
$UnantM1_{(-1)}$	0.090481	0.072318	1.251166	0.2185
Akaike info criterion :-		-4.186236	R^2 :-	0.165139
Schwarz criterion :-		-4.060852	Adj. R^2:-	0.121199
Durbin-Watson stat:-		2.428238	RSS :-	0.031528
F- statistic:-	3.758272	Prob.(F- statistic):-		0.032409

($\Delta Yt = \alpha + \beta_1 AntM1_{(-1)} + \varepsilon_t$)

Constant(α)	-0.014494	0.020054	-0.722764	0.4743
$AntM1_{(-1)}$	0.339936	0.138484	2.454693	0.0188
R^2 :- 0.130746		Adj. R^2 :-0.108458		RSS:- 0.032827
F- statistic:-	5.866082	Prob.(F- statistic):-		0.020184

($\Delta Yt = \alpha + \beta_2\, UnantM1_{(-1)} + \varepsilon_t$)

Constant(α)	0.033477	0.004781	7.002400	0.0000
$UnantM1_{(-1)}$	0.088299	0.076830	1.149273	0.2574
R^2 :- 0.032758		Adj. R^2 :-0.007957		RSS:- 0.036527
F- statistic:-	1.320828	Prob.(F- statistic):-		0.257443

6.3.1 Findings

It is observed from the Table (6.6) that -

(i) The first lag of anticipated part of money supply(M1) is significant at 5% level of significance and,

(ii) The same lag of unanticipated part of money supply (M1) is completely insignificant.

The lag selection in the above estimation has been confirmed on the basis AIC and SC. The finding has been supported by the estimation of the OLS regression equation only with anticipated and unanticipated part of money supply separately as independent variable. This means the findings from the above table have not been supporting the 'Invariance Proposition' in Nepalese economy for the period of study.

6.4 Relationship between Output Level and Anticipated & Unanticipated Parts of Money Supply (M2)

The estimations of OLS regression equation between the real output for the study period and first lag of both parts of M2 have been presented in the following tables (Table 6.7 & 6.8).

Table 6.7: Estimation of the Model for Invariance Proposition for M2

($\Delta Yt = \alpha + \beta_1 AntM2_{(-1)} + \beta_2\ UnantM2_{(-1)} + \varepsilon_t$) Sample (adjusted):- 1963 2003

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	-0.019721	0.019440	-1.014479	0.3168
$AntM2_{(-1)}$	0.323294	0.115044	2.810173	0.0078
$UnantM2_{(-1)}$	0.124475	0.097799	1.272764	0.2108
Akaike info criterion :- -4.216505			R^2 :- 0.190031	
Schwarz criterion :- -4.091121			Adj. R^2:- 0.147401	
Durbin-Watson stat:- 2.381462			RSS :- 0.030588	
F- statistic:- 4.457675		Prob.(F- statistic):- 0.018235		

Table 6.8: Estimation of the Model for Invariance Proposition for M2

$(\Delta Yt = \alpha + \beta_1 AntM2_{(-1)} + \varepsilon_t)$

Constant(α)	-0.017254	0.019496	-0.884997	0.3816
AntM1$_{(-1)}$	0.309315	0.115425	2.679790	0.0107
R^2 :- 0.155502	Adj. R^2 :-0.133848		RSS:- 0.031892	
F- statistic:-	7.181272	Prob.(F- statistic):-	0.010735	

$(\Delta Yt = \alpha + \beta_2 \text{ UnantM2}_{(-1)} + \varepsilon_t)$

Constant(α)	0.033469	0.004809	6.959774	0.0000
UnantM2$_{(-1)}$	0.098238	0.105610	0.930192	0.3580
R^2 :- 0.021705	Adj. R^2 :--0.003380		RSS:- 0.036945	
F- statistic:-	1.320828	Prob.(F- statistic):-	0.257443	

,

6.4.1 Findings

The estimation for the model of Invariance Proposition for M2 presents the information that-

(i) The first lag of anticipated part is significant to influence the real output at 1% level of significance and,

(ii) The same lag of unanticipated part of M2 is insignificant to affect real output.

The estimation of the equations, when only anticipated and unanticipated parts are taken as independent variables separately, anticipated part is significant at 5% level and unanticipated part is insignificant to affect the real output. Hence, for the case of broad money supply (M2) also the 'Invariance Proposition' is not applicable in Nepalese economy like narrow money supply (M1).

6.5: The Effectiveness of Anticipated and Unanticipated Parts of Money Supply

The effectiveness of anticipated and unanticipated parts of money supply to influence the real output has been checked with the help of F-statistic.

$$F = \frac{RSS_R - RSS_{UR}/r}{RSS_{UR}/n\text{-}q} \tag{6.2}$$

Where, RSS_R= residual sum of squares of restricted regression equation.

RSS_{UR} = residual sum of squares of unrestricted regression equation.

r = no. of restrictions.

n = no. of observations. q = no. of parameters of unrestricted equations.

6.5.1 Findings

The 'F-statistic' has been calculated based on the residual sum of squares of restricted and unrestricted regression equations and the RSS values are taken from the Tables 6.6 (for M1), 6.7 and 6.8 (for M2).

6.5.1.1 Narrow Money Supply (M1)

According to the Table (6.6), it has been observed-

(i) When unanticipated part of M1 is restricted

RSS_{UR} = 0.031528, RSS_R = 0.032827

r = 1, n = 42, q = 3

Using the formula from equation (6.2),

$F_{stat.} = 1.56$

$F_{(1, 39)} = 4.08$ (level of significance = 0.05)

Since the computed value of 'F' (F- statistic) is less than its critical value at 5% level of significance, the null hypothesis (Ho) - ineffectiveness of unanticipated part of narrow money supply has been accepted. The conclusion is consistent with the findings of Table (6.6), i.e. the unanticipated part of M1 has been ineffective to influence the real output for the period of study.

(ii) When anticipated part of M1 is restricted

$RSS_{UR} = 0.031528$, $RSS_R = 0.036527$

$r = 1$, $n = 42$, $q = 3$

Using the formula from equation (6.2),

$F_{stat.} = 6.025$

$F_{(1, 39)} = 4.08$ (level of significance = 0.05)

Since the computed value of 'F' (F- statistic) is greater than its critical value at 5% level of significance, the null hypothesis (Ho) of ineffectiveness of anticipated part of narrow money supply (M1) has been rejected. The conclusion is consistent with the findings of Table (6.6), i.e. the anticipated part of M1 has been effective to influence the real output for the period of study.

6.5.1.2 Broad Money Supply (M2)

According to the Table (6.7 & 6.8), it has been observed-

(i) When unanticipated part of M2 is restricted

$RSS_{UR} = 0.030588$, $RSS_R = 0.031892$

$r = 1$, $n = 42$, $q = 3$

Using the formula from equation (6.2),

$F_{stat.} = 1.62$

$F_{(1, 39)} = 4.08$ (level of significance = 0.05)

Since the computed value of 'F' (F- statistic) is less than its critical value at 5% level of significance, the null hypothesis (Ho) - ineffectiveness of unanticipated part of broad money supply (M2) has been accepted. The conclusion is consistent with the findings of Table (6.7 & 6.8), i.e. the unanticipated part of M2 has been ineffective to influence the real output for the period of study.

(ii) When anticipated part of M2 is restricted

$RSS_{UR} = 0.030588$, $RSS_R = 0.036945$

$r = 1$, $n = 42$, $q = 3$

Using the formula from equation (6.2),

$F_{stat.} = 7.897$

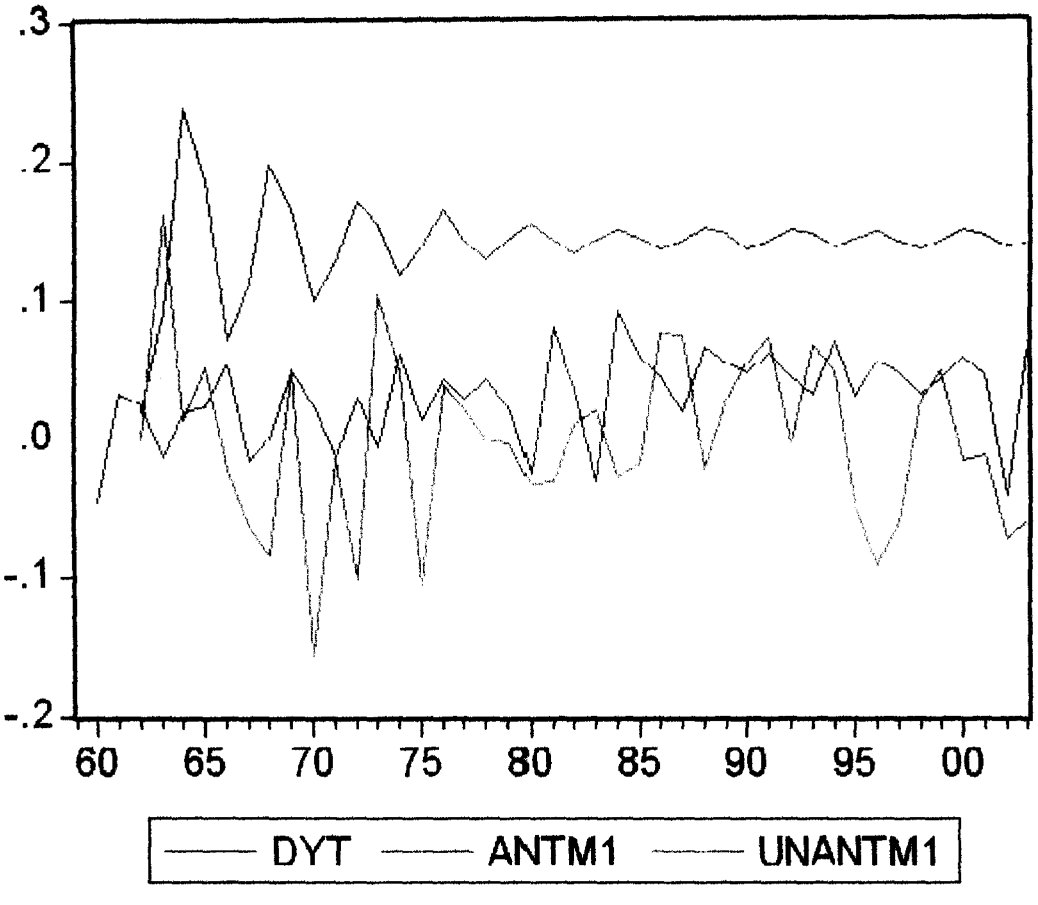
$F_{(1, 39)} = 4.08$ (level of significance = 0.05)

Since the computed value of 'F' (F- statistic) is greater than its critical value at 5% level of significance, the null hypothesis (Ho) of ineffectiveness of anticipated part of narrow money supply (M2) has been rejected. The conclusion is consistent with the findings of Table (6.7 & 6.8), i.e. the anticipated part of M2 has been effective to influence the real output for the period of study.

