Chapter II

The Model
2.1 Introduction

As described earlier, the macro model builders of Indian economy tried to specify the macro economic system in terms of its partial exposition in various degrees. As a result of these exercises, number of specifications are available for explaining various segments of the economy. Some specifications are found to be explained better than others as judged by conventional econometric tests. Though specification of the model for part of the system is often found to be a kind of complete system for the segment of the economy in question, the researchers tried to estimate the equations of the system by treating them as independent components of the system. Several reasons are ascribed to this kind of approach by individual researchers. It appears to be a valid approach to try to specify the model for the macro economic system pertaining to India such that improvements are made over the earlier approaches to the problem depending upon the prevailing constraints under which a model of this kind has to be built in actual practice.

This chapter contains discussion about the type of modelling approach, the specification of the constituents of the system and the desirable properties to be possessed by such a system.

2.2 Complete System Modelling

Any model that may be specified for an operating economy must be compatible to the underlined behavioural process of the decision making agents involved in the system, the relevant theoretical postulate pertaining to the constitu-
ents of the system and the way the economy has actually operated during the period for which the same is sought to be modelled. A model as is understood at present is a kind of hypothesis pertaining to specific segment of the economy. This hypothesis is tested with the help of available data pertaining to variables involved in the model and if the hypothesis stands the tests in its rigorous application then the estimated structure so obtained is thought to have explained the economic structure during the period in question. In this sense modelling an economy can be thought to be a plausible frame of involvement of various economic variables in the system which can acquire a number of alternative forms at the hypothetical and testing stages of the whole exercise. Accordingly sufficient care needs to be taken at the stage of formulating such models so as to avoid unnecessary exercises at various stages of the study.

It is well accepted that any such modelling exercise pertaining to a segment or whole economy turns out to be a kind of complete system modelling. Algebraic specifications of such systems are well known in econometric texts. We shall reproduce them in what follows very briefly, so as to be able to use the same for reference purposes at various stages of the present study.

An algebraic statement of a complete system in terms of $M$ endogenous variables and $N$ predetermined variables is expressed in matrix form as follows.

$$Y \Gamma + X \beta = U \quad \ldots (2.2.1)$$

where the observation matrices $Y$ and $X$ are defined as
\[ \Pi = - B \Gamma^{-1} \quad \ldots \tag{2.2.6} \]
\[ v = u \Gamma^{-1} \]

Some of the equations contained in the system (2.2.1) may be simply identifies which need not be estimated for obvious reasons. Specification of any economic system in terms of a complete system is supposed to minimize the simultaneity bias depending upon the extent and coverage of specification. It should be remembered that this virtue is often not retained at the final stage if estimation of such a system is not done by following a method of estimation that retains in itself the main characteristic of the complete system. Actual specification of the constituents of the complete system is proposed to be described in the next section.

2.3 Specification of the System

Since the data available for estimating a complete system pertaining to Indian economy are 39, annual observations pertaining to the years beginning from 1950-51 to 1988-89, as described in details in chapter III and the theoretical requirements of a complete system as mentioned towards the end of this chapter do not permit us to incorporate large number of variables in the system to be specified, a compromise has necessarily to be made between level of disaggregation and the extent of coverage in any exercise of the present variety. Considering these practical aspects and examining the models prepared so far as well as the departmental structuring of Indian economy for operative purposes, we have decided to examine the Indian economy in terms of the following endogenous macro variables.
1. Consumption  
2. Investment  
3. Exports  
4. Imports  
5. Wholesale Price Index  
6. Gross National Product at Factor Cost  
7. Money Supply  
8. Bank Credit  
9. Total Bank Deposits  
10. Employment  
11. Infant Mortality Rate  
12. Tax Revenue  
13. Nontax Revenue  
14. Developmental Expenditure  
15. Nondevelopmental Expenditure  
16. Government Final Consumption Expenditure  
17. Gross Domestic Saving  
18. Demand Deposit  
19. Deficit  
20. Balance of Trade  
21. Direct Tax Revenue  
22. Net Inflow of Foreign Capital  
23. Urban Population  
24. Gross Domestic Product at Factor Cost  

It will be clearer later on that any attempt to disaggregate these variables further will create problems because of the data limitations. It is well known for Indian economy that data prior to the year 1950-51 are not organized properly and the scope for using quarterly or monthly data is severely limited. Consequently, one has to use annual data over the years mentioned earlier which could provide only 39 observations for each one of the variable involved in the system till the time this study was being completed. Strictly speaking, even if larger number of annual observations were available for the study the same would have hardly helped any substantial improvement over the scope of coverage of the
economy in respect of its level of disaggregation. This is because of the fact that in a growing and dynamic economy the possibility of structural break over time increases more and more as the number of observations are sought to be increased beyond a reasonable time span. Since econometric literature in its empirical coverage has hardly grown where problems of structural break in context to complete system specification is sought to be overcome, we do not propose to examine this aspect of the problem so far as present study is concerned. In what follows it is proposed to describe the specifications of various economic relations, as briefly as possible, for the segments of the economy as mentioned above.

