This study pays attention to the dynamic changes in key economic variables viz., 1) money supply, 2) economic growth as measured by real GDP or that per capita, c) inflation and d) fiscal deficit and inter relationships among them. The methodology used for the collection, processing and analysis of data is described in this chapter. It begins with the concept of money.

**Money**

A review of various concepts of money used in past studies, points out that money is defined in two ways, one broader than the other. The narrow definition of money, having emphasis on the property of money as a convenient medium of exchange, includes currency (c) with the public, the demand deposits (DD) of banks and other deposits (OD) of the Reserve Bank of India which are of the nature of demand deposits and it is called $M_1$ money. It has a very high level of liquidity but earns little or no interest. This definition ignores the functions of money as (i) a store of value and (ii) means of deferred payment that help creation of bank money. So a broader definition of money is necessary. On the recommendation of the Second Working Group of Money
Supply, the RBI has adopted four alternative definitions or measures of money supply, denoted $M_1$, $M_2$, $M_3$, and $M_4$. They are:

$$M_1 = C + DD + OD$$

$$M_2 = M_1 \text{ plus saving deposits with post offices}$$

$$M_3 = M_1 \text{ plus net time deposits of banks (TD)}$$

$$M_4 = M_3 \text{ plus total deposits with post offices and other organisations (excluding National Savings Certificate)}$$

There is also another concept high powered money ($H$) which refers to total money produced by the RBI and the government and held by the public and banks. It is simply government money held by the public and the banks. It comprises of currency with public (C) cash reserves of banks (R) and other deposits (OD) of RBI.

$$(i.e.) \quad H = C + R + OD$$

$H$ serves as the base for the generation of DD in the fractional reserve system prevalent in the country. It is the monetary base and is also called reserve money. It sets the limit to money creation but it is not a component of money supply.

**Money Supply**

This study is concerned with the supply of money. The RBI controls the supply of money with the help of several instruments of monetary policy such as open market
operations, discount rate, statutory reserve ratio (SRR), cash reserve ratio (CRR) and moratorium on deficit financing and borrowing by governments. The control measures may be aiming at curtailing purchasing power of the people as a means for demand management or it may be for enabling investment to push up production and for supply management; overall aim being to achieve a sort of equilibrium in money market, that does not however act in isolation of product market and labour market. Inequilibrium in money market will have its impact on product market in its supply of goods and services and on the labour market, through changes in real wages. Thus an equilibrium in money market per se is desired and it is an instrument to help achieving equilibrium in other markets and the economy as a whole. Imbalances result in inflation / deflation. That brings to focus the importance of monetary policy, the effect of which depends upon the nature of fiscal policies and structural constraints for supply response of the economy. The inter-relationship between money supply, economic growth and price level decide the final outcome and consequent policy options. Therefore, money supply receives attention first.

The supply of money can also be seen in two different ways. The supply of narrow money (M₁) refers to the total value of currency (i.e. paper money and coins) in the hands of non-bank public plus demand deposits
in banks. It is a measure of liquid assets that are generally accepted as means of exchange in the economy. However, it may understate the real purchasing power of the public because there are other innovative financial instruments have in use and are becoming popular. They include credit cards, by-now-pay-later schemes, ATMs etc. Therefore, the concept of broad money (M₃) is seen to be more appropriate as a measure of money supply. The supply of M₃ includes time (also called term) deposits with commercial banks and other financial institutions. They are less liquid than M₁ but help creation of bank money to encourage investments in productive enterprises. Therefore in their study dynamic changes in both M₁ and M₃ money are studied; but the supply of M₃ is used to study interrelationship between money supply, economic growth and inflation.

**Monetary Policy**

To maintain a reasonable balance between aggregate demand and aggregate supply of goods and services both monetary and fiscal policies are used. They are demand management strategies. Of them, policies used to control money supply at desired levels are the monetary policies. Money supply changes are effective only (a) if the change affects the interest (b) if these changes affect investment spending. Therefore one can expect a lag in response to changes in the money supply and there is some degree of
uncertainty in outcome. These are kept in view in analysing money supply and its effects on growth.

**Economic Growth**

Economic growth is measured by the rise in real income (i.e.) real gross domestic product (gdp) or that per capita to allow for the growth of population. It is a simple aggregate measure of growth, though its limitations as an indicator of welfare of the population are well documented. The prefix real is important as it allows for correction to the inflationary trend. A significant growth in nominal gross domestic product (GNP), may be accompanied by non-significant growth in real gross domestic product (gdp) if growth is inflationary enough to neutralise the growth in nominal output. The suffix per capita takes care of pressure of population. A growth in gdp larger than the growth rate of population is necessary to allow growth of real gdp per capita.