6.5.2 Time Plots of Real Output, Anticipated and Unanticipated Parts of M1

Time plots of real output and anticipated as well as unanticipated parts of narrow supply (M1) for the period of study are being presented through the Figure 6.3.

Figure 6.3: Real Output, Anticipated and Unanticipated parts of M1

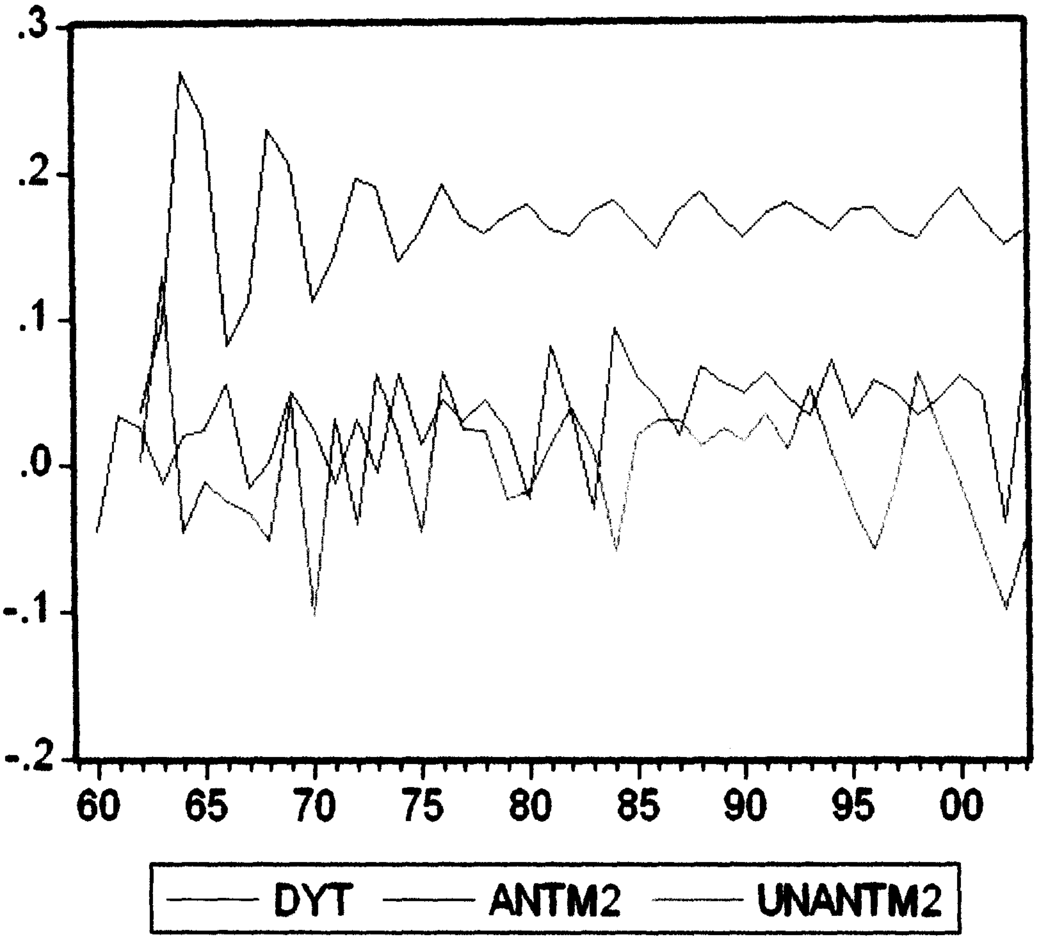


From the figure, it has been observed that there is positive correlation between real output and anticipated part of M1. The real output has been affected by the first lag of anticipated part of M1 while such relationship has not been established between real output and unanticipated part of M1. The finding from the observation of the time plots is consistent with the findings of 'F-statistic' which has been explained in previous section. The blue line (real output) and red line (anticipated part) are in same direction.

6.5.3 Time Plots of Real Output, Anticipated and Unanticipated Parts of M2

Time plots of real output and anticipated as well as unanticipated parts of narrow supply (M2) for the period of study are being presented through the Figure 6.4.

Figure 6.4: Real Output, Anticipated and Unanticipated money supply (M2)



From the figure, it has been observed that there is positive correlation between real output and anticipated part of M2. The real output has been affected by the first lag of anticipated part of M2 while such relationship has not been established between real output and unanticipated part of M2. The finding from the observation of the time plots is consistent with the findings of 'F-statistic' which has been explained in previous section. The blue line (real output) and red line (anticipated part) are in same direction.

6.6 Summary

The present chapter is devoted to analyze the relationship between output level and money supply based on 'Invariance Proposition' of Rational Expectations Hypothesis. For this purpose, the anticipated and unanticipated parts of both money supplies (M1& M2) have to be quantified. Though there are several procedures to quantify these parts of money supply, the present work has been concentrated to identify such parts of M1 & M2 on the basis of relevant ARIMA structures. In the process, several alternative ARIMA structures have been presented. Among these alternative ARIMA structures, ARIMA (2, 1, 2) has been used as more appropriate model to quantify both parts for both money supplies (M1 &M2).

The model of ' Invariance Proposition' has been applied to find the effectiveness of anticipated and unanticipated parts of money supply. The equation for this model has been used based on OLS method taking real output as dependent variable and anticipated as well as unanticipated parts of money supply as explanatory variables. It has been found from the OLS method that the anticipated part of narrow money supply (M1) has significant role to influence the real output at 5% level of significance while the real output has not been affected significantly by unanticipated part of narrow money supply during the period of present study (1959-2003). The OLS method has also been applied for the case of broad money supply to find the relationship between real output and money supply according to ' Invariance Proposition'. The 't-statistic' of the coefficients of anticipated and unanticipated parts of M2 has shown that the effectiveness of anticipated part has been significant at 1% level while unanticipated part has been insignificant to influence the real output for the period of study.

CHAPTER –VII

Output-Money Supply Relationship in Different Sub- Periods

7.1 Introduction

Lucas (1976a) has pointed out that econometric relationship among variables may change over time. So the relationship obtained from a historical dataset may not represent the dynamic relationship among variables concerned. More specifically, he argues that any dataset may contain several structural breaks in it and the economic relationships among variables may undergo changes in those periods. In such case the estimated relationship may not remain stable over the period concerned.

It is, therefore, pertinent upon over parts to consider if such structural breaks occurred in our dataset. After identifying the relationship between output level and money supply for the study period (1959-2003) according to Rational Expectations proposition, it is necessary to identify several structural breaks based on stability test. The stability test presents the idea of structural breaks of the series, on the basis of which several sub periods can be identified. Chow Breakpoint test, Chow Forecast test, Ramsey RESET tests and Recursive Least Squares Estimates are some of the methods for stability test. But only Chow Breakpoint Test has been used to identify structural breaks in the present study.

7.2 Window Finding on the Basis of Chow Break Point Test: Methodology

The idea of Chow Breakpoint Test is to fit the equation separately for each sub sample and to see whether there are significant differences in the estimated equations. A significant difference indicates a structural change in the relationship. This test can be used with least squares and two- stage least squares regressions also. In order to carry out this test, the data should be partitioned into two or more sub samples. Each sub sample must contain more observations than the number of coefficients in the equation so that the equation can be estimated.

The Chow Breakpoint test compares the sum of squared residuals obtained when separate equations are fitted to each sub sample of the data. Two test statistics i.e. F-statistic and log likelihood ratio statistic are relevant for the Chow Breakpoint Test. The F-statistic is based on comparison of the restricted and unrestricted sum of squared residuals and in the simplest case involving a single breakpoint is computed as;

$$F = \frac{[u'u-(u_1'u_1+u_2'u_2)]/k}{(u_1'u_1+u_2'u_2)/T-2k} \qquad (7.1)$$

Where,

$u'u$ = the restricted sum of squared residuals.

$u_i'u_i$ = the squared residuals from sub sample i.

T = the total number of observations.

k = the number of parameters in the equation.

The formula from equation (7.1) can be generalized normally to more than one breakpoint. The F-statistic has an exact finite sample F-distribution if errors are independent and identically distributed normal random variables.

7.3 Structural Breaks in Nepalese Economy

The structural breaks of the Nepalese economy have been identified on the basis of the following equations:

$$\Delta \ln Y_t = \gamma_1 + \gamma_2 \Delta \ln M1_t + z_t \tag{7.2}$$

$$\Delta \ln Y_t = \gamma_1 + \gamma_2 \Delta \ln M2_t + z_t \tag{7.3}$$

The findings of Chow Break Point Test based on equation (7.2) are being presented through the Table 7.1.

Table 7.1: Chow Break Point Test on Equation

($\Delta \ln Y_t = \gamma_1 + \gamma_2 \Delta \ln M1_t + z_t$)

year	F-statistic	Probability	year	F-statistic	probability
1962	2.950003	0.063818	1982	3.301397	0.047093
1963	1.936622	0.157473	1983	3.154393	0.053448
1964	3.337275	0.045666	1984	5.456637*	0.008027
1965	3.149697	0.053665	1985	3.648420	0.035039
1966	2.974834	0.062453	1986	3.040833	0.058971
1967	3.255711	0.048979	1987	2.597257	0.086993
1968	2.988600	0.061709	1988	3.266955	0.048508
1969	3.568794	0.037485	1989	2.636285	0.084042
1970	2.513371	0.093711	1990	2.114993	0.133926
1971	2.492143	0.095496	1991	1.787623	0.180469
1972	3.494605	0.039924	1992	1.032955	0.365253
1973	3.444294	0.041673	1993	0.897865	0.415491
1974	5.012411*	0.011415	1994	1.149365	0.327080
1975	3.654317	0.016169	1995	0.410810	0.665879
1976	3.843565	0.029729	1996	0.420738	0.659434
1977	3.243019	0.049516	1997	0.661914	0.521421
1978	3.221204	0.050455	1998	0.920367	0.406644
1979	2.894032	0.067012	1999	1.056660	0.357117
1980	3.077765	0.057112	2000	1.555817	0.223517
1981	4.698475	0.014696	2001	1.201244	0.311439
			2002	3.709741	0.033271

* indicates highly significant F-statistic.