It is worthwhile here to describe very briefly the procedure followed in arriving at the finally accepted specification of each equation in the system. As described earlier a number of specifications have been used by different model builders of the Indian economy. Since these models were built for different time span of data coverage the estimated versions of these specifications are not comparable in strict sense. Accordingly, we reestimated all these specifications by using the data as given in Appendix A of the present study. Since the data were themselves modified several times during the course of the present study we are reporting the data as they are available in their final form in the secondary sources of publication. But we used all other earlier versions of the data for estimating all these specifications as used by earlier researchers as well as the modified specification. It is not proposed to describe here the estimated versions of all these specifications which were tried in the present study for the sake of conciseness of presentation. However, the general procedure followed in arriving at the final specifications in case of each equation is worth description. Considering the data for the same time span and estimating alternative specifications of each equation

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of the system by using such data we use the following criteria for final acceptance of the model in each case.

A. Performance of the model in regard to various econometric and statistical tests,

B. Relative relevance of estimated results in respect of available economic reasoning and theoretical appropriateness,

C. Performance of the alternative estimated models in respect of point as well as interval forecasts.

Several specifications for the segments of the Indian economy were tried. They also include those used by prominent macro model builders of the Indian economy. The more prominent ones are reported below. The specification given towards the end of each macro variable is chosen to constitute the present model. The specifications found to be best amongst those tried in the present study are the same as given towards the end in case of each macro variable.

2.3.1 Consumption Function:

\[
PFCE = a_0 + a_1 (NNP) + u \quad \cdots (2.3.1.1)
\]

\[
\frac{PFCE}{POP} = a_0 + a_1 \left( \frac{PDY}{POP} \right)_t + a_2 \left( \frac{X_{tax}}{Y} \right)_t + a_3 t + u \quad \cdots (2.3.1.2)
\]

\[
PFCE = a_0 + a_1 (NNP) + a_2 \left( \frac{L_{t-2}}{WPI} \right) + a_3 (POP) + u \quad \cdots (2.3.1.3)
\]
\[
\frac{PFCE}{POP} = a_0 + a_1 \left(\frac{PDY}{POP}\right) + a_2 \left(\frac{Y_{ag}}{Y_{nag}}\right) + a_3 t + u
\] ... (2.3.1.4)

\[PFCE = a_0 + a_1 (PDY) + a_2 (PFCE)_{-1} + a_3 (POP) + u\] ... (2.3.1.5)

\[PFCE = a_0 + a_1 (PDY) + a_2 (LQD) + a_3 (POP) + u\] ... (2.3.1.6)

\[PFCE = a_0 + a_1 (PDY) + a_2 (PFCE)_{-1} + a_3 (POP) + a_4 (WPI) + u\] ... (2.3.1.7)

\[PFCE = a_0 + a_1 (PDY) + a_2 (PFCE)_{-1} + a_3 (POP) + a_4 (LQD) + u\] ... (2.3.1.8)

\[PFCE = a_0 + a_1 (PDY) + a_2 (PFCE)_{-1} + a_3 (POP) + a_4 (LQD) + a_5 (WPI) + u\] ... (2.3.1.9)

\[PFCE = a_0 + a_1 (PDY) + a_2 (PFCE)_{-1} + a_3 (POP) + a_4 (WPI) + u\] ... (2.3.1.10)

### 2.3.2 Investment Function:

\[NDCF = a_0 + a_1 (RI) + a_2 (GDCF)_{-1} + a_3 (NNP_{fc}) + a_4 (BC) + u\] ... (2.3.2.1)

\[NDCF = a_0 + a_1 (RI) + a_2 (GDCF)_{-1} + a_3 (NNP_{fc}) + a_4 (B&I) + a_5 (WPI) + u\] ... (2.3.2.2)

\[NDCF = a_0 + a_1 (RI) + a_2 (BC) + a_3 (WPI) + a_4 (NIOFC) + a_5 (NDCF)_{-1} + a_6 (DTXR) + u\] ... (2.3.2.3)

\[NDCF = a_0 + a_1 (RI) + a_2 (BC) + a_3 (WPI) + a_4 (GDCF)_{-1} + a_5 (NIOFC) + u\] ... (2.3.2.4)

