CHAPTER III

THE SIMULTANEOUS EQUATION MODEL

1. Introduction

In the previous chapters, we have discussed the basic framework for our new approach of measuring the distribution and welfare impacts of government expenditures. We have also derived a simplistic model to relate, measure and interprete government expenditures and changes in Basic Welfare (BW) in the economy over time.

As we have argued, changes in our basic welfare (dX) can be adequately measured only when we consider its various components. Similarly, there are different categories of government expenditures indicating increased government efforts in respective direction. These dimensions merely extend our basic simple model by adding postulated functional interdependences between components of dX and categories of government expenditure.

Thus, in order to operationalise our simple model for empirical exercise, we need to consider specification of various functional interdependences ultimately resulting into a set of simultaneous equations in its structural form. This is done in the next section.

Having specified the structural form of the model, it is necessary to convert it into a reduced form since our basic interest is not in the structural form parameters but in the impact parameters of the reduced form. The reduced form of the model is presented in the third section. The interpretation of the reduced parameters would remain the same as discussed at length in the previous chapters.

The detailed estimation procedures for obtaining the estimates of reduced form parameters, testing the stability of the parameters over time etc. are then discussed in the final section of the present chapter.

2. The Structural Form of The Simultaneous Equation Model

In order to account for the interdependences of our endogenous variables, we now present the structural form of the simultaneous equation model. A system describing the joint dependence of variables is called a system of simultaneous equation model.*1 A structural form of the simultaneous equation model is a complete system of equations which describe the structure of the relationships of the economic variables. Structural equations express the endogenous variables as functions of other endogenous variables, predetermined variables and disturbances (random

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* 1 See, A. Koutsoyiannis : THEORY OF ECONOMETRICS, The Macmillan Press Ltd., 1981, p. 331.

variables).*2 Thus in the structural form of the model, the endogenous variables appear on the left hand as well as right hand side of the equations as can be seen as follows.

It may be recalled here, that our endogenous variables are the Disparity Reduction Rates in different socio-economic variables and our exogenous variables are the average annual rates of government expenditure at constant prices. The hypothesised structural equations, specifying the causal relationship between endogenous and exogenous variables, are presented and described below.

For the sake of convenience the discussion of structural equations has been divided into three parts viz. Health, Basic Literacy and General Economic And Social Conditions.

3.2.1 Structural Equations for Health :

$$DDR = f_1 (EMHF; DFLR; DMLR; DIMR; DBR; DPBP; PCI) \quad -(1)$$

$$DBR = f_2 (EMHF; DFLR; DBR; EOE; DPBP; DFMAM; PCI) \quad -(2)$$

$$DIMR = f_3 (EMHF; DFLR; DBR; EOE; DPBP; DFMAM; PCI) \quad -(3)$$

$$DLE = f_4 (EMHF; DDR; DFLR; DMLR; DPBP; PCI) \quad -(4)$$

$$DHI = (K_1 DDR + K_2 DBR + K_3 DIMR + K_4 DLE) \quad -(5)$$

All the functional relations are assumed to be linear. The equations specify the postulated functional relations between Disparity Reduction Rates (denoted by letter D) in various health indicators and other socio-economic

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* 2 See, A. Koutosoyiannis, Ibid., p. 336.

variables appearing on the right hand side of the equations. Since our composite Health Index is constructed out of four indicators, disparity reduction rate in composite Health Index (DHI) is nothing but the weighted average of the variables appearing on the left hand side of the equations (1) to (4). This is described by our identity (5) above where K_i's are appropriate weights.

Health Variables And Expenditure on Medical Health And Family Planning (EMHF) : The system hypothesises that the disparity reduction rates in index of death rate (DDR), birth rate (DBR), life expectancy (DLE) and Infant Mortality Rate (DIMR) are positively affected by the government expenditure on medical, health and family planning services (EMHF). A study by Farukee (1979) and a study on the Narangwal project experience in Punjab also demonstrated that substantial positive changes can be brought about through special programmes on health, (See Kielmann and others, 1983).