7.3.1 Findings

From the Table (7.1), it appeared that,

(i) The significant F-statistic is appeared at the year 1974 and 1984.

(ii) Structural breaks, therefore, are found to occur at 1974 and 1984. Consequently, the series has been divided into three sub-periods viz. 1959-1973, 1974-1983 and 1984-2003.

7.3.2 Window Findings with Broad Money Supply (M2):

The findings from Chow Break Point Test on equation (7.3) are being presented through the Table 7.2.

Table 7.2: Chow Break Point Test on Equation

$(\Delta \ln Y_t = \gamma_1 + \gamma_2 \Delta \ln M2_t + z_t)$

year	F-statistic	Probability	year	F-statistic	probability
1962	3.112136	0.055437	1982	3.654303	0.034866
1963	2.177345	0.126593	1983	3.497533	0.039825
1964	3.584623	0.036985	1984	6.064398*	0.005008
1965	3.480489	0.040407	1985	4.976243	0.011751
1966	3.265001	0.048589	1986	4.055509	0.024906
1967	3.733498	0.032611	1987	3.723098	0.032898
1968	3.448876	0.041511	1988	4.501608	0.017247
1969	4.259612	0.021034	1989	3.304359	0.046974
1970	2.798105	0.072883	1990	2.756304	0.075608
1971	2.769318	0.074748	1991	2.502867	0.094590
1972	3.979145	0.026542	1992	1.757261	0.185573
1973	3.839184	0.029838	1993	1.593240	0.215896
1974	5.730793*	0.006479	1994	2.035707	0.143900
1975	4.580791	0.016169	1995	1.445086	0.247767
1976	4.771320	0.013855	1996	1.490969	0.237400
1977	3.953770	0.027110	1997	1.646106	0.205591
1978	3.966869	0.026815	1998	1.598144	0.214917
1979	3.558228	0.037822	1999	2.244367	0.119179
1980	3.703235	0.033454	2000	2.935430	0.064634
1981	5.401293*	0.008385	2001	3.955935	0.027061
			2002	4.072332	0.024560

* indicates more significant F-statistic.

7.3.3 Findings

It is observed from the Table (7.2) that,

(i) F- statistics are significant at 1974, 1981 and 1984.

(ii) The structural break at 1981 has been neglected in the present study.

(iii) The virtual significant structural changes occurred on 1974 and 1984. Consequently, the series has been divided into three sub-periods i.e., 1959-1973, 1974- 1983 and 1984-2003.

7.4 The ARIMA structure for the first sub-period (1959-1973) of M1

In order to find anticipated and unanticipated parts of narrow money supply (M1) for the sub-period (1959-1973), ARIMA structure narrow money supply (M1) for this sub-period has been identified and estimated. The model is based on the correlogram of the series. Figure 7.1 depicts the correlogram for this sub-period.

Figure 7.1: Correlogram of the series (M1) for the first sub-period (1959-1973)

Included observations: 14

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.010	-0.010	0.0016	0.969
		2	-0.149	-0.150	0.4187	0.811
		3	-0.153	-0.160	0.8961	0.826
		4	0.369	0.356	3.9440	0.414
		5	0.089	0.057	4.1419	0.529
		6	-0.229	-0.199	5.6141	0.468
		7	-0.428	-0.380	11.480	0.119
		8	0.137	-0.016	12.181	0.143
		9	0.043	-0.128	12.263	0.199
		10	-0.085	-0.053	12.665	0.243
		11	-0.148	0.195	14.307	0.216
		12	-0.043	-0.111	14.518	0.269

The following table (Table 7.3) presents the estimated ARIMA structure. The appropriate lag for this model has been selected according to Akaike info criterion and Schwartz criterion.

Table 7.3: Estimation of ARIMA (1, 1, 1) Model for M1

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.091010	0.055866	1.629074	0.1344
AR(1)	0.457857	0.166979	2.741996	0.0208
MA(1)	-2.490160	0.885643	-2.811698	0.0184
Akaike info criterion :- -2.982930			R^2 :- 0.820512	
Schwarz criterion :- -2.852557			Adj. R^2:- 0.784614	
Durbin-Watson stat:- 2.072056			RSS :- 0.024297	

The estimated ARIMA model for M1 (1959-1973) is as follows:

$$\hat{m}_{1t} = 0.091010 + 0.457857M1_{t-1} - 2.490160\epsilon_{t-1} \tag{7.4}$$

Based on the fitted part of the above estimations, the anticipated part of money supply can be obtained while the unanticipated part of money supply for this sub-period will be obtained from residuals. The anticipated and unanticipated parts of M1 for this sub- period are being presented through the following table (Table 7.4).

Table 7.4: Actual, Anticipated and Unanticipated Parts of M1 (1959-1973)

Sample (adjusted): 1961- 1973

Year	Actual M1	Anticipated. M1	Unanticipated. M1
1961	0.20475	0.19311	0.01164
1962	0.01905	0.11409	-0.09504
1963	0.25467	0.29474	-0.04006
1964	0.25316	0.26571	-0.01254
1965	0.23996	0.19649	0.04347
1966	0.05043	0.05096	-0.00053
1967	0.04895	0.07376	-0.02481
1968	0.11383	0.13353	-0.01971
1969	0.21593	0.15053	0.06541
1970	-0.05590	-0.01466	-0.04124
1971	0.11485	0.12643	-0.01158
1972	0.07063	0.13076	-0.06013
1973	0.25869	0.23142	0.02727

7.5 Output-Money supply (M1) relationship for the first sub period (1959-1973)

The following table depicts the relationship between output level and money supply of this sub-period based on the regression equation where output level is regressed on the first lag of anticipated ($M1^{e}_{t-1}$) and unanticipated ($UM1^{e}_{t-1}$) part of money supply. The appropriate lags of the model are determined on the basis of AIC and SC. The estimations are being presented through the following table (Table 7.5).

Table 7.5: Output – Money supply (M1) relationship for the first sub-period[a]

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.000926	0.010729	0.086333	0.9331
$AntM1_{(-1)}$	0.131913	0.062214	2.120309	0.0630
$UnantM1_{(-1)}$	0.274279	0.124574	2.201731	0.0552
Akaike info criterion =		-5.030338	R^2 =	0.561927
Schwarz criterion =		-4.909111	Adj. R^2=	0.464577
Durbin-Watson stat=		2.724245	RSS =	0.002786
F- statistic=	5.772252	Prob.(F- statistic)=		0.024376
($\Delta Yt = \alpha + \beta_1 AntM1_{(-1)}$)				
Constant(α)	-0.007040	0.011885	-0.592354	0.5668
$AntM1_{(-1)}$	0.158043	0.071866	2.199119	0.0525
R^2 :- 0.325970		RSS :- 0.004286	Adj. R^2:-	0.258567
($\Delta Yt = \alpha + \beta_1 UnantM1_{(-1)}$)				
Constant(α)	0.020561	0.006294	3.266896	0.0085
$UnantM1_{(-1)}$	0.324665	0.142062	2.285386	0.0454
R^2 :- 0.343099		RSS :- 0.004177	Adj. R^2:-	0.277409

[a]($\Delta Yt = \alpha + \beta_1 AntM1_{(-1)} + \beta_2 UnantM1_{(-1)} + \varepsilon_t$) Sample (adjusted):- 1962 1973

The estimated equation is,

$$\hat{y}_t = 0.000926 + 0.131913\, M1^{e}_{t-1} + 0.274279\, UM1^{e}_{t-1} \quad (7.5)$$

$$(0.010729)\ (0.062214) \qquad (0.124574)$$

$$[0.086333]\ [2.120309] \qquad [2.201731]$$

R^2 = 0.561927 Adj. R^2 = 0.464577

F- stat = 5.772252 D-W stat = 2.724245

The estimations based on the first part of the above table present the findings that both explanatory variables (anticipated and unanticipated parts of M1) have influenced real output at 10% level of significance. Again for assessing the significance of anticipated and unanticipated parts of narrow money supply (M1) on output level, restricted regression equations have also been estimated. The second part of the Table 7.5 presents the regression equation where unanticipated part is restricted. Similarly, the third part of the table presents the regression equation where anticipated part of narrow money supply (M1) is subject to restriction. It has been observed from the table that the anticipated and unanticipated parts are significant at 10% and 5% level respectively.

It is also found that-

$F^* = 4.845$ when unanticipated part of M1 is restricted.

$F^* = 4.49$ when anticipated part of M1 is restricted.

It is further observed that both estimated F^* statistics are less than the critical value for $F_{(1,9)} = 5.12$ (at 5% level) but greater than $F_{(1,9)} = 3.36$ (at 10% level).

The F-statistic of both cases shows that both parts of money supply do not affect the output level in this sub-period at 5 % level of significance. This indicates that-

(i) Both anticipated and unanticipated parts of narrow money supply (M1) have insignificant effects (at 5%) on real output but significant effects at 10% level.

(ii) Monetary policy as well as 'Invariance Proposition' has insignificant impact (at 5%) on real output level but significant impact at 10% level of significance.

(iii) Surprise in money supply (unanticipated part of narrow money supply) has comparatively greater influence to affect real output level in this sub-period.

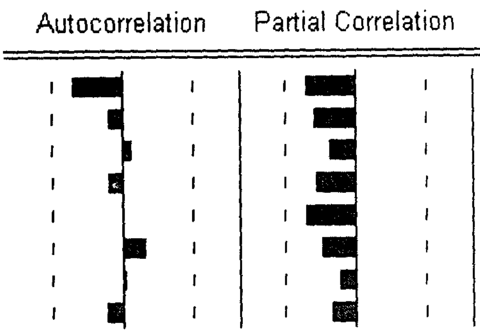
7.6 The ARIMA structure for second sub-period of M1 (1974-1983)

The ARIMA structure of M1, which is used to identify anticipated and unanticipated part of money supply, has also been estimated for the sub-period (1974-1983). The estimation is based on the correlogram of M1 for this period. Figure 7.2 depicts the correlogram for this purpose, on the basis of which ARIMA (2, 1, 2) has been identified. However, in order to check its appropriateness, the AIC and SC has also been used.