\[NDCF = a_0 + a_1 (RI) + a_2 (BC) + a_3 (WPI) + a_4 (NIOFC)\]
\[ GDCF = a_0 + a_1 (PDY) + a_2 (\text{NNP}_{fc})_{-1} + a_3 (RI)_{-1} + LQD + (GDCF)_{-1} + u \]  \hspace{1cm} \text{(2.3.2.6)}

\[ NDCF = a_0 + a_1 (RI) + a_2 (BC) + a_3 (WPI) + a_4 (NIOFC) + a_5 (DTXR) + a_6 (\text{GNP}_{fc}) + a_7 (WPI)_{-1} + a_8 (NDCF)_{-1} + u \]  \hspace{1cm} \text{(2.3.2.7)}

\[ NDCF = a_0 + a_1 (RI) + a_2 (BC) + a_3 (NIOFC) + a_4 (DTXR) + a_5 (\text{GNP}_{fc}) + a_6 (WPI)_{-1} + a_7 (NDCF)_{-1} + u \]  \hspace{1cm} \text{(2.3.2.9)}

\[ NDCF = a_0 + a_1 (RI) + a_2 (BC) + a_3 (WPI) + a_4 (NIOFC) + a_5 (DTXR) + a_6 (NDCF)_{-1} + a_7 (ITXR) + a_8 (\text{GNP}_{fc}) + u \]  \hspace{1cm} \text{(2.3.2.9)}

2.3.3 Export Function:

\[ EX = a_0 + a_1 (\text{GDP}_{fc}) + a_2 (\text{UVIE}) + a_3 (EX)_{-1} + u \]  \hspace{1cm} \text{(2.3.3.1)}

\[ EX = a_0 + a_1 (\text{GDP}_{fc}) + a_2 (\text{UVIE}) + a_2 (\text{UVIWE}) + a_3 (WPI) + a_4 (\text{WWPI}) + a_5 (EX)_{-1} + u \]  \hspace{1cm} \text{(2.3.3.2)}

\[ EX = a_0 + a_1 (\text{GDP}_{ps}) + a_2 (\text{GDP}_{ss}) + a_3 (\text{UVIE}) + a_4 (\text{UVIWE}) + a_5 (\text{WPI}) + a_6 (\text{WWPI}) + a_7 (EX)_{-1} + u \]  \hspace{1cm} \text{(2.3.3.3)}

\[ EX = a_0 + a_1 (\text{GDP}_{ps}) + a_2 (\text{GDP}_{ss}) + a_3 (\text{UVIE}) + a_4 (WPI) + a_5 (\text{WPI}) + a_6 (EX)_{-1} + u \]  \hspace{1cm} \text{(2.3.3.4)}

\[ EX = a_0 + a_1 (\text{NNP}_{fc}) + a_2 (\text{UVIE}) + a_3 (\text{UVIWE}) + a_4 (\text{WPI}) + a_5 (\text{WWPI}) + a_6 (\text{IM}) + a_7 (EX)_{-1} + a_8 (\text{IWGDP}) + u \]  \hspace{1cm} \text{(2.3.3.5)}

\[ EX = a_0 + a_1 (\text{UVIE}) + a_2 (\text{UVIWE}) + a_3 (\text{WPI}) + a_4 (\text{WWPI}) + a_5 (EX)_{-1} + a_6 (\text{IM}) + a_7 (\text{IWGDP}) + a_8 (\text{GDP}_{fc}) + u \]  \hspace{1cm} \text{(2.3.3.6)}
2.3.4 Import Function:

\[
IM = a_0 + a_1 (\text{NNP}_{fc}) + a_2 (\text{UVII}) + a_3 (\text{POP})_{-1} + a_4 (\text{IM})_{-1} + u \quad \ldots (2.3.4.1)
\]

\[
IM = a_0 + a_1 (\text{GNP}_{fc}) + a_2 (\text{UVII}) + a_3 (\text{POP})_{-1} + a_4 (\text{WPI}) + a_5 (\text{IM})_{-1} + u \quad \ldots (2.3.4.2)
\]

\[
IM = a_0 + a_1 (\text{UVII}) + a_2 (\text{UVIWI}) + a_3 (\text{WWPI}) + a_4 (\text{POP}) + a_5 (\text{IM})_{-1} + u \quad \ldots (2.3.4.3)
\]

\[
IM = a_0 + a_1 (\text{UVII}) + a_2 (\text{UVIWI}) + a_3 (\text{WWPI}) + a_4 (\text{FER}) + a_5 (\text{UPOP} + a_6 (\text{IM})_{-1} + u \quad \ldots (2.3.4.4)
\]

\[
IM = a_0 + a_1 (\text{GDP}_{fc}) + a_2 (\text{UVII}) + a_3 (\text{UVIWI}) + a_4 (\text{WWPI}) + a_5 (\text{POP}) + a_6 (\text{FER}) + a_7 (\text{IM})_{-1} + u \quad \ldots (2.3.4.5)
\]

