Chapter One

Inter-Industry Linkages of Housing Investment

1. Introduction

Housing is a crucial sector of the national economy. It plays a significant role in promoting economic growth and improving the general level of social well-being. Provision of adequate housing produces multifarious effects in the national economy mainly in the form of direct and indirect income generation, direct and indirect employment generation and improvement in productivity levels, besides serving also as a means of increased social welfare.

The total impact of housing investment on the process of income generation and economic growth extends much beyond what may be called the initial or direct effect, because housing investment generates significant growth impulses in the economy which are transmitted from one sector to another. The extent of inter-sectoral transmission of growth impulses depends on the nature and strength of inter-industry linkages of housing sector with the rest of national economy. It is evident, therefore, that to evaluate the overall impact of housing investment on the national economy, it is necessary to estimate the intersectoral linkages and the overall output expansion resulting from the additional expenditure on housing. Moreover, from the viewpoint of policy makers, the decision regarding additional investment in housing is closely related to the overall impact not only of housing investment but also of investment in other alternative fields.

Optimal allocation of scarce national resources involving housing vis-a-vis other sectors can be determined after a comparative evaluation of the intersectoral linkages of investment in housing and other sectors in the economy. The present study is an attempt in this direction. It seeks to measure the total direct and indirect output generation impact of additional expenditures on various sectors of Indian economy and to assess the relative importance of housing investment in the context of assigning priority for resource allocation.

2. The Methodology

The concept of inter-industry linkages involves an attempt to trace the flow of various types of materials and their product through different stages of production in order to determine the quantities and the disposition of inputs consumed while supplying finished products to final demand activities. The final demand activities are defined in terms of activities other than production and include private consumption, government consumption, private investment, public investment, change in inventories and the demand for exports from the foreign sector net of imports.

The crucial element in inter-industry linkages is the phenomenon of inter-dependence of production activities which arises from the fact that each production activity requires the output of several other production activities in the form of inputs. Accordingly, a given sector depends on those sectors which supply inputs to it and also on those which use its output as their inputs. It follows, therefore, that the expansion of a given sector generates additional demand for the output of its input-supplying sectors and also simultaneously provides larger supply to its output-using sectors. According to the conventional classification of inter-industry linkages, the former type of inter-dependence is called the backward linkage, while the latter is called the forward linkage.

It is customary to use the methods based on Leontief's input-output analysis to quantify the extent of inter-sectoral linkages. Leontief's input-output table is a useful device of summarising the origin of each of the various inputs and the destination of each of the various outputs of all industries in an economy. It shows the inter-industry transactions in the form of flow of goods and services. Assuming that there are n sectors in the economy, we can denote the gross output of the jth sector by X_j and the amount of i^{th} sector's output consumed in the process of producing i^{th} sector's output as X_{ij}. The matrix X consist of elements X_{ij} (I = 1, 2, ...n; and j = 1,2, ...,n) represents the input-output transactions matrix of dimension n x n. From the transactions matrix, we can derive the technology matrix A by defining the technical input-output coefficient $A_{ij} = X_{ij}/X_j$. The coefficient A_{ij} indicates the amount of i^{th} sector's output required as input for producing one unit of the j^{th} sector's output.

The output of any given industry is used partly to meet the inter-industry demand and partly to meet the final demand. Accordingly, we have the following basic identity indicating how the i^{th} sector disposes of its output :

$$\sum_{j=1}^{n} X_{ij} + F_i = X_i \qquad (i = 1,2,\ldots\ldots, n)$$

where $\sum_{j=1}^{n} X_{ij}$ shows the total use of jth industry's output by each of the n sectors;

and F_i shows the final demand for the product of sector i.

In matrix notation, the system of equations implicit in the above identity can be expressed as

$$AX + F = X \qquad (1)$$

Equation (1) can also be re-written as

$$X - AX = F$$

i.e $(I-A)X = F$ .... where I represents the identity matrix of dimension n x n

Pre-multiplying both sides of the above equation by

$(I-A)^{-1}$, we get

$$X = (I-A)^{-1} F \qquad (2)$$

In the open Leontief system, the final demand vector F is given exogenously. We can, therefore, raise the following question : Given the final demand for various goods and services, what should be the level of gross output that each sector will have to produce to meet the final demand? The levels of gross output that will exactly meet the final demand for various goods and services will be the ones that will also support all the production activities required in producing various types of output. The output requirements for supporting a specified level of production activity in different sectors depends on the given technology of production as indicated by the technical input-output coefficients. As shown in equation (2), these equilibrium output levels consistent with the given final demand and the corresponding inter-industry demand can be readily obtained once we have the inverse matrix $(I-A)^{-1}$, also knows as the Leontief Inverse'.