Figure 7.2: Correlogram of the series for the second sub-period of M1

Correlogram of DM1T2

Included observations: 10



	AC	PAC	Q-Stat	Prob
1	-0.429	-0.429	2.4571	0.117
2	-0.119	-0.372	2.6692	0.263
3	0.071	-0.226	2.7546	0.431
4	-0.124	-0.351	3.0644	0.547
5	0.000	-0.429	3.0644	0.690
6	0.183	-0.288	4.0661	0.668
7	0.012	-0.139	4.0722	0.771
8	-0.133	-0.210	5.1340	0.743

7.6.1 Estimation of the ARIMA (2, 1, 2) Structure of M1 (1974- 1983)

The following table presents the findings of the ARIMA (2, 1, 2) model for M1 of this sub-period.

Table 7.6: Estimation of ARIMA (2, 1, 2) Model for M1

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.149324	0.014774	10.10754	0.0021
AR(1)	-0.438463	0.239573	-1.830185	0.1646
AR(2)	-0.125499	0.429431	-0.292245	0.7891
MA(1)	4.721212	4.191919	1.126265	0.3420
MA(2)	2.003681	2.980606	0.672239	0.5496
Akaike info criterion =		-6.747948	R^2 =	0.974193
Schwarz criterion =		-6.698297	Adj. R^2 =	0.939784
Durbin-Watson stat =		1.309419	RSS =	0.000157

The estimated ARIMA model for M1 (1974- 1983) is as follows:

$$\hat{m}_{1t} = 0.149324 - 0.438463M1_{t-1} - 0.125499M1_{t-2} + 4.721212\epsilon_{t-1} + 2.003681\epsilon_{t-2} \quad (7.6)$$

(0.014774)	(0.239573)	(0.429431)	(4.191919)	(2.980606)
[10.10754]	[-1.830185]	[-0.292245]	[1.126265]	[0.672239]

R^2 = 0.974193 Adj. R^2 = 0.939784 Durbin-Watson stat = 1.309419

Akaike info criterion = -6.747948 Schwarz criterion = -6.698297

On the basis of the model, the anticipated and unanticipated parts of money supply of this sub-period have been estimated. The anticipated and unanticipated parts of M1 for this sub-period are being presented through the following table (Table 7.7).

Table 7.7: Actual, Anticipated and Unanticipated Parts of M1 (1974-1983)

Sample (adjusted): 1976- 1983

Year	Actual M1	Anticipated. M1	Unanticipated. M1
1976	0.20433	0.19783	0.00650
1977	0.16668	0.17044	-0.00376
1978	0.12973	0.13010	-0.00036
1979	0.14137	0.14649	-0.00513
1980	0.12244	0.13034	-0.00790
1981	0.11226	0.11453	-0.00227
1982	0.14501	0.14242	0.00259
1983	0.16422	0.16357	0.00065

7.7 Output-Money supply (M1) relationship for the second sub-period (1974-1983)

The output level has been regressed over the anticipated and unanticipated parts of M1 over the period 1974-1983. The appropriate lag selection has been confirmed on the basis AIC and SC. The results of estimation are given in the following table (Table 7.8). The results of the estimation of two restricted equations are also being presented through the second and third parts of the Table 7.8.

Table 7.8: Output – Money supply (M1) relationship for the second sub-period*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	-0.089474	0.060455	-1.480010	0.1989
$AntM1_{t-1}$	0.695618	0.390186	1.782788	0.1347
$UnantM1_{t-1}$	-4.439031	2.284330	-1.943253	0.1096
Akaike info criterion =		-4.441358	R^2 :-	0.472341
Schwarz criterion =		-4.411567	Adj. R^2:-	0.261277
Durbin-Watson stat:-		1.927340	RSS :-	0.002606
F- statistic:-	2.237906	Prob.(F- statistic):-		0.202248

$(\Delta Yt = \alpha + \beta_1 AntM1_{t-1})$

Constant(α)	-0.020507	0.059191	-0.346452	0.7408
$AntM1_{t-1}$	0.270125	0.390592	0.691577	0.5151
R^2 :- 0.073828	RSS :- 0.004575		Adj. R^2:- -0.080534	

$(\Delta Yt = \alpha + \beta_1 UnantM1_{t-1})$

Constant(α)	0.017262	0.009795	1.762204	0.1285
$UnantM1_{t-1}$	-2.153688	2.207445	-0.975648	0.3669
R^2 :- 0.136925	RSS :- 0.004263		Adj. R^2:- -0.006921	

* $(\Delta Y_t = \alpha + \beta_1 AntM1_{t-1} + \beta_2 UnantM1_{t-1} + \varepsilon_t)$ Sample (adjusted):- 1977 1984

It has been observed from the table that the coefficients for anticipated and unanticipated parts of M1 are not statistically significant even at 10% level of significance. Thus both the systematic and surprise parts of money supply failed to exert any significant influence on output level over the period 1974-1983.

These results have further been verified through the estimation of two restricted equations. In our estimation-

F* =3.7778 when unanticipated part of money supply was restricted.

F*=3.1792 when anticipated part of money supply was restricted.

Critical Value = $F_{(1,5)}$ at 5% level is 6.61; $F_{(1,5)}$ at 10 % level is 4.06.

Consequently, both the estimated F-statistic falls short of the critical value of 'F' at 5% level of significance. This indicates that both the anticipated and unanticipated part of money supply had no significant effect on the variation in output level over the period concerned. Consequently, money supply (M1) was completely 'neutral' over the period.

7.8 The ARIMA structure for third sub-period of M1 (1984-2003)

The Figure (7.3) presents the ACF and PACF of M1 for the third sub-period (1984-2003). The AC and PAC for the first lag seem more significant than other lags.

Figure 7.3: Correlogram of the series for the third sub-period of M1

Correlogram of DM1T3

Included observations: 20

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.440	0.440	4.4782	0.034
		2	-0.064	-0.319	4.5792	0.101
		3	-0.141	0.051	5.0906	0.165
		4	-0.015	0.033	5.0970	0.277
		5	0.060	0.014	5.2043	0.391
		6	0.119	0.109	5.6504	0.463
		7	0.210	0.165	7.1368	0.415
		8	0.010	-0.205	7.1404	0.522
		9	-0.332	-0.263	11.538	0.241
		10	-0.291	0.038	15.264	0.123
		11	-0.139	-0.179	16.207	0.134
		12	-0.011	0.012	16.214	0.182

On the basis of this pictorial presentation of ACF and PACF of M1, the ARIMA structure has been identified. The lag structure has been rationalized on the basis of AIC and SC. M1 is found to have ARIMA (2, 1, 2) model for the period concerned such that the model is,

$$(1-\Phi_1 L-\Phi_2 L^2)\ dM1t = (1-\theta_1 L-\theta_2 L^2)e_t \qquad (7.7)$$

7.7.1 Estimation of ARIMA (2, 1, 2) Model for M1 (1984- 2003)

The results of estimation of the model (Equation 7.7) are being presented through the Table 7.9.

Table 7.9: Estimation of ARIMA (2, 1, 2) Model for M1

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.137223	0.019260	7.124691	0.0000
AR(1)	0.136558	0.190693	0.716114	0.4866
AR(2)	-0.488222	0.240962	-2.026136	0.0638
MA(1)	0.781524	0.071989	10.85620	0.0000
MA(2)	0.920149	0.140036	6.570814	0.0000
Akaike info criterion =		-3.346158	R^2 =	0.584085
Schwarz criterion =		-3.098832	Adj. R^2 =	0.456111
Durbin-Watson stat =		2.217500	RSS =	0.021296

The estimated ARIMA (2, 1, 2) equation is,

$$\hat{M}1t = 0.137223 + 0.136558M1_{t-1} - 0.\ 0.488222M1_{t-2} + 0.781524\epsilon_{t-1} + 0.920149\epsilon_{t-2} \quad (7.8)$$

(0.019260) (0.190693) (0.240962) (0.071989) (0.140036)
[7.124691] [0.716114] [-2.026136] [10.85620] [6.570814]

R^2 = 0.584085 Adj. R^2 = 0.456111 Durbin-Watson stat = 2.217500
Akaike info criterion = -3.346158 Schwarz criterion = -3.098832

7.7.2 Findings

It is observed from the estimated equation (7.8) that,

(i) $\hat{\Phi}_1$ = 0.136558 is insignificant even at 10% level of significance.

(ii) $\hat{\Phi}_2$ = -0.488222 is significant only at 10 % level of significance.

(iii) $\hat{\theta}_1$ = 0.781524 is significant at 1% level of significance.

(iv) $\hat{\theta}_2$ = 0.920149 is significant at 1% level of significance.

These indicate that,

(i) Money supply in this sub period was not significantly affected by its own first lag, but it was negatively affected at 10% level by its own second lag.

(ii) Money supply in this sub period was significantly affected by first two lags of residual term.

On the basis of these estimations the anticipated and unanticipated parts of money supply of this sub period has been estimated. The series of anticipated and unanticipated parts are being presented through the following table (Table 7.10).

Table 7.10: Actual, Anticipated and Unanticipated Parts of M1 (1984-2003)

Sample (adjusted): 1986- 2003

Year	Actual M1	Anticipated M1	Unanticipated M1
1986	0.21328	0.21860	-0.00531
1987	0.21659	0.20312	0.01347
1988	0.12956	0.11656	0.01299
1989	0.17627	0.11997	0.05629
1990	0.19230	0.20225	-0.00995
1991	0.21510	0.16970	0.04540
1992	0.14821	0.14729	0.00092
1993	0.21469	0.14320	0.07149
1994	0.18692	0.19916	-0.01224
1995	0.09461	0.16241	-0.06780
1996	0.05765	0.04289	0.01476
1997	0.08237	0.09631	-0.01394
1998	0.16477	0.17127	-0.00650
1999	0.19136	0.14986	0.04150
2000	0.13430	0.15762	-0.02332
2001	0.13533	0.13035	0.00498
2002	0.06692	0.12082	-0.05390
2003	0.08206	0.09100	-0.00894

7.9: Output-Money supply (M1) relationship for the third sub period (1984-2003)

The relationship between output level and anticipated and unanticipated parts money supply has been enquired into through the estimation of the equation,

$$y_t = \alpha + \beta_1 M1^{c}_{t} + \beta_2 UM1^{c}_{t} + \upsilon_t \qquad (7.9)$$

The results of estimation are being presented through the first part of the following table (Table 7.11).