2.3.5 Wholesale Price Index Function:

\[
\text{WPI} = a_0 + a_1 (\text{GDP}_{ps}) + a_2 (\text{POP}) + a_3 (\text{IM}) + a_4 (\text{EX}) + a_5 (\text{MS}) + a_6 (\text{DTXR}) + a_7 (\text{WPI})_{-1} + u \quad \ldots (2.3.5.1)
\]

\[
\text{WPI} = a_0 + a_1 (\text{GDP}_{ps}) + a_2 (\text{POP}) + a_3 (\text{IM}) + a_4 (\text{EX}) + a_5 (\text{WPI})_{-1} + u \quad \ldots (2.3.5.2)
\]

\[
\text{WPI} = a_0 + a_1 (\text{GDP}_{ps}) + a_2 (\text{POP}) + a_3 (\text{IM}) + a_4 (\text{EX}) + a_5 (\text{DTXR}) + a_6 (\text{ITXR}) + a_7 (\text{D}) + a_8 (\text{WPI})_{-1} + u \quad \ldots (2.3.5.3)
\]

\[
\text{WPI} = a_0 + a_1 (\text{GDP}_{ps}) + a_2 (\text{POP}) + a_3 (\text{IM}) + a_4 (\text{EX}) + a_5 (\text{ITXR}) + a_6 (\text{D}) + a_7 (\text{WPI})_{-1} + u \quad \ldots (2.3.5.4)
\]

\[
\text{WPI} = a_0 + a_1 (\text{GDP}_{ps}) + a_2 (\text{GDP}_{ss}) + a_3 (\text{IM})
\]

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\[ WPI = a_0 + a_1 (GDP_{fc}) + a_2 (IM) + a_3 (EX) + a_4 (ITXR) - 1 + a_5 (POP) + a_6 (WPI) - 1 + u \]  \hspace{1cm} \ldots (2.3.5.5)

\[ WPI = a_0 + a_1 (Y_{ag}) + a_2 (MS) + a_3 (ITXR) + a_4 (WPI) - 1 + u \]  \hspace{1cm} \ldots (2.3.5.6)

\[ WPI = a_0 + a_1 (GNP_{fc}) + a_2 (ITXR) + a_3 (POP) + a_4 (D) + a_5 (WPI) - 1 + u \]  \hspace{1cm} \ldots (2.3.5.8)

2.3.6 Gross National Product Function:

\[ GNP_{fc} = a_0 + a_1 (NDCF) + a_2 (TW) + a_3 (TLR) + u \]  \hspace{1cm} \ldots (2.3.6.1)

\[ GNP_{fc} = a_0 + a_1 (NDCF) + a_2 (TW) + a_3 (BC) + a_4 (RI) + u \]  \hspace{1cm} \ldots (2.3.6.2)

\[ GNP_{fc} = a_0 + a_1 (NDCF) + a_2 (TW) + a_3 (ITXR) + u \]  \hspace{1cm} \ldots (2.3.6.3)

\[ GNP_{fc} = a_0 + a_1 (NDCF) + a_2 (TW) + a_3 (ITXR) + a_4 (WPI) + u \]  \hspace{1cm} \ldots (2.3.6.4)

\[ GNP_{fc} = a_0 + a_1 (NDCF) + a_2 (TW) + a_3 (ITXR) + a_4 (WPI) + a_5 (BC) + a_6 (RI) + u \]  \hspace{1cm} \ldots (2.3.6.5)

\[ GNP_{fc} = a_0 + a_1 (NDCF) + a_2 (TW) + a_3 (NDEE) + a_4 (WPI) + a_5 (GNP_{fc}) - 1 + u \]  \hspace{1cm} \ldots (2.3.6.6)

2.3.7 Money Supply Function:

\[ MS = a_0 + a_1 (PFCE) + a_2 (RI) + a_3 (WPI) + u \]  \hspace{1cm} \ldots (2.3.7.1)

\[ MS = a_0 + a_1 (RI) + a_2 (TBD) + a_3 (PA&D) + u \]  \hspace{1cm} \ldots (2.3.7.2)

\[ MS = a_0 + a_1 (RI) + a_2 (BC) + a_3 (FER) + a_4 (WPI) + a_5 (NIOFC) + a_6 (D) + u \]  \hspace{1cm} \ldots (2.3.7.3)

\[ MS = a_0 + a_1 (D) + a_2 (RI) + a_3 (LQD) + u \]  \hspace{1cm} \ldots (2.3.7.4)

\[ MS = a_0 + a_1 (BC) + a_2 (FER) + a_3 (D) + a_4 (WPI) \]
2.3.8 Bank Credit Function:

\[
BC = a_0 + a_1 (RI) + a_2 (TD) + a_3 (DD) + a_4 (NNP_{fC}) + a_5 (NOB) + a_6 (T) + u
\]

\[
BC = a_0 + a_1 (RI) + a_2 (TD) + a_3 (DD) + a_4 (GDP_{ps}) + a_5 (GDP_{ss}) + a_6 (GDP_{ts}) + u
\]

\[
BC = a_0 + a_1 (RI) + a_2 (TD) + a_3 (DD) + a_4 (GDP_{fc}) + a_5 (BC)_{-1} + u
\]

\[
BC = a_0 + a_1 (TLR) + a_2 (NDCF) + u
\]

\[
BC = a_0 + a_1 (RI) + a_2 (TD) + a_3 (DD) + a_4 (GDP_{ps}) + a_5 (GDP_{ss}) + a_6 (BC)_{-1} + u
\]

2.3.9 Total Bank Deposit Function:

\[
TBD = a_0 + a_1 (TLR) + a_2 (NNP_{fC}) + a_3 (RI) + u
\]

\[
TBD = a_0 + a_1 (TLR) + a_2 (PDY) + a_3 (DRI) + a_4 (OSMPI) + a_5 (TBD)_{-1} + a_6 (NOB) + u
\]

\[
TBD = a_0 + a_1 (NNP_{fC}) + a_2 (DRI) + a_3 (NOB) + a_4 (TLR) + u
\]

\[
TBD = a_0 + a_1 (NNP_{fC}) + a_2 (DRI) + a_3 (NOB) + a_4 (BC) + u
\]

\[
TBD = a_0 + a_1 (PDY) + a_2 (DRI) + a_3 (TLR) + a_4 (OSMPI) + a_5 (TBD)_{-1} + u
\]

2.3.10 Employment Function:

\[
TW = a_0 + a_1 (GNP_{fC}) + a_2 (TLR) + u
\]
TW = \( a_0 + a_1 (\text{GNP}_c) + a_2 (\text{TLR}) + a_3 (\text{WPI}) + u \) \quad \ldots (2.3.10.2)

TW = \( a_0 + a_1 (\text{GDPP}_5) + a_2 (\text{GDP}_{55}) + a_3 (\text{GDP}_{ts}) + a_4 (\text{FPOP}) + a_5 (\text{MPOP}) + u \) \quad \ldots (2.3.10.3)

TW = \( a_0 + a_1 (\text{GNP}_c) + a_2 (\text{WPI}) + a_3 (\text{PFCE}) + a_4 (\text{TW})_1 + u \) \quad (2.3.10.4)

TW = \( a_0 + a_1 (\text{GNP}_c) + a_2 (\text{WPI}) + a_3 (\text{PFCE}) + a_4 (\text{TW})_1 + a_5 (\text{DTXR}) + a_6 (\text{ITXR}) + u \) \quad \ldots (2.3.10.5)

TW = \( a_0 + a_1 (\text{GNP}_c) + a_2 (\text{WPI}) + a_3 (\text{PFCE}) + a_4 (\text{TW})_1 + a_5 (\text{TTXR}) + u \) \quad \ldots (2.3.10.6)

TW = \( a_0 + a_1 (\text{GNP}_c) + a_2 (\text{TLR}) + a_3 (\text{WPI}) + a_4 (\text{TW})_1 + a_5 (\text{PFCE}) + u \) \quad \ldots (2.3.10.7)

2.3.11 Infant Mortality Rate Function:

IMR = \( a_0 + a_1 (\text{CBR}) + a_2 (\text{CDR}) + a_3 (\text{M}&\text{PH}) + a_4 (\text{NNP}_c) + a_5 (\text{FLR}) + u \) \quad \ldots (2.3.11.1)

IMR = \( a_0 + a_1 (\text{POP}) + a_2 (\text{PDY}) + a_3 (\text{FLR}) + a_4 (\text{M}&\text{PH}) + a_5 (\text{IMR})_1 + u \) \quad \ldots (2.3.11.2)

IMR = \( a_0 + a_1 (\text{FPOP}) + a_2 (\text{PDY}) + a_3 (\text{FLR}) + a_4 (\text{M}&\text{PH}) + a_5 (\text{IMR})_1 + u \) \quad \ldots (2.3.11.3)

IMR = \( a_0 + a_1 (\text{POP}) + a_2 (\text{PDY}) + a_3 (\text{FLR}) + a_4 (\text{M}&\text{PH}) + a_5 (\text{IMR})_1 + a_6 (\text{IMR})_1 + u \) \quad \ldots (2.3.11.4)