The elements of the Leontief Inverse have special interpretation. Let the elements of the inverse matrix $(I-A)^{-1}$ be denoted by C_{ij}, i = 1,2,...,n; and j = 1,2,...,n. The elements of j^{th} column (C_{1j}, C_{2j}, ... C_{nj}) indicate the gross output from each of the n sectors required to meet one unit of final demand for the product of j^{th} sector. It is evident that to produce one unit of final output of a given sector, inputs are required from various sectors. It is necessary, therefore, to produce some output in each of the different sectors to support one unit of final output of a given sector. The necessity to produce some positive output levels in other sectors, in turn, implies further requirements of the output of various sectors to serve as inputs in each sector's output. The total output requirements for all sectors taken together for supporting one unit of final output of a given sector would thus consist of the direct and indirect output requirements. The elements of a given column vector of the inverse matrix $(I-A)^{-1}$ represent the direct and indirect output levels in various sectors associated with one unit of final demand for the output of the corresponding sector.

Limitations of Input-Output Analysis :

Before we examine the various measures of inter-industry linkages that can be derived from a given technology matrix, it would be useful to take note of the limitations of input-output analysis. The methodology of input-output analysis depends on some crucial assumptions regarding the nature of input-output relations. For instance, the use of technical input-output coefficient derived from the inter-industry transactions matrix assumes that any given change in the level of output is accompanied by a proportionate change in the amounts of all inputs required in the process of production. This is known as assumption of fixed input-coefficients of production. This assumption, in turn, implies that there are constant returns to scale in transforming the basic inputs into final output, and that different industries are operating under the conditions of competitive equilibrium. In reality, however, the input-output coefficients may undergo some changes with the passage of time on account of (a) changes in the basic technology of production, (b) changes in the relative prices, and/or (c) the existence of economics of scale. Moreover, an analysis of inter-industry linkages based on the given input-output table, concentrates only on the production linkages and examines the impact of changes in sectoral outlays on output levels. In the process, it usually, abstracts from the kinds of effects it may have on the distribution of purchasing power among different categories of consumers.

In addition to this, there are many practical difficulties in data compilation and empirical derivation of the input-output table especially for an under-developed economy. However, notwithstanding the limitations, the input-output analysis is still being widely used mainly because it remains the only powerful device available for estimating the inter-industry linkages and conducting impact analysis of policies relating to resource allocation.

Measures of Inter-Industry Linkages :

Given the technology matrix A and the inverse matrix $(I-A)^{-1}$, we can measure the strength of different types of inter-industry linkages. The following two measures are of special significance for our purpose :

(1) The first measure indicates the direct backward linkage representing the direct input demand generated by a unit change in the level of production of a given sector. This measure is known as the coefficient of backward linkage or BL_j. The coefficient of direct backward linkage associated with the expansion of sector j is measured by :

$$BL_j = \frac{\sum_{i=1}^{n} X_{ij}}{X_j}$$

Direct intermediate input requirement of sector j per unit of its gross output

(2) The second measure indicates the total impact of an increase in the output of a given sector on all sectors taken together. This measure, known as 'total linkage coefficient' or the 'index of power of dispersion' (Y_j) accounts for the direct as well as indirect linkages induced via feedback and spillovers of the initial impact to all other

sectors in the economy. The total linkage coefficient associated with the expansion of sector j is measured by :

$$Y_j = \frac{\sum_{i=1}^{n} C_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{n} C_{ij}}$$

Total direct and indirect requirements of inputs per unit of final demand of sector j in relation to the corresponding national average

3. Input-Output Data for Indian Economy

During the last three decades considerable research work in the field of input-output economics involving empirical construction and analysis of input-output tables relating to Indian economy has been carried out. The information on inter-industry transactions depicted by the input-output tables has been extensively used in the formulation of India's five year plans. Planning Commission has estimated the inter-industry transactions in Indian economy for 1996-97 which represents the base year for the Ninth Five Year Plan. The Transactions Matrix for 1996-97 prepared by the Planning Commission is based on a 65-sector classification of the economy and it captures the latest available information on inter-industry flows in Indian economy. We have used this input-output table for the present study.

From the information relating to the Transactions Matrix for 1996-97, we have estimated the technical coefficients matrix indicating the total input requirements and also the import coefficients matrix indicating the import requirements per unit of a given industry's output. Both the total coefficients matrix as well as the import coefficients matrix show input requirement per rupee of gross output at factor cost at 1996-97 prices. From these two matrices, we can derive the intra-regional or domestic technology matrix. The elements of domestic technology matrix indicate the supply of inputs from within the country per unit level of output of a given sector in the country.