Table 7.11: Output – Money supply (M1) relationship for the third sub-period*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.044332	0.020626	2.149313	0.0483
$AntM1_t$	-0.010615	0.134300	-0.079038	0.9380
$UnantM1_t$	0.252911	0.172216	1.468565	0.1626
Akaike info criterion :-		-4.394965	R^2 :-	0.127824
Schwarz criterion :-		-4.246569	Adj. R^2:-	0.011533
Durbin-Watson stat:-		2.634208	RSS :-	0.009318
F- statistic:- 1.099177		Prob.(F- statistic):-		0.358536
($\Delta Yt = \alpha + \beta_1 AntM1_t$)				
Constant(α)	0.047626	0.021232	2.243091	0.0394
AntM1t	-0.027317	0.138571	-0.197132	0.8462
R^2 :- 0.002423		RSS :- 0.010658	Adj. R^2:-	-0.059926
($\Delta Yt = \alpha + \beta_1 UnantM1_t$)				
Constant(α)	0.042770	0.005716	7.482413	0.0000
$UnantM1_t$	0.254063	0.166183	1.528815	0.1458
R^2 :- 0.127460		RSS :- 0.009322	Adj. R^2:-	0.072927

*($\Delta Yt = \alpha + \beta_1 AntM1t + \beta_2 UnantM1t + \varepsilon_t$) Sample (adjusted):- 1986 2003

Critical Value for $F_{(1, 14)}$ at 5% level of significance is 4.60.

It has been observed that,

(i) Both $\hat{\beta}_1$ and $\hat{\beta}_2$ are insignificant even at 10% level of significance.

(ii) Output level was irresponsive to variation to that in anticipated and unanticipated parts of money supply (M1) over the period concerned

This finding has further been examined through the estimation of two restricted equations (following Chow). The results of such estimations are being presented through second and third parts of the Table 7.11.

In this estimation,

$F^* = 2.157$ when unanticipated part of money supply is restricted.

$F^* = 0.0064$ when unanticipated part of money supply is restricted.

$F_{0.05}^{(1,15)} = 4.54$ (Critical Value for $F_{(1,15)}$ at 5% level of significance is 4.54)

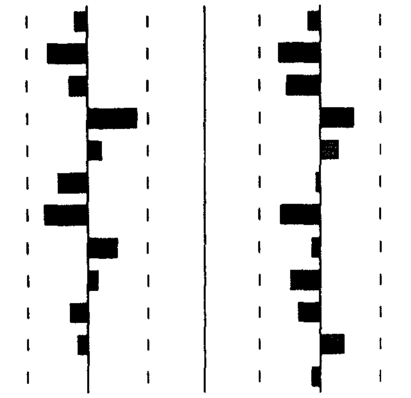
Here, both F^*s fall short of $F_{0.05}^{(1,15)}$. Consequently, both anticipated and unanticipated parts of M1 appear to appear to have no impact on output variation over the period 1984-2003. Thus systematic monetary policy and monetary surprise shocks are found to be non-effective in influencing output level over the sub-period concerned.

7.10: The ARIMA structure for first sub-period of M2 (1959-1973)

The broad money supply for the period of study has also been divided into three sub-periods (i.e.1959-1973, 1974-1983 and 1984-2003) following Chow Breakpoint Test. It is, therefore, necessary to identify the anticipated and unanticipated parts of money supply for each sub-period. The identification has been estimated on the basis of ARIMA structure for each sub period. The following figure (Figure 7.4) presents the correlogram for first sub-period of M2, on the basis of which the informal idea for finding the appropriate lag for ARIMA structure can be drawn.

Figure 7.4: Correlogram of the series for the first sub-period of M2

Included observations: 14



Autocorrelation / Partial Correlation	AC	PAC	Q-Stat	Prob
1	-0.111	-0.111	0.2135	0.644
2	-0.345	-0.362	2.4415	0.295
3	-0.157	-0.291	2.9442	0.400
4	0.442	0.291	7.3147	0.120
5	0.126	0.159	7.7073	0.173
6	-0.269	-0.041	9.7327	0.136
7	-0.393	-0.351	14.672	0.040
8	0.261	-0.077	17.206	0.028
9	0.087	-0.260	17.542	0.041
10	-0.151	-0.193	18.819	0.043
11	-0.097	0.207	19.519	0.052
12	0.001	-0.065	19.519	0.077

The following table (Table 7.12) presents the estimations of ARIMA structure for the first sub-period of M2. The appropriate lag for this model has been confirmed on the basis of AIC and SC.

Table 7.12: Estimation of ARIMA (2, 1, 2) Model for M2 (1959-1973)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.142594	0.018984	7.511409	0.0001
AR(1)	-1.078007	0.383875	-2.808224	0.0262
AR(2)	-0.107202	0.276402	-0.387848	0.7097
MA(1)	-0.124030	3.121399	-0.039735	0.9694
MA(2)	-7.577349	4.009974	-1.889625	0.1007
Akaike info criterion =		-5.063530	R^2 =	0.977135
Schwarz criterion =		-4.861486	Adj. R^2 =	0.964069
Durbin-Watson stat =		1.292068	RSS =	0.001931

The estimated ARIMA (2, 1, 2) equation is,

$$\hat{m}_{2t} = 0.142594 - 1.078007M2_{t-1} - 0.107202M2_{t-2} - 0.124030\epsilon_{t-1} - 7.577349\epsilon_{t-2} \quad (7.10)$$

(0.018984) (0.383875) (0.276402) (3.121399) (4.009974)

[7.511409] [-2.808224] [-0.387848] [-0.039735] [-1.889625]

R^2 = 0.977135 Adj. R^2 = 0.964069 Durbin-Watson stat = 1.29206

The 't-statistic' of the coefficient of AR (1) is significant at 5% level while AR(2), MA(1) and MA(2) are insignificant even at 10% level of significance. On the basis of the estimations of the ARIMA structure which has been presented in the equation (7.10), the estimations of anticipated and unanticipated part of broad money supply for this sub period have been estimated. The fitted part of the above estimations shows the anticipated part while residual term of this estimation presents unanticipated part of money supply. The anticipated and unanticipated parts of M2 for this sub period are being presented through the following table (Table 7.13)

Table 7.13: Actual, Anticipated and Unanticipated Parts of M2 (1959-1973)

Sample (adjusted): 1962- 1973

Year	Actual M1	Anticipated M1	Unanticipated M1
1962	0.03977	0.06087	-0.02110
1963	0.22831	0.24977	-0.02147
1964	0.22249	0.22376	-0.00127
1965	0.22724	0.21010	0.01714
1966	0.05643	0.05029	0.00614
1967	0.07901	0.09577	-0.01677
1968	0.17702	0.17593	0.00109
1969	0.25037	0.23920	0.01117
1970	0.00939	0.01310	-0.00371
1971	0.17440	0.19049	-0.01609
1972	0.15404	0.15270	0.00133
1973	0.25182	0.24864	0.00318

7.11: Output-Money supply (M2) relationship for the first sub period (1959-1973)

The following table (Table 7.14) presents the relationship between output level and the first lag of anticipated and unanticipated parts of money supply for this sub period.

Table 7.14: Output-Money supply (M2) relationship for the first sub-period*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	-0.016824	0.011460	-1.468005	0.1803
$AntM2_{(-1)}$	0.219796	0.065283	3.366832	0.0098
$UnantM2_{(-1)}$	0.421837	0.409615	1.029837	0.3332
Akaike info criterion :-		-5.099765	R^2 :-	0.636731
Schwarz criterion :-		-4.991249	Adj. R^2:-	0.545913
Durbin-Watson stat:-		2.612283	RSS :-	0.002276
F- statistic:-	7.011116	Prob.(F- statistic):-		0.017415
$(\Delta Yt = \alpha + \beta_1 AntM2_{t-1})$				
Constant(α)	-0.020256	0.011002	-1.841239	0.0987
$AntM2_{t-1}$	0.231466	0.064508	3.588179	0.0059
R^2 :- 0.588572		RSS :- 0.002578	Adj. R^2:-	0.542858
$(\Delta Yt = \alpha + \beta_1 UnantM2_{t-1})$				
Constant(α)	0.017333	0.007813	2.218307	0.0537
$UnantM2_{t-1}$	0.661212	0.591276	1.118280	0.2924
R^2 :- 0.121998		RSS :- 0.005502	Adj. R^2:-	0.024443

* $(\Delta Yt = \alpha + \beta_1 AntM2_{(-1)} + \beta_2 UnantM2_{(-1)} + \varepsilon_t)$ Sample (adjusted):- 1963 1973

The estimated equation is,

$$\hat{y}_t = -0.016824 + 0.219796\ M2^{e}_{t-1} + 0.421837 UM2^{e}_{t-1} \qquad (7.11)$$

$$\begin{array}{lll} (0.011460) & (0.065283) & (0.409615) \\ [-1.468005] & [3.366832] & [1.029837] \end{array}$$

$R^2 =$ 0.636731 Adj. $R^2 =$ 0.545913

F- stat = 7.011116 D-W stat = 2.612283

The estimations based on the equation (7.11) present the findings that first lag of anticipated part of M2 has influenced real output at 1% level of significance while same lag of unanticipated part of M2 has no significant influence on real output even at 10% level. Again for assessing the significance of anticipated and unanticipated parts of broad money supply (M2) on output level, restricted regression equations have also been estimated. The second part of the Table 7.14 presents the regression equation where unanticipated part is restricted. Similarly, the third part of the table presents the regression equation where anticipated part of broad money supply (M2) is subject to restriction. It has been observed from the table that the anticipated part is significant at 1% level while unanticipated part is insignificant even at 10% level.

It is also found that-

$F^* = 1.0615$ when the first lag of unanticipated part of M2 is restricted.

$F^* = 11.3392$ when the first lag of anticipated part of M2 is restricted.

Critical Value for $F_{(1, 8)}$ at 5% level of significance is 5.32.