IMR = \( a_0 + a_1 (\text{FLR}) + a_2 (\text{PDY}) + a_3 (\text{PFCE}) + a_4 (\text{M}&\text{PH}) + a_5 (\text{IMR})_1 + u \) \quad \ldots (2.3.11.5)

2.3.12 Tax Revenue Function:

\[ \text{20} \]
TXR = a_0 + a_1(GDP_{fc}) + a_2(EX) + a_3(FIREBS) + u \quad \ldots \quad (2.3.12.1)

TXR = a_0 + a_1(GNP_{fc}) + a_2(POP) + a_3(WPI) + a_4(TXR)_{-1} + u \quad (2.3.12.2)

TXR = a_0 + a_1(GDP_{fc}) + a_2(EX) + a_3(IM) + a_4(D)_{-1} + u \quad \ldots \quad (2.3.12.3)

TXR = a_0 + a_1(GDP_{fc}) + a_2(PFCE) + a_3(GFCE)
\quad + a_4(NIOFC) + u \quad \ldots \quad (2.3.12.4)

TXR = a_0 + a_1(IM) + a_2(EX) + a_3(GDP_p) + a_4(GDP_{ss})
\quad + a_5(GDP_{t_s}) + a_6(UPOP) + a_7(TXR)_{-1} + u \quad \ldots \quad (2.3.12.5)

2.3.13 Nontax revenue Function:

NTXR = a_0 + a_1(GDCF_{pub.sec}) + a_2(EX) + a_3(IM)
\quad + a_4(BC) + a_5(NTXR)_{-1} + u \quad \ldots \quad (2.3.13.1)

NTXR = a_0 + a_1(NDP_{pub.sec}) + a_2(EX)
\quad + a_3(BC) + a_4(NTXR)_{-1} + u \quad \ldots \quad (2.3.13.2)

NTXR = a_0 + a_1(NDP_{pub.sec}) + a_2(NIOFC)
\quad + a_3(NTXR)_{-1} + u \quad \ldots \quad (2.3.13.3)

NTXR = a_0 + a_1(NDP_{pub.sec}) + a_2(NIOFC) + a_3(D)
\quad + a_4(NTXR)_{-1} + u \quad \ldots \quad (2.3.13.4)

NTXR = a_0 + a_1(NTXR)_{-1} + a_2(NIOFC)
\quad + a_3(MS) + a_4(DEE) + u \quad \ldots \quad (2.3.13.5)

2.3.14 Developmental Expenditure Functions:

DEE = a_0 + a_1(TXR) + a_2(NTXR) + a_3(FER)
\quad + a_4(DEE)_{-1} + u \quad \ldots \quad (2.3.14.1)

DEE = a_0 + a_1(TXR) + a_2(NTXR) + a_3(NIOFC)
\quad + a_4(D) + a_5(DEE)_{-1} + u \quad \ldots \quad (2.3.14.2)
DEE = \( a_0 + a_1 (G_{NPfC}) + a_2 (NTXR) + a_3 (D) \)
\[ + a_4 (DEE)_{-1} + u \] ... (2.3.14.3)

DEE = \( a_0 + a_1 (G_{NPfC}) + a_2 (TXR) + a_3 (NTXR) \)
\[ + a_4 (D) + a_5 (WPI) + a_6 (DEE)_{-1} u \] ... (2.3.14.4)

DEE = \( a_0 + a_1 (DEE)_{-1} + a_2 (TXR) + a_3 (NTXR) \)
\[ + a_4 (FER) + a_5 (WPI) + u \] ... (2.3.14.5)

2.3.15 Nondevelopmental Expenditure Functions:

NDEE = \( a_0 + a_1 (TXR) + a_2 (NTXR) + a_3 (MS) \)
\[ + a_4 (NDEE)_{-1} + u \] ... (2.3.15.1)

NDEE = \( a_0 + a_1 (TXR) + a_2 (NTXR) + a_3 (MS) + a_4 (D) \)
\[ + a_5 (NDEE)_{-1} + u \] ... (2.3.15.2)

NDEE = \( a_0 + a_1 (TXR) + a_2 (NTXR) + a_3 (WPI) \)
\[ + a_4 (NIOFC) + a_5 (NDEE)_{-1} + u \] ... (2.3.15.3)

NDEE = \( a_0 + a_1 (G_{NPfC}) + a_2 (NTXR) + a_3 (D) \)
\[ + a_4 (NDEE)_{-1} + u \] ... (2.3.15.4)

NDEE = \( a_0 + a_1 (G_{NPfC}) + a_2 (NTXR) + a_3 (GFCE) \)
\[ + a_4 (D) + a_5 (NDEE)_{-1} + u \] ... (2.3.15.5)