Governments of some 85 countries, comprising more than 90 percent of the population of the developing world, provide some type of public support for health and family planning services, to bring about substantial changes in health variables. Some countries did experience some positive changes in health variables due to additional expenditure on

health and family planning. For instance, a report of the Malaysian government contended, that the rapid fall in child mortality was a direct consequence of the maternal and child health care services, provided by the rural health programmes (Abu Baker, 1981, p. 257).

Mitra Ashok (1978) also observed that it is the improvement in public health and nutrition and not economic and social development per se, which have been the factors mainly responsible for mortality differential in state, during 1951-61 and 1961-71. If this is so then there are reasons to expect a high correlation between EMHF and improvement in the indices of health. Hence, EMHF appears as an explanatory variable in all the structural equations of health, as can be seen from above.

Health Variables And Nutrition : It is generally agreed, that nutrition is the basic input for health and removal of nutritional deficiency can cause positive changes in the health variables. Therefore, the variable DPBP-Disparity Reduction Rate in the index of Poverty appears as an explanatory variable for the disparity reduction rates in health variables. Different studies on causes of mortality and morbidity also, very clearly reveal that poverty (defined in terms of calorie consumption) is the major disease in developing countries, causing high mortality and morbidity (Social Information, 1982).

In one of the studies on inter-country data for 65-69 and 1975-79, the variable of LE was regressed on GDP, literacy rate and excess of daily calorie supply per capita above 1500 (Mensch et al., 1983). It was found that all the coefficients were statistically significant, which implied that keeping other determinants constant the nutritional factor had positive impact on LE. Similarly, nutritional status of mother also affect the infant deaths. The Narangwal experience also confirmed this hypothesis. The correlation coefficient between prenatal child care - in terms of nutrition and health care of mothers and infant death rate was negative and significant implying that improved index of health and nutrition would improve the index (reduce the IMR) of IMR (Kielmann and others, 1983).

Even Index of BR is also likely to improve due to improvement in the index of PBP. It is believed that production of large number of children in developing economies is largely an outcome of economic consideration - to generate sufficient labour in the family in older to ultimately earn certain minimum level of income. If the poverty index improves (poverty ratio falls), the 'labour value' of children is likely to fall which may in turn decrease the demand for children. However, the data for 1971-81 do not appear to support the hypothesis of strong linear correlations between DPBP and health variations,

since the individual zero order coefficient of correlations between DPBP and health variables are statistically insignificant even at 10 percent level of significance (see, Table 3.1).

Health Variables and Education : We have adopted the dichotomy between literate and illiterate for males' and females' basic education. Nevertheless, we have also considered the impact of higher education through inclusion of expenditure on other education (EOE which includes expenditure on Education Other than Primary education). It can be seen from the above that variable EOE appears on the right hand side of the equations (2) and (4).

Investigation in many countries have consistently shown a strong positive relationship between improvement in education and improvement in health indicators, keeping other determinants constant. It is believed that health output is largely a product of wide spread diffusion of knowledge rather than of socio-economic advance or of enlightened government programmes for which education is a necessary condition (See, Mensch et al., 1983). The factor of literacy was found to be significant in explaining the variations in life expectancy in various studies (Preston Samuel, 1985).

Further, between male and female education, the role of female education is found to be quite important in terms

Table 3.1 : Correlation Matrix Among Endogenous Variables, 1971-81.

Variables		DMLR	DFLR	DIMR	DBR	DDR	DFMAM	DPP	DCWPR	DCR	DMPRNA
1		2	3	4	5	6	7	8	9	10	11
1)	DMLR	1.0000									
2)	DFLR	0.8786	1.0000								
3)	DIMR	0.2118	0.4910	1.0000							
4)	DBR	0.4138	0.6706	0.6452	1.0000						
5)	DDR	0.5460	0.7587	0.7865	0.7725	1.0000					
6)	DFMAM	0.3772	0.4571	0.1241	0.4728	0.5490	1.0000				
7)	DPBP	0.3663	0.2747	0.0003	0.0960	0.1480	-0.0632	1.0000			
8)	DCWPR	0.2560	0.2956	0.2939	0.5153	0.3656	0.1846	0.3203	1.0000		
9)	DCR	-0.1461	-0.0342	0.1937	0.1168	0.2333	0.2522	0.1139	0.4990	1.0000	
10)	DMPRNA	0.3815	0.2638	0.0546	-0.0567	-0.1256	-0.4073	0.2029	-0.1102	-0.6869	1.0000
11)	DCWI	0.7218	0.8384	0.6825	0.7582	0.8640	0.4188	0.4492	0.5347	0.3222	0.0385