It is further observed that estimated 'F^* -statistic' is less than the critical value for $F_{(1, 8)}$ at 5% level of significance for the first case (when unanticipated part of M2 is restricted) while 'F^* -statistic' is greater than the critical value for the second case.

The F-statistic of first case shows that the unanticipated part of money supply does not affect the output level in this sub-period at 5 % level of significance while the anticipated part has affected the real output at 5% level. This indicates that-

(i) The first lag of anticipated part of M2 has significant effect on real output while same lag of unanticipated part of M2 has insignificant effect on real output level.

(ii) Monetary policy contrary to 'Invariance Proposition' had significant impact on real output level.

(iii) Surprise in money supply (unanticipated part of broad money supply) supplanted the influence of money supply on real output level in this sub-period.

The following table (Table 7.15) presents the relationship between output level and anticipated and unanticipated parts of money supply for the same period.

Table 7.15: Output-Money supply (M2) relationship for the first sub-period*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.040876	0.011804	3.462732	0.0071
$AntM2_t$	-0.131109	0.064476	-2.033465	0.0725
$UnantM2_t$	1.322521	0.423797	3.120648	0.0123
Akaike info criterion :-		-5.036964	R^2 :-	0.564820
Schwarz criterion :-		-4.915737	Adj. R^2:-	0.468113
Durbin-Watson stat:-		2.262722	RSS :-	0.002767
F- statistic:- 5.840545		Prob.(F- statistic):-		0.023660
($\Delta Y_t = \alpha + \beta_1 AntM2_t$)				
Constant(α)	0.029525	0.015373	1.920596	0.0837
$AntM2_t$	-0.087755	0.086187	-1.018193	0.3326
R^2 :- 0.093933	RSS :- 0.005761		Adj. R^2:- 0.003327	
($\Delta Y_t = \alpha + \beta_1 UnantM2_t$)				
Constant(α)	0.019376	0.006017	3.220454	0.0092
$UnantM2_t$	1.136831	0.474295	2.396883	0.0375
R^2 :- 0.364880	RSS :- 0.004039		Adj. R^2:- 0.301368	

* ($\Delta Yt = \alpha + \beta_1 AntM2_t + \beta_2 UnantM2_t + \varepsilon_t$) Sample (adjusted):- 1962 1973

The estimated equation is,

$$\hat{y}_t = 0.040876 - 0.131109M2^e_t + 1.322521UM2^e_t \quad (7.12)$$
$$(0.011804)\ (0.064476)\quad (0.423797)$$
$$[3.462732]\ [-2.033465]\quad [3.120648]$$

$R^2 =$ 0.564820 Adj. $R^2 =$ 0.468113

F- stat = 5.840545 D-W stat = 2.262722

The estimations based on the equation (7.12) present the findings that anticipated part of M2 has influenced real output at 10% level of significance while unanticipated part of M2 has significant influence on real output at 5% level. Again for assessing the significance of anticipated and unanticipated parts of broad money supply (M2) on output level, restricted regression equations have also been estimated. The second part of the Table 7.15 presents the regression equation where unanticipated part is restricted. Similarly, the third part of the table presents the regression equation where anticipated part of broad money supply (M2) is subject to restriction. It has been observed from the table that the anticipated part is significant at 10% level while unanticipated part is insignificant even at 5% level.

It is also found that-

$F^* = 9.7383$ when the first lag of unanticipated part of M2 is restricted.

$F^* = 4.137$ when the first lag of anticipated part of M2 is restricted.

Critical Value for $F_{(1,9)}$ at 5% level of significance is 5.12.

Critical Value for $F_{(1,9)}$ at 10 % level of significance is 3.36.

It is further observed that estimated 'F^* -statistic' is greater than the critical value for $F_{(1,9)}$ at 5% level of significance for the first case (when unanticipated part of M2 is restricted) while 'F^* -statistic' is less than the critical value at 5% level but greater than the critical value at 10% level of significance for the second case.

The F-statistic of first case shows that the unanticipated part of money supply has affected the output level in this sub-period at 5 % level of significance while the anticipated part has not affected the real output at 5% level but it has affected at 10% level of significance. This indicates that-

(i) The anticipated part of M2 has no significant effect (at 5%) on real output while the unanticipated part of M2 has significant effect on real output level.

(ii) Monetary policy contrary to 'Invariance Proposition' had no significant impact on real output level.

(iii) Surprise in money supply (unanticipated part of broad money supply) did not supplant the influence of money supply on real output level in this sub-period.

7.12 The ARIMA structure for second sub-period of M2 (1974-1983)

In order to identify the relationship between the output level and money supply (M2) for the second sub period according to 'Invariance Proposition of Rational Expectation', it is necessary to quantify the anticipated and unanticipated parts of money supply. The following figure (Figure 7.5) has presented the correlogram of M2 series for second sub period, on the basis of which the ARIMA structure has been identified.

Figure 7.5: Correlogram of the series for the second sub-period of M2

Correlogram of DM2T2

Included observations: 10

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.173	-0.173	0.3985	0.528
		2	-0.227	-0.265	1.1724	0.556
		3	-0.305	-0.444	2.7635	0.430
		4	0.026	-0.325	2.7766	0.596
		5	0.145	-0.264	3.2794	0.657
		6	0.156	-0.168	4.0118	0.675
		7	-0.043	-0.181	4.0845	0.770
		8	-0.068	-0.124	4.3605	0.823

7.12.1 Estimation of the ARIMA structure of M2 (1974-1983)

The correlogram shows that the estimations of ACF and PACF are almost insignificant at all the lags presented in the Figure (7.5). This scenario presents an informal idea for ARIMA structure for this sub period. The following table (Table 7.16) presents the estimations for ARIMA model of this sub-period.

Table 7.16: Estimation of ARIMA (2, 1, 2) Model for M2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.167736	0.022326	7.513006	0.0049
AR(1)	-0.101416	0.365324	-0.277606	0.7993
AR(2)	0.309093	0.203580	1.518287	0.2262
MA(1)	1.602355	0.248077	6.459106	0.0075
MA(2)	0.994995	1.31E-05	75755.51	0.0000
Akaike info criterion =		-5.794281	R^2 =	0.942954
Schwarz criterion =		-5.744630	Adj. R^2 =	0.866892
Durbin-Watson stat =		1.330037	RSS =	0.000409

The table shows that the ARIMA structure has been estimated appropriately according to AIC and SC. The fitted part of this estimation provides the anticipated part of money supply. The estimated ARIMA model for M2 (1974-1983) is as follows:

$$\hat{m}_{2t} = 0.167736 - 0.101416M2_{t-1} + 0.309093M2_{t-2} + 1.602355\epsilon_{t-1} - 0.994995\epsilon_{t-2} \quad (7.13)$$

(0.022326) (0.365324) (0.203580) (0.248077) (1.31E-05)

[7.513006] [-0.277606] [1.518287] [6.459106] [75755.51]

The't-statistic' of the coefficients of AR (1) and AR(2) are insignificant even at 10% level while MA(1) and MA(2) are significant at 1% level of significance. On the basis of the estimations of the ARIMA structure which has been presented in the equation (7.13), the estimations of anticipated and unanticipated part of broad money supply for this sub period have been estimated. The fitted part of the above estimations shows the anticipated part while residual term of this estimation presents unanticipated part of money supply. The anticipated and unanticipated parts of M2 for this sub period are being presented through the following table (Table 7.17)

Table 7.17: Actual, Anticipated and Unanticipated Parts of M2 (1974-1983)

Sample (adjusted): 1976- 1983

Year	Actual M2	Anticipated. M2	Unanticipated. M2
1976	0.25406	0.24964	0.00442
1977	0.19061	0.19647	-0.00586
1978	0.17960	0.18710	-0.00750
1979	0.14649	0.15575	-0.00926
1980	0.15929	0.15126	0.00803
1981	0.17459	0.16569	0.00891
1982	0.19385	0.18669	0.00715
1983	0.18331	0.18753	-0.00421

7.13: Output-Money supply (M2) relationship for the second sub period (1974-1984)

The following table (Table7.18) presents the output –money supply relationship for the second sub-period (1974-1983). Output level for this sub-period has been regressed with the anticipated and unanticipated parts of money supply of the same period.

Table 7.18: Output – Money supply (M2) relationship for the second sub-period*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	-0.012821	0.067652	-0.189515	0.8571
$AntM2_t$	0.168343	0.361298	0.465939	0.6609
$UnantM2_t$	0.773795	1.462631	0.529043	0.6194
Akaike info criterion :-		-3.925692	R^2 :-	0.092020
Schwarz criterion :-		-3.895902	Adj. R^2:-	-0.271172
Durbin-Watson stat:-		2.138955	RSS :-	0.004365
F- statistic:-	0.253364	Prob.(F- statistic):-		0.785581
($\Delta Yt = \alpha + \beta_1 AntM2_t$)				
Constant(α)	-0.013344	0.063456	-0.210285	0.8404
$AntM2_t$	0.172046	0.338860	0.507720	0.6298
R^2 :- 0.041193	RSS :- 0.004609		Adj. R^2:-	-0.118608
($\Delta Yt = \alpha + \beta_1 UnantM2_t$)				
Constant(α)	0.018322	0.009745	1.880129	0.1091
$UnantM2_t$	0.786999	1.363616	0.577141	0.5848
R^2 :- 0.052595	RSS :- 0.004555		Adj. R^2:-	-0.105305

* ($\Delta Yt = \alpha + \beta_1 AntM2t + \beta_2 UnantM2t + \varepsilon_t$) Sample (adjusted):- 1976 1983

It has been observed from the table that the coefficients for anticipated and unanticipated parts of M2 are not statistically significant even at 10% level of significance. Thus both the systematic and surprise parts of money supply failed to exert any significant influence on output level over the period 1974-1983.

These results have further been verified through the estimation of two restricted equations. In our estimation-

F* =0.2795 when unanticipated part of money supply was restricted.

F*=0.2176 when anticipated part of money supply was restricted.

Critical Value for $F_{(1, 5)}$ at 5% level of significance is 6.61.

Consequently, both the estimated F-statistic falls short of the critical value of 'F' at 5% level of significance. This indicates that both the anticipated and unanticipated parts of money supply had no significant effect on the variation in output level over the period concerned. Consequently, money supply (M2) was completely 'neutral' over the period.