NDEE = \( a_0 + a_1 (TXR) + a_2 (NTXR) + a_3 (WPI) \)
\[ + a_4 (NDEE)_{-1} + u \] ... (2.3.15.6)

2.3.16 Identities:

GFCE = \( G_{NPfC} - PFCE - GDCF - EX + IM \) ... (2.3.16.1)

GDS = \( G_{NPfC} - PFCE - GFCE \) ... (2.3.16.2)
\[
\begin{align*}
\text{DD} &= \text{TBD} - \text{TD} \quad \ldots \quad (2.3.16.3) \\
\text{D} &= \text{DEE} + \text{NDEE} - \text{TXR} - \text{NTXR} \quad \ldots \quad (2.3.16.4) \\
\text{BOT} &= \text{EX} - \text{IM} \quad \ldots \quad (2.3.16.5) \\
\text{DTXR} &= \text{GNP}_{fc} - \text{PDY} \quad \ldots \quad (2.3.16.6) \\
\text{NIOFC} &= \text{GDCF} - \text{GDS} \quad \ldots \quad (2.3.16.7) \\
\text{UPOP} &= \text{POP} - \text{RPOP} \quad \ldots \quad (2.3.16.8) \\
\text{GDP}_{fc} &= \text{GDP}_{ps} + \text{GDP}_{ss} + \text{GDP}_{ts} \quad \ldots \quad (2.3.16.9)
\end{align*}
\]

Non linear models were also tried but the linear models appear to be performing better in respect of acceptable specifications. The specified model reported towards the end of the alternatives was found to be performing better in terms of the criteria mentioned above.

Some of the symbols for variables used in specification of various functions which do not find mention in Appendix C are explained below:

- **B & I** - Banking and Insurance
- **CBR** - Crude Birth Rate
- **CDR** - Crude Death Rate
- **FIREBS** - Financing Insurance, Real Estate and Business Services
- **FPOP** - Female Population
- **(GDCF)\_1** - Gross Domestic Capital Formation lagged by one year
- **(GDCF\_pub.sec)** - Gross Domestic Capital Formation
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LQD</td>
<td>Liquid Assets in Public Sector</td>
</tr>
<tr>
<td>$L_{t-2}$</td>
<td>Liquid Assets lagged by two years</td>
</tr>
<tr>
<td>MPOP</td>
<td>Male Population</td>
</tr>
<tr>
<td>$(\text{NDP}_{\text{pub.sec}})$</td>
<td>Net Domestic Product in Public Sector</td>
</tr>
<tr>
<td>$(\text{NNP}_{t0}).-1$</td>
<td>Net National Product at factor cost lagged by one year</td>
</tr>
<tr>
<td>NOB</td>
<td>Number of Banks</td>
</tr>
<tr>
<td>PA &amp; D</td>
<td>Public Administration and Defence</td>
</tr>
<tr>
<td>$(\text{RI}).-1$</td>
<td>Rate of Interest lagged by one year</td>
</tr>
<tr>
<td>$t$</td>
<td>Time trend</td>
</tr>
<tr>
<td>TTXR</td>
<td>Total Tax Revenue</td>
</tr>
<tr>
<td>$Y$</td>
<td>National Income</td>
</tr>
<tr>
<td>$Y_{\text{ag}}$</td>
<td>Income generated from Agricultural sector</td>
</tr>
<tr>
<td>$Y_{\text{nag}}$</td>
<td>Income generated from Non-Agricultural sector</td>
</tr>
</tbody>
</table>