Note : The relevant critical values of coefficients of correlation at 1% level, 5% level and 10% level of significance are respectively 0.6411, 0.5141, and 0.4411.

of reduction of birth rate and infant mortality rate. The official document of sixth and seventh five year plans have explicitly recognised the role of female literacy, particularly in terms of fertility reduction (See, Seventh Five Year Plan, 1985-90). Since these are among the major objectives of our nation, the section cannot end without discussing the synergism between female literacy and variables like BR and IMR.

Female Literacy And Infant Mortality Rate : Investigations in many countries have consistently shown a strong inverse relationship between mother's education and child mortality (Caldwell, 1979; Caldwell and McDonald, 1981). The resources of mother influence greatly the quality of care the child receives from conception through the early years of life (See, Mosely and Chen, 1984). In interpreting Nigerian data Caldwell (1979:13-14) suggests three links : (i) mothers with more education tend to be less fatalistic about illness and therefore prone to seek outside medical assistance for an ill child (ii) educated mothers are more likely to adopt improved child care practices at home; and (iii) education may change intra-family relationships leading to a more 'child-centred' orientation that would have a positive impact on children's health. Similarly, the study by Julie Da Vanzo (1985) also concluded that mother's education was an important determinant of IMR and economic development may

complement, instead of substitute for the beneficial effect of mother's education in promoting infant survival. The data for 1971-81 also appear to support this hypothesis as the correlation coefficient between DIMR and DFLR (-0.49) has turned out to be statistically significant at 10 percent level of significance (See, Table 3.1).

Female Literacy Rate And Birth Rate : Many of the studies on fertility have demonstrated that fertility is inversely related with the level of education. A study by Zacharia and Sulekha Patel (1984) had shown that out of all other factors FLR had the highest explanatory power in explaining the variation in family planning practices which has direct impact on BR.

Womens' education can also affect the BR directly : (i) by delaying marriages to permit the completion of schooling, for example; (ii) through increasing womens' qualifications for jobs outside home that can compete with child-bearing as a means of gaining satisfaction and status; and (iii) by enhancing the likelyhood that the lower family size ideals of younger women will prevail over those of older generations. Such effects would produce additional downward pressures on birth rates (See, David Gwatkin, 1984; Cochrane, Hill, 1979).

A recent study by Jain, A. and Moni Nag (1986) on India

has demonstrated that female education in India monotonically increases the use of contraceptives and age at marriage, both of which in turn decrease fertility. The most important and interesting conclusion, which emerges from their arguments is that as far as fertility reduction is concerned, the educational policy should give high priority to expansion of female primary education rather than beyond primary level of schooling, on margin.

The cross section data for 1971-81 on India also give the correlation coefficient of 0.67 between DFLR and DBR, which is statistically significant even at one percent level of significance (See, Table 3.1). Finally it may also be noted that for 1971-81 the correlation coefficient between DHI and DFLR is significant whereas that between DHI and DMLR is statistically insignificant (See, Table 3.2). This may imply that the role of female education plays greater role than male education, in terms of improvement in health index.

Impact of Female Mean Age At Marriage On IMR and BR : The variable of female mean age at marriage (DFMAM) is also an important determinant of DBR and DIMR, along with other factors. The relationship between FMAM and IMR can be explained in this way : A very young mother is biologically not fully mature, so that the probability of pregnancy related complications is high. Also young mothers may not be

Table 3.2 : Correlation Matrix Among Endogenous Variables (Component Indices)