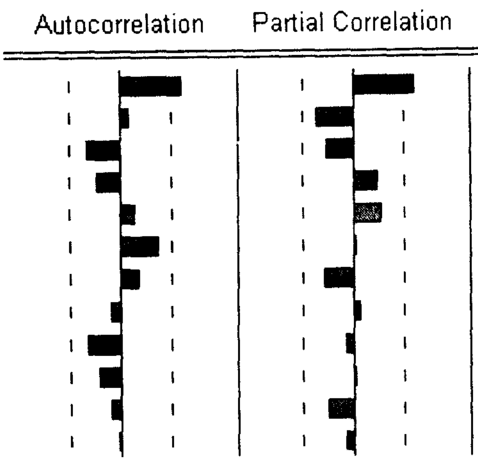
7.14: The ARIMA structure for third sub-period of M2 (1984-2003)

The Correlogram for the third sub-period of M2, which has been presented in the following figure (Figure 7.6), depicts the ACF and PACF at different lags.

Figure 7.6: Correlogram of the series for the third sub-period of M2

Correlogram of DM2T3

Included observations: 20



	AC	PAC	Q-Stat	Prob
1	0.542	0.542	6.7937	0.009
2	0.063	-0.326	6.8906	0.032
3	-0.289	-0.250	9.0520	0.029
4	-0.200	0.217	10.152	0.038
5	0.126	0.245	10.619	0.059
6	0.331	0.014	14.067	0.029
7	0.152	-0.255	14.846	0.038
8	-0.093	0.052	15.161	0.056
9	-0.302	-0.068	18.800	0.027
10	-0.197	0.017	20.501	0.025
11	-0.090	-0.237	20.894	0.034
12	-0.013	-0.076	20.903	0.052

On the basis of this pictorial presentation of ACF and PACF of M2, the ARIMA structure has been identified. The lag structure has been rationalized on the basis of AIC and SC. M2 is found to have ARIMA (2, 1, 2) model for the period concerned such that the model is,

$$(1-\Phi_1 L-\Phi_2 L^2)\, dM2t = (1-\theta_1 L-\theta_2 L^2)\epsilon_t \qquad (7.14)$$

Table 7.19: Estimation of ARIMA (2, 1, 2) Model for M2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.169381	0.008815	19.21425	0.0000
AR(1)	1.177409	0.098077	12.00497	0.0000
AR(2)	-1.120551	0.126385	-8.866179	0.0000
MA(1)	-0.507991	0.073687	-6.893883	0.0000
MA(2)	0.981397	0.070479	13.92463	0.0000
Akaike info criterion =		-4.421542	R^2 =	0.792538
Schwarz criterion =		-4.174217	Adj. R^2 =	0.728704
Durbin-Watson stat =		2.079583	RSS =	0.007266

The table shows that the ARIMA structure has been estimated appropriately according to AIC and SC. The fitted part of this estimation provides the anticipated part of money supply. The estimated ARIMA model for M2 (1984-2003) is as follows:

$$\hat{m}_{2t} = 0.169381 + 1.177409 M2_{t-1} - 1.120551 M2_{t-2} - 0.507991 \epsilon_{t-1} + 0.981397 \epsilon_{t-2} \quad (7.15)$$

(0.008815) (0.098077) (0.126385) (0.073687) (0.070479)

[19.21425] [12.00497] [-8.866179] [-6.893883] [13.92463]

On the basis of the estimations of the ARIMA model, anticipated and unanticipated parts of money supply for this sub-period have been estimated. The fitted part of above model presents the anticipated part of M2 while the residual part presents the unanticipated part of money supply for this sub-period. The series of anticipated and unanticipated parts of M2 for this sub-period are being presented through following table (Table 7.20).

Table 7.20: Actual, Anticipated and Unanticipated Parts of M2 (1984-2003)

Sample (adjusted): 1986- 2003

Year	Actual M1	Anticipated M1	Unanticipated M1
1986	0.17757	0.18241	-0.00484
1987	0.20210	0.19900	0.00310
1988	0.19927	0.19240	0.00687
1989	0.19101	0.16747	0.02354
1990	0.16969	0.15613	0.01356
1991	0.20435	0.16173	0.04262
1992	0.18822	0.20186	-0.01364
1993	0.22139	0.20114	0.02025
1994	0.16665	0.18583	-0.01918
1995	0.14504	0.13751	0.00753
1996	0.11503	0.12113	-0.00610
1997	0.14638	0.14315	0.00323
1998	0.21520	0.19558	0.01962
1999	0.19575	0.24230	-0.04655
2000	0.17227	0.19199	-0.01972
2001	0.10905	0.10757	0.00148
2002	0.05035	0.07500	-0.02465
2003	0.10746	0.11081	-0.00335

7.15: Output-Money supply (M2) relationship for the third sub-period (1984-2003)

The relationship between output level and anticipated and unanticipated parts of money supply (M2) for the third sub-period has been presented through the following table (Table 7.21).

Table 7.21: Output – Money supply (M2) relationship for the third sub-period*

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant(α)	0.008254	0.023814	0.346605	0.7337
$AntM2_t$	0.213741	0.139898	1.527832	0.1474
$UnantM2_t$	0.279747	0.286829	0.975311	0.3449
Akaike info criterion :-		-4.442409	R^2 :-	0.168237
Schwarz criterion :-		-4.294014	Adj. R^2:-	0.057336
Durbin-Watson stat:-		2.780245	RSS :-	0.008886
F- statistic:- 1.516994		Prob.(F- statistic):-		0.251186
($\Delta Yt = \alpha + \beta_1 AntM2_t$)				
Constant(α)	0.010414	0.023674	0.439883	0.6659
$AntM2_t$	0.201018	0.139076	1.445380	0.1677
R^2 :- 0.115491		RSS :- 0.009450	Adj. R^2:- 0.060209	
($\Delta Yt = \alpha + \beta_1 UnantM1_t$)				
Constant(α)	0.043566	0.005972	7.295393	0.0000
$UnantM2_{t-1}$	0.238885	0.297248	0.803654	0.4334
R^2 :- 0.038800		RSS :- 0.010269	Adj. R^2:- -0.021275	

* ($\Delta Yt = \alpha + \beta_1 AntM2_t + \beta_2 UnantM2_t + \varepsilon_t$) Sample (adjusted):- 1986 2003

It has been observed from the table that the coefficients for anticipated and unanticipated parts of M2 are not statistically significant even at 10% level of significance. Thus both the systematic and surprise parts of money supply failed to exert any significant influence on output level over the period 1984-2003.

These results have further been verified through the estimation of two restricted equations. In our estimation-

F* =0.9521 when unanticipated part of money supply was restricted.

F*=2.2346 when anticipated part of money supply was restricted.

Critical Value for $F_{(1, 15)}$ at 5% level of significance is 4.54.

Consequently, both the estimated F-statistic falls short of the critical value of 'F' at 5% level of significance. This indicates that both the anticipated and unanticipated parts of money supply had no significant effect on the variation in output level over the period concerned. Consequently, money supply (M2) was completely 'neutral' over the period.

7.16: Summary

The present chapter has been related to the output-money supply relationship in different sub-periods. The different sub-periods have been identified on the basis of stability test and hence the structural breaks of the period of study. The structural breaks have been identified using Chow Break-point Test. After identifying the structural breaks, the series of real output, M1 and M2 of the present study have been divided into three sub-periods i.e. 1959-1973, 1974-1983 and 1984-2003. The anticipated and unanticipated parts of money supply for each sub-period have been found using ARIMA structure.

The findings of the present study have been presented separately for narrow money supply and broad money supply.

7.13.1 Narrow Money Supply (M1)

(i) The anticipated and unanticipated parts of M1 for the first sub-period (1959-1973) have been estimated using ARIMA (1, 1, 1) structure. Regressing the real output level for the first sub-period (1959-1973) with the first lag of anticipated and unanticipated parts of narrow money supply, the't-statistic' of the coefficients of both anticipated and unanticipated parts are significant only at 10 % level of significance. The 'F-statistic' of both cases shows that both parts of money supply do not affect the output level in this sub-period at 5 % level of significance.

(ii) The anticipated and unanticipated parts of M1 for the second sub-period (1974-1983) have been estimated using ARIMA (2, 1, 2) structure. The real output level for the second sub-period (1974-1983) has been regressed with the first lag of anticipated and unanticipated parts of narrow money supply, the 't-statistic' of the coefficients of both anticipated and unanticipated parts are insignificant even at 10 % level of significance. The 'F-statistic' of both cases shows that both parts of money supply do not affect the output level in this sub-period at 5 % level of significance.

(iii) The anticipated and unanticipated parts of M1 for the third sub-period (1984-2003) have been estimated using ARIMA (2, 1, 2) structure. The real output level for the third sub-period (1984-2003) has been regressed with the anticipated and unanticipated parts of narrow money supply. The't-statistic' of the coefficients of both anticipated and unanticipated parts are insignificant even at 10 % level of significance. The 'F-statistic' of both cases shows that both parts of money supply do not affect the output level in this sub-period at 5 % (even at10%) level of significance.

7.15.2 Broad Money Supply (M2)

(i) The anticipated and unanticipated parts of M2 for the first sub-period (1959-1973) have been estimated using ARIMA (2, 1, 2) structure. The real output level for this sub-period (1959-1973) has been regressed with the first lag of anticipated and unanticipated parts of broad money supply. The't-statistic' of the coefficient of the anticipated part is significant at 1% level while the coefficient of unanticipated part is insignificant even at 10 % level of significance. The 'F-statistic' of both cases shows that the anticipated part of money supply has affected the real output level in this sub-period at 5 % level of significance while the unanticipated part has no significant influence on real output. Similarly the real output for this sub-period has also been regressed with anticipated and unanticipated parts of money supply for the same period (i.e. no lags). It has found from this estimation that the't-statistic' of the coefficient of the anticipated part is significant only at 10% level while the coefficient of unanticipated part is significant even at 5 % level of significance. The 'F-statistic' of both cases shows that the anticipated part of money supply has not affected the real output level in this sub-period at 5 % level of significance but it has affected the real output at 10% level of significance while the unanticipated part has significant influence on real output at 5% level of significance.