### 2.3.17 Completeness and Other Features of the System

An algebraic representation of the complete system inclusive of the specifications that are finally accepted in the present study and the relevant identities are given below. These equations are intact are normalised equations pertaining to the complete system.
PFCE = b₁,₁ + c₅,₁ (WPI) + b₂,₁ (PFCE) -₁ + b₁₇,₁ (PDY) + b₁₈,₁ (POP) + uₙ
NDCF = b₂,₁ + c₅,₂ (WPI) + c₆,₂ (GNP₇C) + c₈,₂ (BC) + c₂₁,₂ (DTXR) + c₂₂,₂ (NIOFC) + b₃,₂ (NDCF) -₁ + b₁₉,₂ (RI) + b₂₀,₂ (ITXR) + uₙ
EX = b₃,₁ + c₅,₃ (WPI) + c₄,₃ (IM) + c₂₃,₃ (GDP₇C) + b₄,₃ (EX) -₁ + b₂₁,₃ (UVIE) + b₂₂,₃ (UVIWE) + b₂₃,₃ (WWPI) + b₂₄,₃ (IWGDP) + uₙ
IM = b₄,₁ + c₂₄,₄ (GDP₇C) + b₅,₄ (IM) -₁ + b₁₈,₄ (POP) + b₂₃,₄ (WWPI) + b₂₅,₄ (UVII) + b₂₆,₄ (UVIWI) + b₂₇,₄ (FER) + uₙ
WPI = b₅,₁ + c₆,₅ (GNP₇C) + c₁₉,₅ (D) + b₆,₅ (WPI) -₁ + b₁₈,₅ (POP) + b₂₀,₅ (ITXR) + uₙ
GNP₇C = b₆,₁ + c₂₆,₆ (NDCF) + c₅,₆ (WPI) + c₁₀,₆ (TW) + c₁₅,₆ (NDEE) + b₇,₆ (GNP₇C) -₁ + uₙ
MS = b₇,₁ + c₅,₇ (WPI) + c₈,₇ (BC) + c₁₉,₇ (D) + c₂₂,₇ (NIOFC) + b₈,₇ (MS) -₁ + b₁₉,₇ (RI) + b₂₇,₇ (FER) + uₙ
BC = b₈,₁ + c₁₈,₈ (DD) + b₉,₈ (BC) -₁ + b₁₉,₈ (RI) + b₂₈,₈ (TD) + b₂₉,₈ (GDP₇S) + b₃₀,₈ (GDP₇S) + uₙ
TBD = b₉,₁ + b₁₀,₉ (TBD) -₁ + b₁₇,₉ (PDY) + b₃₂,₉ (DRI) + b₃₃,₉ (TLR) + b₃₄,₉ (OSMPI) + uₙ
TW = b₁₀,₁ + c₁₈,₁₀ (PFCE) + c₅,₁₀ (WPI) + c₆,₁₀ (GNP₇C) + b₁₁,₁₀ (TW) -₁ + b₃₃,₁₀ (TLR) + uₙ
IMR = b₁₁,₁ + c₁₁,₁₁ (PFCE) + b₁₂,₁₁ (IMR) -₁ + b₁₈,₁₁ (PDY) + b₃₅,₁₁ (FLR) + b₃₆,₁₁ (M&PH) + uₙ
TXR = b₁₂,₁ + c₃,₁₂ (EX) + c₄,₁₂ (IM) + c₁₂,₁₂ (TXR) + c₂₃,₁₂ (UPOP) + b₂₉,₁₂ (GDP₇S) + b₃₀,₁₂ (GDP₇S) + b₃₁,₁₂ (GDP₇S) + uₙ
A careful examination of the system reported as above reveals that the same is indeed a simultaneous causative model which represents the Indian economy at the level of aggregation found to be relevant for the present study. The model consists of 24 endogenous variables, 22 current exogenous variables and 15 lagged endogenous variables. Thus, predetermined variables in the system are 37. These variables are specified as below:

\[
\begin{align*}
\text{NTXR} &= b_{13,1}c_{7,13}(MS) + c_{14,13}(DEE) + c_{22,13}(NIOFC) \\
&\quad + b_{14,13}(NTXR) - 1 + u \\
\text{DEE} &= b_{14,1}c_{5,14}(WPI) + c_{12,14}(TXR) + c_{13,14}(NTXR) \\
&\quad + b_{15,14}(DEE) - 1 + b_{27,14}(FER) + u \\
\text{NDEE} &= b_{15,1}c_{5,15}(WPI) + c_{12,15}(TXR) + c_{13,15}(NTXR) \\
&\quad + b_{16,15}(NDEE) - 1 + u \\
\text{GFCE} &= (\text{GNP}_f - (PFCE) - (GDCF) - (EX) + IM \\
\text{GDS} &= (\text{GNP}_f) - (PFCE) - (GFCE) \\
\text{DD} &= (\text{TBD}) - (TD) \\
\text{D} &= (\text{DEE}) + (\text{NDEE}) - (TX) - (\text{NTXR}) \\
\text{BOT} &= (\text{EX}) - (IM) \\
\text{DTXR} &= (\text{GNP}_f) - (PDY) \\
\text{NIOFC} &= (\text{GDCF}) - (\text{GDS}) \\
\text{UPOP} &= (\text{POP}) - (\text{RPOP}) \\
\text{GDP}_f &= (\text{GDP}_{ps}) + (\text{GDP}_{ss}) + (\text{GDP}_{ts})
\end{align*}
\]
NTXR, NDEE and lowest(28) in case of the relations explaining the variables NDCF and EX. It is obvious that enough number of moments of simultaneous equations estimator of coefficients in the system would exist and inference should be made in proper context. Since number of observations available for the present study are 39 and the total number of pre-determined variables are 37, the number (n- ) is positive, where n represents sample size. Accordingly, reduced form of the system as given in relation (2.2.5) can be easily estimated and structural estimates of the unknown coefficients involved in the model can be obtained for the present system. These properties of the present specification will be taken for granted for all future treatment of the model.