Variables	DMLR	DFLR	DHI	DGESC
1961-71				
DMLR	1.0000			
DFLR	0.9206	1.0000		
DHI	0.3523	0.3964	1.0000	
DGESC	-0.3631	-0.4173	0.0936	1.0000
DCWI	0.5426*	0.5952*	0.8767*	0.2558
1971-81				
DMLR	1.0000			
DFLR	0.8785*	1.0000		
DHI	0.2426	0.5154*	1.0000	
DGESC	0.3953	0.4204	0.2090	1.0000
DCWI	0.7218*	0.8384*	0.7034*	0.7300*
1961-81				
DMLR	1.00000			
DFLR	0.8833*	1.00000		
DHI	0.1965	0.3919*	1.0000	
DGESC	0.0681	-0.0075	0.0144	1.0000
DCWI	0.6198*	0.7018*	0.7137*	0.4850*

* Significant at 5% level.

able to take proper care of the young infants (See, Leela Visaria, 1986). These two causes make the IMR also a function of age at marriage.

Some of the studies for Pakistan, Indonesia, Philippines and Sri Lanka also demonstrated the close relationship between IMR and age of giving birth (See, Martha Ainsworth, 1985). The study on EI Salvador also revealed that IMR is higher for mothers under twenty than for mothers in the 20-30 years age group. The study revealed that IMR for teenage mother was 120 per thousand as compared to 73 per thousand for mothers 25-29. After age 30, IMR increases gradually but does not reach the high levels found among teenage mothers (Martha Ainsworth, 1985). Ashok Mitra (1978) also observed, that increase in mean age at marriage to 20 or above 22 years would achieve not only demonstrable demographic impact but work in favour of more responsible parenthood and make a decisive different to help safeguard the health of the mother and the child.

The data for 1971-81 also support the positive relationship between improvement in FMAM and DBR since the coefficient of correlation between DBR and DFMAM is statistically significant at 10 percent level of significance (See, Table 3.1). However, there does not appear to be a linear correlation between DIMR and DFMAM, since the

coefficient of correlation between them is statistically insignificant even at 10 percent level of significance (Table 3.1).

Two Way Causal Relationship between IMR and BR : It can be observed from the above set of equations that DIMR which appears as a determining variable for the DBR is also determined by the DBR along with other factors. IMR and BR affect one another. If the fertility is influenced by desired family size then the infant survival rate is an important determinant of expectations. In addition, lactation has some contraceptive effect, so that an enhanced infant survival rate should have a purely physiological impact on fertility (Wheeler, 1985; Jain, A.K., 1986). The hypothesis regarding the labour value of children also appear to hold quite good for India. Kulkarni (1975) finds that in a country like India, one of the reasons for high B.R. is that with a high IMR the economic necessity of bearing many children rises so that at least some may survive to provide much needed manual labour for a peasant.

The studies by Heer and Smith (1968) and Hassan (1966) also demonstrated that the experience of child mortality tends to raise fertility. Mitra (1978) also observed that high infant deaths themselves would offer a stiff backlash to the birth rate and push up the latter, or at least resist its further fall.

Similarly, it can be argued that fertility has an impact on infant mortality, and hence DIMR should also be a function of DBR. Some evidence suggest that child spacing affects infant survival probability and child spacing is clearly related to fertility (Wheeler, 1985). It is argued that short intervals contribute to higher child survival risk due both to biological disadvantage of maternal depletion (low birth weight) and to between - child competition for care (Mosely and Chen, 1984). A study in Thailand predicted that infant mortality could be reduced by 27 percent if women were to give birth to no more than 4 children and only between the age 20-34 (Wright, 1975).

The correlation coefficient between the variables of DIMR and DBR is 0.6407 which is statistically significant even at 1 percent level of significance which appear to support the hypothesis of positive relationship between the index of IMR and index of birth rate. (Table - 3.1)

Impact of Birth Rate and Infant Mortality Rate on Death Rate : It can also be hypothesized that improvement in BR and IMR would significantly improve the index of DR and LE. There are two reasons for this :

(1) Reduction in birth rate is likely to reduce the rate of maternal mortality, which would cause the reduction in the overall death rate.