(ii) The anticipated and unanticipated parts of M2 for the second sub-period (1974-1983) have been estimated using ARIMA (2, 1, 2) structure. The real output level for the second sub-period (1974-1983) has been regressed with the anticipated and unanticipated parts of broad money supply. The't-statistic' of the coefficients of both anticipated and unanticipated parts are insignificant even at 10 % level of significance. The 'F-statistic' of both cases shows that both parts of money supply do not affect the output level in this sub-period even at 10 % level of significance.

(iii) The anticipated and unanticipated parts of M2 for the third sub-period (1984-2003) have been estimated using ARIMA (2, 1, 2) structure. The real output level for the third sub-period (1984-2003) has been regressed with the anticipated and unanticipated parts of broad money supply. The't-statistic' of the coefficients of both anticipated and unanticipated parts are insignificant even at 10 % level of significance. The 'F-statistic' of both cases shows that both parts of money supply do not affect the real output level in this sub-period at 5 % (even at10%) level of significance.

7.13.2 Conclusion:

The broad conclusion of the present chapter has been summarized as following:

(i) The real output has been influenced by both money supplies at the initial sub-period (1959-1973) but the effectiveness of broad money supply is comparatively higher than narrow money supply.

(ii) The monetary policy seems more effective to affect real output in the case of first lag of anticipated and unanticipated parts of M2 while the 'Invariance Proposition' has been effective when there is no lag of these parts for this sub-period. Unanticipated part of M2 for the same period is more effective.

(iii) The real output has not been affected by both money supplies at the second and third sub periods. Both parts of money supplies are ineffective to influence the real variable in these sub-periods. Neither anticipated part nor surprise part has influential role to affect real output in these sub-periods.

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CHAPTER- VIII

Summary and Conclusions

8.1 Summary

8.1.1 The first chapter of the present study has focused on a brief introduction of the basic feature of Nepalese economy. Analyzing the characteristics of Nepalese economy, current trend and tendencies of macroeconomic variables of the economy have been presented. A glance on global economy for the comparison with Nepalese economy has also been mentioned. Objectives of the study, theoretical background of Rational Expectation hypothesis and plan of the study have also been included in this chapter.

8.1.2 In the second chapter, Literature Survey for the present work has been presented. In this process, the conclusions of several works related to the present study in developed and developing economies have been reviewed. Reviewing those works, it has been found that the invariance proposition of Rational Expectations hasn't been applicable in all the countries. Even though the policy ineffectiveness theorem has been applied in some of the developed economies, this proposition hasn't been applicable in most of the developing economies.

8.1.3 The third chapter has focused on the methodological issues as well as data and variables of the present study. The introductions of several econometric tools like Testing for stationarity, Cointegration test, Vector Error Correction Modeling, Granger Causality

Test, Unrestricted vector auto regression modeling, ARIMA structure of the variables and Chow Breakpoint Test have been presented.

8.1.4 The fourth chapter is related to the analysis of the nature of macroeconomic variables which are used in the present work. Testing for stationarity of the variables has been presented for identifying the nature of variables. For this purpose unit root tests, Correlogram of the variables and nature of line graphs have been presented. Testing for unit root has been conducted on the basis of Augmented Dickey-Fuller, Phillips-Perron, DF-GLS, KPSS, ERS Point optimal and Ng-Perron modified unit root tests. It has been found from these tests that all the variables i.e. real output, nominal output, narrow money supply (M1) and broad money supply (M2) are non-stationary at level whereas they are stationary at first differences.

8.1.5 The fifth chapter is related to the cointegration test, vector error correction modeling, unrestricted vector auto regression modeling and conventional Granger causality test. The cointegration test has been applied with the help of Durbin-Watson test, Engle-Granger's method and Johansen's cointegration test. The Durbin-Watson test (CRDW) has provided the result that there is no cointegration between real output and both forms of money supply but the long run relationship has been found between nominal output and both money supplies. The Engle-Granger's method of cointegration, which is based on the stationarity test of the residual series from the OLS regression equation between two variables, has provided mixed findings from the different cases. The ADF unit root test on the residual between real output and money supplies with exogenous as constant shows that there is no cointegration between these variables even though there is cointegration between nominal output and both level of money supplies. The same unit root test with no exogenous provides the result that there is cointegration between the real output and money supplies (M1 & M2). The Phillips- Perron unit root test on residual with constant as exogenous provides the finding that there is cointegration between real output and narrow money supply (M1) at 5% level of significance but there is no cointegration between real output and broad money supply. The same unit root test on residual with no exogenous presents the finding that there is cointegration between real output and both level money supplies. The residual is stationary at 1% level for real output and M1 while it is stationary at 5% level for real output and M2. The Johansen's method of cointegration test is quite different method than earlier two methods. It is based on trace statistic and max-eigen statistic. Comparing these statistic values with critical values, the finding shows that there is long run relationship between real output and both money supplies (M1 and M2).

Vector Error Correction modeling and Conventional Granger Causality test provided the result that there is unidirectional causality from money to output. The unrestricted vector auto regression (UVAR) modeling has provided the finding that the real output has been affected by first lag of both money supplies. The broad money supply has also been affected by its own second lag. In the case of nominal output and money supplies, the narrow money supply (M1) has been influenced by first lag of nominal output and its own second lag at 10% level of significance. Again nominal output has been affected by first lag of broad money supply (M2) at 1% level and M2 has also been influenced by first lag of nominal output (at 5 %) and its own second lag (at 1%).

8.1.6 The anticipated and unanticipated parts of both money supplies (M1& M2) have been estimated in sixth chapter. These parts have been identified on the basis of relevant ARIMA structures. The equation based on OLS method taking real output level as dependent variable with anticipated and unanticipated parts of money supply, it has been found that the anticipated part of both money supplies has significant role to influence the real output level while this level has not been affected by unanticipated part of money supply during the period of study (1959-2003).

8.1.7 The seventh chapter has presented the output-money supply relationship in different sub-periods. The different sub-periods have been identified on the basis of stability test and hence the structural breaks of the study period. The structural breaks have been identified using Chow Breakpoint Test. After identifying the structural breaks, the whole series have been divided into three sub-periods i.e. 1959-1973, 1974-1983 and 1984-2003. The anticipated and unanticipated part of money supply of each sub-period has been found using ARIMA modeling. Regressing the real output level for the first sub-period (1959-1973) separately with the first lag of anticipated and unanticipated parts of narrow money supply, the t-statistic of the coefficients of both anticipated and unanticipated parts are significant only at 10 % level of significance. However, the F-statistic of both cases shows that both parts of money supply do not affect the output level in this sub-period at 5 % level of significance but both parts have significant affect on the real output at 10% level of significance.

The first lag of anticipated part of broad money supply has significant role (at 1%) to influence the real output level in this sub period while the same lag of unanticipated part has no significant influence on real output. The relationship between output level and anticipated as well as unanticipated parts of broad money supply with no lags has presented the findings that the anticipated part of money supply has affected the output level at 10% level of significance while the unanticipated part of money supply has affected the output level at 5% level of significance.

The output level at the second sub-period has not been affected by both parts of money supplies (M1 &M2). The same situation has been applied in the case third sub-period also. Both parts of money supplies (M1 &M2) have been ineffective to influence the real out in this sub-period.

8.2 Conclusions

The following inferences can be drawn from the econometric study of the money-output relationship in Nepal.

8.2.1 First, all the macroeconomic variables have generally been found to suffer from non-stationarity or random walk process when they are in level. The regression equations based on these variables in such a situation produce spurious relationship between the variables. Generally these variables are stationary at the first differences which is also called integrated at first differences and denoted by I (1). The relationship between these variables should be based on first differences of these variables.

8.2.2 Second, even though the variables are non stationary at level, there may be long run relationship between the variables which is also called cointegrating relationship between the variables. Though there are several methods to find cointegrating relationship between the variables, Johansen's method cointegration test is more powerful method than other two methods (i.e. Engle-Granger method and Durbin-Watson method) which can express the cointegrating relationship between the variables in a better way based on cointegrating vector. This method has explained the cointegrating relationship between real output and both money supplies in the present study whereas the Engle-Granger method has expressed the cointegrating relationship between these variables only in some cases and CRDW method has unable to establish such relationship between these variables.

8.2.3 Third, Conventional Granger Causality test, Vector Error Correction modeling and unrestricted vector auto regression model concluded that there is unidirectional causality from money to income. This means different lags of money supply have affected output level significantly but the effectiveness of output to influence money supply is nominal or insignificant.

8.2.4 Fourth, the anticipated and unanticipated part of money supply can be estimated with the help of ARIMA structures of the variables. Since the predicted part (anticipated part) of money supply is more powerful to affect real output for the period of study (i.e. 1959-2003), it can be concluded that the policy ineffectiveness theorem or which is also called 'Invariance Proposition' of Rational Expectations Hypothesis, propounded by Lucas, Sargent and Wallace (also called LSW proposition) has not been applied in

Nepalese economy for the long period like other some developing economies. This means effective monetary policy can play a vital role to influence real output level for the long period.

8.2.5 Fifth, however, the policy ineffectiveness theorem has not been applied for the long period in Nepalese economy; the case of short periods is slightly different. At the initial sub-period both parts (i.e. predicted as well as unpredicted parts) of M1 have significant role to affect real output level at 10% level of significance. The first lag of anticipated part of M2 has significant (1%) role to influence the output level while the unanticipated and anticipated parts (with no lags) have significant role to influence the real output at 5% and 10% level respectively. This means the effectiveness of M2 is more powerful than M1 to affect real output either from predicted part or from unpredicted part. The second sub period presents the complete different conclusion than the first sub-period, that is, both parts of money supplies (M1 & M2) have no role to affect output level. This mean the monetary policy losses its effectiveness to influence real variables and simultaneously the surprise part also losses its effectiveness. The same conclusion can be drawn for the third sub-period in the case of effectiveness of both money supplies.

8.2.6 Finally, a developing country like Nepal's economic prosperity cannot be increased only by monetary policies. Though at the initial period of the development history of the country it had played a significant role to influence the output level from both anticipated and unanticipated parts but in the course of time it started to loss its effectiveness either from predicted or from unpredicted part. However, the effectiveness of M2 is more powerful than M1; it also cannot be taken as a powerful tool for the development of the country. The Government should adopt other policies like fiscal policy effectively along with monetary policies for the economic prosperity of the country because the economic activities are not fully monetized in such a country like Nepal. In such a situation the effective monetary policy alone can not play a significant role for the economic development of the country.

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