**General Price Level**

In India, a very commonly used measure of the general price level is the whole sale price index (WPI) regularly published weekly, monthly, quarterly and annually. However it fails to reflect adequately the real change in the purchasing power of the people. As an alternative the Consumer price index (CPI) is suggested because it is based on retail prices ultimately paid by
the consumer. However, it has several limitations. First, available sources give estimate of CPI for defined groups such as industrial workers, agricultural labours etc and there is no unique aggregate measure of it for all sections of the population. Second, it does not cover changes in the general price level due to investment activities. Still another alternative is to use the implicit GNP deflator which is the ratio of nominal GNP to real GNP (denoted gnp). The values of nominal and real GNP’s are available annually in the Economic Survey of India presented to the Parliament before the annual budget for the next year. This ratio is expressed as a percentage and used as a measure of the general price level, simply denoted GPL.

**Inflation**

By the definition of inflation (Ackley), it is the persistent and significant rise in the general price level. Therefore an appropriate measure of inflation would be the trend rate of GPL where it is positive and significant. However the purpose of the present study is to relate change in GPL to the changes in money supply and the real gdp with lagged variable, if necessary. Therefore inflation for the purpose of the study was measured by annual percentage change in GPL estimated by a simple linear trend equation. (i.e. \( \frac{\hat{GPL}_t}{\hat{GPL}_{t-1}} \times 100 \) where hat shows that the values are trend values estimated by a simple linear trend equation:
\( G \hat{P}_t = \hat{a} + \hat{b}t \) for \( t = 1, 2, \ldots 28 \)

**Period of Study**

The data on the macro variable are available in several publications of the RBI and the Government of India for the period of planned development of India i.e. from the year 1950-51. However, the RBI adopted the four fold classification \( (M_1, M_2, M_3 \text{ and } M_4) \) of money and began publishing data on that basis only in 1970-71. Therefore estimates of \( M_1 \) and \( M_3 \) money supplies are available only from the year 1970-71. At the time of study the latest year for which estimates of macro variable are available is 1997-98. Therefore, for all the macro variables data were collected for the same period of 28 years from 1970-71 to 1997-98. This is the period for which time series data on selected macro variables are collected and studied.

**Source of Data**

The time series data were collected for (i) currency with public (c); (ii) time deposits (TD); (iii) Demand deposit (DD); (iv) narrow money (M1); (v) Broad money (M3); (vi) source of reserve money; (vii) deficit financing; (viii) fiscal deficit; (ix) Bank Rate of interest; (x) SRR; (xi) CRR; (xii) GNP at current and constant price; (xiii) GDP at current and constant prices;
(xiv) implicit deflator; (xv) wholesale price index (WPI); and (xvi) size of population (interpolated annually for years between census of 1971, 1981 and 1991 and projected for years up to 1998.

The data were collected from several sources. They are: Reserve Bank of India Bulletin, Report on Currency and Finance, Statistical Abstract of India, Economic Survey and Basic Statistics provided by the centre for Monitoring Indian Economy.


**Analysis**

Collected secondary data were first processed to make them comparable. Particularly the time series data for some of the indexed variables such as GNP and GDP at constant prices, wholesale price index and implicit GNP deflator were available with 1970-71 as the base for the period upto 1980-81, with 1980-81 as base for the next decade and with 1990-91 as base for the 1990's. First
attempt was therefore to bring the data to a common base of 1980-81 = 100.

**Dynamic changes**

To provide a feel of the data, the macro variables were studied decade wise for 1970's, 1980's and for eight years of 1990's. The mean, coefficient of variation (CV), annual growth rates were worked out for each decade and compared for the magnitude of changes. In India a major economic reform of liberalization was initiated in 1990-91. Therefore a comparative study decadewise showed the difference between pre and post reform periods. Some general inferences on the impact of the economic reforms on GDP money supply, inflation and fiscal deficit are discernible.

**Trend Analysis**

For a more detailed study of dynamic changes in money supply and other macro variables trend equations were specified and estimated. The following three forms of trend equations were considered and the best fits among them were retained for inference.