(2) Similarly in a developing country like India the share of infant deaths in the overall deaths is almost 30 percent (Mitra, 1978) which implies that reduction in IMR can also significantly bring down the death rate. This is also evident from the coefficient correlations (Table 3.1). The coefficient of correlation between DDR and DBR is 0.77 and DDR and DIMR is 0.76, which are statistically significant even at 1 percent level of significance.

It may be observed that in all our structural equations the variable of per capita income (PCI) appear as an explanatory variable. This variable is introduced to capture the impact of all other factors of development not explicitly considered in the equations.

3.2.2 Structural Equations on Basic Literacy :

$$DMLR = f_5 \ (EPE, DPBP, DCWPR, PCI) \quad \ldots (6)$$

$$DFLR = f_6 \ (EPE, DPBP, DCWPR, PCI) \quad \ldots (7)$$

The system hypothesizes that improvement in literacy is a function of improvement in the index of poverty, child worker rate, per capita income as well as per capita expenditure on primary education. It is very well recognised that among the major cause for not attending the schools the causes of easy accessibility to schools and/or economic

conditions of the people in a given region are of paramount importance. In an economy like India, with a predominantly large agriculture sector, children are almost forced to participate in the earning activity of the family. Hence a large number of children are deprived of the opportunity to get education. Another major factor is the availability of educational facilities in a nearby area. It is very well recognised that proximity is an important determinant of the enrollment as well as retention ratio, which can be increased through greater efforts on the part of the government.

3.2.3 Index of General Economic And Social Conditions (GESC):

$$DCWPR = f_8 (DFLR, DMLR, DEPE, EOE, DPBP, PCI) \quad \ldots (8)$$

$$DPBP = f_9 (DMPRMA, EOSC, EAG, PCI) \quad \ldots (9)$$

$$DMPRNA = f_{10} (EAG, ETC, EWPP, EIM, PCI) \quad \ldots (10)$$

$$DCR = f_{11} (DFLR, DMLR, EOE, DPBP, PCI) \quad \ldots (11)$$

$$DFMAM = f_{12} (DFLR, DMLR, DMPRNA, DPBP, PCI) \quad \ldots (12)$$

$$DGESC = (K_1 DCWPR + K_2 DPBP + K_3 DMPRNA + K_4 DCR + K_5 DFMAM) \quad \ldots (13)$$

Where, K_i's are the weights of individual indicator indexes.

The component index of GESC is constructed out of the five different indices such as CWPR, PBP, MPRNA, CR, FMAM. Hence the DRR in component index of GESC is nothing but the weighted average of the DRR's in the above five indices.

This is described by the equation (13) above. The system hypothesizes that increase in expenditure of the government on primary and other education increases the mean age at marriage and reduces the extent of child labour as well as the crime rates. There are enough evidences to show that education increases the mean age at marriage (Mitra Ashok, 1978). Similarly the inter country data do reveal that there is a high association between literacy, poverty etc. and the incidence of child-labour and cognizable crimes, keeping other determinants constant (Kulshreshtha, 1978, pp. 12-13). But poverty in turn is likely to get affected through : (i) employment opportunities in non-A sector and (ii) improved productivity in agriculture sector. Moreover, some expenditures on social and community services, such as expenditure on labour and employment, social security and welfare, relief on natural calamities etc. are also expected to reduce the extent of poverty in a given region. Hence, it is hypothesized that DPBP is a function of DMPRNA, EAG, EOSCS, PCI etc.

Since the inception of planning, the government made efforts to increase the employment opportunities through expansion in irrigation, power, basic industries, transport and other services, envisaging that directly as well as indirectly, there will be new avenues of employment. It was also stated, that the development of non-A sector should be

linked with agriculture sector, to bring about substantial changes in the occupational structure. Hence, we may expect, at least a priority, the improvement in MPRNA to be a function of Expenditure on Agriculture (EAG), Expenditure on Industry and Minerals (EIM), Transport and Communication (ETC), as well as Expenditure on Water and Power Development (EWPD). The variable of the level of PCI is introduced as usual, to account for all other factors of economic development not explicitly considered.