It is necessary to subtract the import transactions from the total transactions and focus mainly on the resulting matrix of domestic transactions especially in an analysis of the impact of sectoral investment on the activity levels in the domestic economy. This is because the imports represent leakages from the incremental inter-sectoral flows generated by the expansion of a given sector. The strength of direct as well as indirect growth impulses originating from a unit increase in the final demand for the product of any sector is reduced in proportion to the direct and indirect input requirements to support the expansion of various sectors needed to meet the increased demand. For the purpose of the present analysis, we have, therefore, used the input-output coefficients derived from the domestic transactions matrix (T-M) to measure the direct and indirect effects of increased expenditure in a given sector on the domestic output levels of various sectors. Accordingly, the modified version of the basic identity that we have used for analysing inter-industry linkages in Indian economy is the following:

$$X + MX = TX + F \qquad (1)$$

where X represents the vector of domestic output levels with the dimension n x 1

M represents the import coefficients matrix of the dimension n x n

T represents total technical coefficients matrix of the dimension n x n

F represents the final demand vector with the dimension n x 1. It includes private consumption, public consumption, gross fixed investment, exports and change in stock.

Equation (3) can be re-written as :

$$X + MX - TX = F$$

i.e. $(I + M - T)X = F$

Pre-multiplying both sides of the above equation by $(I + M - T)^{-1}$, we get

$$X = (I + M - T)^{-1} F. \qquad (2)$$

If we denote (T-M) as A, we can rewrite the above equation as

$$X = (I - A)^{-1} F$$

The elements of each column of $(I - A)^{-1}$ indicate the direct and indirect domestic output levels in different sectors required to support a unit increase in the final demand for the product of the corresponding sector.

Sectoral Classification :

The broad sectoral classification of the 65 sectors in the input-output table prepared by the Planning Commission for the year 1996-97, is as follows:

Table 1 **Analysis of the Sectoral Classification of 65 Sector Input-Output Table for 1996-97 by the Relative Level of Aggregation in Different Sectors**	
Broad Sectoral Category	The extent of Disaggregation as indicated by the number of sectors considered
1. Agriculture and Allied Activities	13
2. Mining	5
3. Manufacturing	35
4. Electricity	3
5. Construction	1
6. Transport	2
7. Trade	1
8. Services including Banking, Insurance, Social Services, Public Admn., Prof. services, etc.	5
TOTAL	**65**

It is evident from the above classification that the main emphasis in preparing the input-output table for Indian economy is essentially on depicting the inter-industry transactions and commodity balances, largely within the manufacturing sector. Two types of factors seem to account for this phenomenon :

(a) the non-availability of the basic statistical source material required for preparing reliable input-output coefficients at dissaggregated levels for sectors other than agriculture and manufacturing; and

(b) the need to focus mainly on the overall commodity balances within the framework of a consistency model for formulating the five year plan.

From the view point of the present analysis, the pattern of sectoral classification revealed by the 65 x 65 sector input-output table for the Indian economy indicates major imbalances in the levels of disaggregation attempted within different broad sectoral categories. Such imbalances would affect the estimates of inter-industry linkages for different sectors. If the analysis of inter-industry linkages is to provide meaningful information for determining the relative allocation of resources among the different sectors, it is necessary that the overall sectoral classification is based on a more or less similar degree of aggregation within each broad category of sectors.

The framework of aggregative sectoral classification based on the broad spheres of economic activity seems to be more appropriate for analysing the inter-industry linkages to formulate resource allocation policy. Moreover, to make the comparison of the overall impact of additional expenditure in each of the alternative sectors effective and meaningful, it is necessary that the final expenditure levels in those sectors are high enough to absorb substantial expansion. Over a narrow time horizon, the possibilities of increasing the final demand expenditures in various sectors are limited essentially by the existing levels of final demand expenditures in the respective sectors. Thus, while analysing and comparing the extent of inter-industry linkages of various sectors, the relative importance of each sector in the national economy as indicated by its contribution to the aggregate national output needs to be considered.

For the purpose of the present study, we have adopted the same system of broad sectoral classification consisting of 14 major sectors that is adopted by the CSO for presentation of national income estimates for Indian economy. The only difference between our 14-sector classification and the corresponding CSO classification is that the latter divides manufacturing sector into the two categories of registered and unregistered manufacturing, while we have divided it into the two categories of construction related manufacturing and other manufacturing. We have aggregated the detailed 65 x 65 sector input-output table prepared by the Planning Commission for the year 1996-97 into the corresponding 14 x 14 sector table by adopting the usual procedures of aggregation. The detailed 65 sector classification provided by the Planning Commission and the scheme of aggregation to reflect sectoral classification covering 14 broad sectors adopted for the present study are shown in *Appendix Tables 1 & 2*, respectively.