1. quadratic trend \( Y = a_0 + a_1 t + a_2 t^2 + e_i \)
2. \( \log - \log = \ln Y = b_0 + b_1 \ln t + C_2 \)
3. \( \text{Semilog } \ln Y = C_0 + C_1 t + e_3 \)
Where \( Y \) is the macro variable studied and \( t = 1,2, \ldots, 28 \)

The choice among the three models was based on the value of \( R^2 \), significance of the coefficients of the trend variable and their sign vis-a-vis the expectations concerning them.

**Instability**

Instability in money supply, GDP, GDP per capita, general price level and fiscal deficit were studied. The coefficient of variation (CV) is a simple and widely used measure of instability in value of a variable over time. However when there is a strong trend, the CV may overstate the variation and there is need to apply CV to the trend corrected series. With this argument Cuddy and Valle suggest and demonstrate the use of an index of instability defined as:

\[
I_x = CV \sqrt{1 - R^2}
\]

which is nothing but a correction for the trend. This index was used.

**Interrelationships**

The interrelationship of three macro variable viz, supply of \( M_3 \), real GDP and the general price level as
measured by the implicit GNP deflator is the main concern of this study. The relationship between those variables is not merely an association but it is a question of causality among them. The causality between money and prices is rooted in the monetarist - structuralist controversy\(^1\) (see Kirkpatrick and Nixon, 1987). On the basis of the quantity theory of money, the monetarists believe that a continuing rise in prices is brought about by increases in aggregate demand, unaccompanied by increases in real output. This increase in aggregate demand is attributed to the excessive expansion of money supply. Then money supply is the cause and price is the effect. However in a developing economy as the price rises, the government expenditure rises faster than its revenue resulting in deficit budgets, which is translated into deficit financing by government borrowing from the Central Bank of the country. The ever increasing size of fiscal deficit in India is a case to point out. The deficit financing in whatever form it is practiced causes the supply of money to increase. Thus the causality between money supply and prices is not unidirectional it is in fact bidirectional.

The structuralist on the other hand, view excessive money supply as permissive rather than casual in explaining

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inflation, particularly in the developing economies. The root cause of inflation, according to them are the structural bottlenecks in the development process. To them, given the aggregate demand for the whole economy, the excess demand for agricultural goods and imports are the factors that initiate inflation. A remedy lies in increasing supply of these goods by ensuring adequate investment and technology for increasing domestic production. Necessary expansion of credit, is again in the domain of monetary policy. Thus, the three variables impact on each other and the direction of causation between them is important. Yet, several studies in the recent past provide conflicting results, especially for the developing countries. (vide Masih and Masih, 1994)². The issue about the direction of causation remains unresolved. The empirical verification of direction of causation is mainly based on Granger (1969)³, Sims (1972)⁴ and the modified Sims test⁵ suggested by Geweke et. al⁶

(1983). Masih and Masih (1994)\textsuperscript{7} point out the limitations of these tests and suggests an alternative model called Error correction model based on Granger and modified Sims tests. It is a sequential process, having four steps.

\textbf{Step 1}

First step is to test independence of the time series. Independence of time series eliminates the possibility of feedback and absence of causality in either direction. To test independence (a) the original series is turned stationary by first and second differencing of the log of the series, (ii) ARIMA models are then estimated for each series; (iii) the residuals of the two series are rendered white noise after ARIMA filter (Box-Ljung - Prierce Q. Statistic) are then used to calculate cross-correlation function (CCF) between the two series. These cross-correlations are used to calculate modified $S^*$ statistic for different lag lengths, in order to test the null hypotheses of independence between each pair of time series. If the null-hypothesis is accepted, then there is no meaning in proceeding further. If the null-hypothesis is rejected, there is interdependence between the two series. Interdependence does not necessarily mean causation. Hence to establish causality we need further test.

Step 2

The recently developed cointegration technique is useful to test for causality. Two or more variables are cointegrated, if they share common trends; then causality must exist at least in one direction (Miller and Russek, 1990). Two variables are said to be cointegrated if the following three conditions are satisfied:

a) the variables must be integrated of the same order*
b) there should be a linear relationship between them (i.e.) in an equation $y_t = a + b x_t$, the coefficient $b$ should be statistically significant.
c) finally, the residuals in the above equation should be stationary

Step 3

Cointegration does not indicate the direction of causation; it implies just that there should be at least one way of causation (i.e.) absence of causation is ruled out). The direction of causation can be tested by following procedure.