3.2.4 Equation Of Composite Welfare Index : The equation of DCWI is an identity. Since the composite index is constructed through combining the component indexes of health, education and GESC, the DRR in composite Index (DCWI) could be represented as the weighted combination of the DRR's in the respective component indexes. The equation of DCWI can be written as

$$DCWI = K_1DHI + K_2DMLR + K_3DFLR + K_4GESC$$

where Ki's are the appropriate weights. With this the structural model is complete. There are in all eleven equations and three identities in the structural model. However, it may be recalled here that our primary interest is not in estimating the impact of one endogenous variables on the other, but it is to estimate the welfare impact of government expenditure. For this purpose, we have to derive

a reduced form model from the structural form which is presented in the subsequent section.

3. The Reduced Form Of The Model

As mentioned above, the reduced form model can be derived from the structural form of the simultaneous equation model. The reduced form model is the one in which the endogenous variable(s) are expressed as a function of the exogenous or predetermined variables and the stochatistic variable.*3

The reduced form parameters measure the total effect - direct as well as indirect - of a change in the predetermined variable(s) on the endogenous variable(s) after taking account of the interdependences among the jointly dependent endogenous variables (Koutsoyinnis, 1981). "The reduced form coefficients are used for forecasting and policy analysis, since it is the total effect of a change in the exogenous variables on the dependent variable(s) that is of interest to the policy maker".*4

The reduced form coefficients which we would be estimating are also known as impact multipliers because they measure

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* 3 See, Damodar Gujrati : BASIC ECONOMETRICS, McGraw-Hill Kogakusha, Ltd., 1978, p. 350.

* 4 See, A. Koutsoyiannis, op. cit., p. 339.

the total impact of a unit change in the value of the exogenous variable(s) on the endogenous variable on margin. Looking to the basic objective of the study, namely, to measure the ultimate impact of various government expenditures on welfare, we must estimate the reduced form parameters.

There is also another reason why we have completely refrained from the estimation of structural coefficients. The estimation of structural coefficients gives rise to the problem of identification.*5 If the structural equations are over identified or exactly identified, they can be estimated through some econometric techniques. But if the equations are under identified then the structural coefficients cannot be uniquely estimated. And the difficulty is that there is a controversy among econometrician regarding the identifiability of the equation. In large number of studies the estimated structural relationships are assumed to be over identified and hence are estimated through different econometric techniques. However, the opposite view is taken by some scholars like Liu (1960), who feels that such estimates may not be reliable. He argues that most economic relationships are under-identified; too many variables are excluded from each function for various reasons. Thus the identification is spurious in most cases, established on

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* 5 The problem of identification is discussed in detail in A. Koutsoyiannis, Ibid., pp. 346-368.

wrong specification of variables included and excluded from the relationship, and hence it is pointless to attempt the estimation of individual coefficients, because they would not be reliable. Under these circumstances, the only meaningful measurement would be the estimation of the reduced form models with a large number of predetermined variables. Thus, according to him the most one could do is to obtain the reduced form coefficients and use them for prediction or forecasting purpose. In order not to fall in any of this type of controversies we have limited our estimation and analysis to the reduced form coefficients only, about which there is a great deal of unanimity among the scholars.

In order to obtain the reduced form equations from the structural form, we have to rewrite the above equations in such a way that all the endogenous variables appear on the left hand side only. This is done by continuous substitution of the variables in the structural equations, which takes into account all important a priori relationships between the structural variables. Since in the reduced form equations the explanatory variables are truly exogenous or predetermined variables, the situation of joint determination (two-way causation) of the variables appearing in a single equation is avoided. The reduced form coefficients then may be estimated by ordinary Least Squares (OLS) applied to the reduced form equations, and can be used for forecasting

despite the fact that the individual structural parameters are not identified. The reduced form equations of the model are presented below :

(1) DDR = g_1 (EMHF,EPE,EOE,EOSC,EAG,EIM,ETC,EWPD,PCI)

(2) DLE = g_2 (EMHF,EPE,EOE,EOSC,EAG,EIM,ETC,EWPD,PCI)

(3) DBR = g_3 (EMHF,EPE,EOE,EOSC,EAG,EIM,ETC,EWPD,PCI)