The aggregated 14 x 14 sector Transactions Matrix as well as the corresponding domestic transactions matrix derived from the detailed input-output tables prepared by the Planning commission for the year 1996-97 are presented in *Appendix Tables 3 and 4* respectively. The domestic technology matrix (T-M) and the inverted residual domestic technology matrix $(I + M - T)^{-1}$ are presented in *Appendix Tables 5 and 6* respectively. The relative importance of each of these 14 sectors in the Indian economy, as indicated by the contribution of each sector to the aggregate gross output, is brought out by the estimates presented in *Table 2*.

Table 2
Estimates of Gross Output for Broad Sectors of Indian Economy, 1996-97

(Rs. Million at Factor Cost)

Sl. No.	Sector	Gross Output	Sectoral Share
1	Agriculture and Related Products	3951223	17.0%
2	Forestry & Logging	125060	0.5%
3	Fishing	157733	0.7%
4	Mining	292842	1.3%
5	Construction related Manufacturing	1851600	8.0%
6	Other Manufacturing	7050406	30.4%
7	**Construction**	**1628708**	**7.0%**
8	Electricity, Gas and Water Supply	866312	3.7%
9	Transport	1416915	6.1%
10	Trade	2182775	9.4%
11	Financial Services	804207	3.5%
12	Social Services	613530	2.6%
13	Public Administration and Defence	602635	2.6%
14	Other Services	1656409	7.1%
	TOTAL	23200355	100.0%

It can be seen from *Table 2* that, in terms of the contribution of gross output, construction ranks sixth among the fourteen broad sectors of Indian economy accounting for 7% aggregate national output.

4. Estimates of Inter-Industry Linkages

4.1 *Estimates of Direct Linkages*

Estimates of the coefficients of direct backward linkages for various sectors computed from the 14 x 14 sector domestic transactions matrix are presented in *Table 3*. It is evident from the figures given in *Table 3* that there are wide variations in the relative strength of backward linkages among different sectors. The coefficient of backward linkages of construction sector is found to be 0.487 which can be considered fairly high. Construction sector ranks fourth among the 14 sectors in terms of the coefficient of direct backward linkage. The three sectors which are found to have a higher value of the coefficient of backward linkage in relation to that for the construction sector are : Construction related Manufacturing, Other Manufacturing and Electricity, Gas & Water Supply. All other sectors of the economy have a coefficient of backward linkage which is lower than that of the construction sector.

Thus, the construction sector has very strong backward linkages with other sectors, which clearly indicates that the growth of construction sector would provide significant stimulus for several other sectors to grow.

Table 3 **Estimates Of Direct Backward Linkage Coefficient**			
Sl. No.	Sector	Direct Backward Linkage Coefficient	Sector's Rank
1	Agriculture	0.2944	6
2	Forestry & Logging	0.0813	13
3	Fishing	0.1237	12
4	Mining	0.2281	10
5	Construction related Manufacturing	0.6818	1
6	Other Manufacturing	0.6299	2
7	**Construction**	**0.4870**	**4**
8	Electricity, Gas and Water Supply	0.5159	3
9	Transport	0.4499	5
10	Trade	0.2481	7
11	Financial Services	0.1804	11
12	Social Services	0.2320	9
13	Public Administration and Defence	0.0000	14
14	Other Services	0.2335	8

4.2 Estimates of Direct and Indirect Linkages

The measures of direct linkages suffer from the basic limitation of considering only the immediate impact or what may be called the first round effects. In view of the overall inter-dependence of different sectors, however, it is necessary to consider the total impact which would consist not only of the first round effects but also of the subsequent effects or the indirect effects. The strength of the backward linkages based on the direct as well as indirect effects of the expansion of a given sector is measured by coefficient of total linkage. *Table 4* shows the coefficient of total linkage for different sectors.

Table 4 **Estimates Of Total Linkage Coefficient**			
Sl. No.	Sector	Total Linkage Coefficient	Sector's Rank
1	Agriculture	0.9482	6
2	Forestry & Logging	0.7199	13
3	Fishing	0.7743	12
4	Mining	0.9070	8
5	Construction related Manufacturing	1.4896	1
6	Other Manufacturing	1.3717	2
7	**Construction**	**1.2581**	**3**
8	Electricity, Gas and Water Supply	1.2188	4
9	Transport	1.1660	5
10	Trade	0.8977	9
11	Financial Services	0.8021	11
12	Social Services	0.9341	7
13	Public Administration and Defence	0.6275	14
14	Other Services	0.8850	10

It is interesting to observe from the estimates of total linkage coefficients for different sectors given in *Table 4* that the rank of the construction sector improves to third when we incorporate the indirect effects based on sectoral inter-dependence into the measurement of linkages. The total linkage coefficient for construction turns out to be 1.26, while this coefficient ranges from the highest level of 1.49 in the case of construction related manufacturing to the lowest level of 0.63 in the case of public administration and defence. Thus, construction sector occupies a predominant position in Indian economy in terms of its inter-industry linkages.