A. Haugh - Pierce Test

The direction of causation can be inferred from the evidence of significant spikes and pulses at positive or negative lags in the cross correlation function (CCF). If

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the current or positive (i.e. past) lags of a variable are significant then the lagged variable leads; but if negative (i.e. future) lags of a variable are significant, then the lead variable follows.

6. Granger Test

The Granger test is a two step regression procedure. Let the variables of two time series be Y and X. To determine, if there is any casualty stemming from x to y, y is first estimated as a function of past values of x; it is called restricted version. Then y is estimated as a function of past values of y and past values of x and it is called the unrestricted version.

Notationally,

\[ Y_t = \sum_{i=1}^{m} a_{xi} Y_{t-i} \]  
\text{(Restricted version)}..1

\[ Y_t = \sum_{i=1}^{m} a_{xi} Y_{t-i} + \sum_{j=1}^{n} a_{xj} x_{t-j} \]  
\text{(unrestricted version)}..2

There is causality in Granger sense from x to y if the inclusion of the past values of x as a group improves the estimation of y significantly (by the F test). Since the present can not affect the past, the direction of causation is from the past to the present.
C. Modified Sims Test

This was suggested by Geweke et al (1983)\(^9\) and it is also a two step regression procedure. In this model \(y\), is first estimated as a function of past values of \(y\), current and past values of \(x\) (restricted version). Next, \(y\) is estimated as a function of past values of \(x\), current and past values of \(x\) and future values of \(x\) (unrestricted version). The two regression equation are

\[
Y_t = \sum_{i=1}^{m} a_{xi} y_{t-i} + \sum_{j=0}^{n} a_{yj} x_{t-j}
\]

(Restricted version) \(..3\)

\[
Y_t = \sum_{i=1}^{m} a_{i} y_{t-i} + \sum_{j=1}^{n} a_{j} x_{t-j} + \sum_{j=n+1}^{k} a_{j} x_{t+j}
\]

(unrestricted version) \(..4\)

There is causality in Sims sense from \(y\) to \(x\) if the coefficients of the future \(x_j\)'s are as a group, significantly different from zero (by the F test). Since future can not affect the present the direction of causation is from the present to the future. The Sims test is for causality from the dependent variable to the independent variable unlike the Granger test in which the direction of causation is from the independent to the dependent variable.

Choice of Model

This modified Sims test (MST) differs from the original version in the inclusion of past values of the dependent variable in the two regression. The past values of the dependent variables are included in order to deal with the problem of serial correlation, while in the original version of the Sims test this problem is dealt with by the pre-filtering of the variables. But the results of the original Sims test are very sensitive to the choice of the filter and the length of the lag structure (Feige and Pearce)\(^\text{10}\). To avoid this problem modified Sims test is more reliable than the original Sims test and so MST, is used in this study.

An important issue in applying MST (and also for Granger test) is the choice of the finite lag lengths for both dependent and independent variables, to approximate theoretically infinite lag distribution. If the lag length is too short in either Granger or Sims test, serial correlation of the residuals may exist invalidating the F test (Kmenta, 1986)\(^\text{11}\). Too many lags will reduce the degrees of freedom.


Therefore a considerable amount of time was spent in selecting the lag structure \((m, n)\) in different equations and finally the structure that gave the minimum of Akaike Final Prediction Error (AFPE) was selected, on the basis of explicit optimality criterion of minimizing the mean square prediction error. For the Sims test, a symmetrical truncation on the two sided lag polynomial associated with the independent variable was used in order to avoid possible biases in the casual inferences brought out by the asymmetrical truncation Geweke\(^{12}\) demonstrated that causality test based on MST are not sensitive to the number of lags as long as enough of them are included. This result also helped the choice of lag structure.

**Statistical Tests**

Statistical tests were conducted with the help of \(t\), \(F\), \(R\), \(R^2\) test statistics and durbinwatson 'd' statistics in trend equations. The \(F\) test for modified Sims test (MST) was:

\[
F = \frac{[(\text{Exp } SS_{ur}^k - \text{Exp } SS_k) / K]}{[\text{Res } SS_{ur} / (n-k-1)]}
\]

where \(K\) refers to the number of new regressors, \(n\) the number of observations and \(k\) is the number of explanatory variables. All statistical tests were conducted for five percent levels of significance.

\(^{12}\) J. Geweke, op. cit.