(4) DIMR = g_4 (EMHF,EPE,EOE,EOSC,EAG,EIM,ETC,EWPD,PCI)

(5) DCWPR = g_5 (EPE,EOE,EOSC,EAG,EIM,ETC,EWPD,PCI)

(6) DCR = g_6 (EPE,EOE,EOSC,EAG,EIM,ETC,EWPD,PCI)

(7) DPP = g_7 (EOSC,EAG,EIM,ETC,EWPD,PCI)

(8) DMPRNA = g_8 (EAG,EIM,ETC,EWPD,PCI)

(9) DFMAM = g_9 (EPE,EOE,EOSC,EAG,EIM,ETC,EWPD,PCI)

(10) DMLR = g_{10}(EPE,EOSC,EAG,EIM,ETC,EWPD,PCI)

(11) DFLR = g_{11}(EPE,EOSC,EAG,EIM,ETC,EWPD,PCI)

(12) DHI = g_{12}(EMHF,EPE,EOE,EOSC,EAG,EIM,ETC,EWPD,PCI)

(13) DGESC = g_{13}(EPE,EOE,EOSC,EAG,EIM,ETC,EWPD,PCI)

(14) DCWI = g_{14}(EPE,EOE, EMHF,EOSC,EAG,EIM,ETC,EWPD,PCI)

It can be easily seen that all the endogenous variables appear on the left side of the equations only. The estimated slope parameters of the above equations are functions of the coefficients of the structural model which would measure

the direct as well as the indirect impact of each of the explanatory variables on the endogenous variables on margin. Further, the sign of these parameters would indicate whether the marginal returns to the government efforts in a given sector, are increasing, decreasing or constant, as discussed in Chapter II.

4. Method Of Estimation

It may be noted at the outset that if our ultimate interest is not to estimate the structural coefficients, then, estimation of all the reduced form equations is not a must. That is, having obtained the reduced form equations from the structural form through continuous substitution, one can choose relatively more relevant equations out of a given set of reduced form equations and estimate them through appropriate techniques.

Looking at the entire set of reduced form equations in Section-3, we find that the last five equations which are the equations relating to the basic components of X as well as composite index of X are most relevant for us. These are namely the equations of DMLR, DFLR, DHI, DGESC and DCWI. These five equations are estimated through OLS, for the period 1961-71 and 1971-81. The estimates are based on the cross section data on Indian states. The regression estimates on these five equations are presented and discussed in Chapter VI.

In order to increase the degrees of freedom and thereby to increase the reliability of the OLS estimates, two linear restrictions are put on the parameters of the regression equations for which a technique of Restricted Least Square (RLS) is used. Further, stability of all these functions between 1961-71 and 1971-81 is tested with the help of the 'Chow test'. In order to measure the changes in the value of intercept as well as slope parameters (which might have occurred due to changes in other factors such as $Z_1, Z_2 \ldots Z_n$. mentioned in Chapter II) between these two periods, the econometric technique of 'dummy variables' is used. All these techniques are discussed at appropriate places.

Apart from this basic exercise of the model, two more empirical exercises have been carried out : One is a broad aggregative kind of exercise, where instead of eight or six categories of government expenditure, only two broad expenditure categories viz. expenditure on Human Capital formation (EHK) and Expenditure on Physical Capital formation (EPK) are considered as explanatory variables. The impact parameters of these regressions are estimated for both the periods viz. 1961-71 and 1971-81. Like the previous exercise, stability of these functions over a period is tested with the help of the 'Chow test'. Similarly, the technique of 'dummy variables' is also used to measure the changes in the value of individual coefficients over years. Epiirical result

of this broad kind of an exercise are presented and discussed in Chapter V.

However, before this, another kind of an exercise is carried out in Chapter IV, in which all the reduced form equations relating to individual indicators are separately estimated. This can be considered as the detailed exercise since regression equations relating to each indicator such as DBR, DDR, DIMR, DCR, DCWPR etc., are estimated. However, looking to the purpose of the present study on one hand and the limitations of the data for 1961-71 on the other, the empirical exercise for individual indicators was carried out only for 1971-81. Empirical results of these exercise are presented and discussed in Chapter IV.