ESTIMATES OF CAPITAL OUTPUT RATIO IN INDIA : A REVIEW

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CONTENTS

		Page
ACKNOWLEDGEMENTS		(i)
LIST OF TABLES		(iv)
INTRODUCTION		(v)
Chapter		
I	CAPITAL OUTPUT RATIO : THE CONCEPT ...	1
1.0	Introduction	1
1.1	Definition of Capital Output Ratio	1
1.2	Usage in Growth Models ...	2
1.3	Classification of Capital-Output Ratios	4
1.4	Estimation	6
1.5	Factors Influencing the Capital-Output Ratio	15
II	DEBATE ON THE CONCEPT OF CAPITAL-OUTPUT RATIO	17
2.0	Introduction	17
2.1	Criticism on Conceptual Grounds...	17
2.2	Comments	
2.3	Discussion of Limitation due to Methodology Used in Estimation ...	24
2.4	Conclusion	30

Chapter			Page
III	ESTIMATES OF CAPITAL OUTPUT RATIOS IN INDIA		32
	3.0	Introduction... ...	32
	3.1	Economy Level Estimates ...	34
	3.1.1	Economy Level Estimates by Simple Method	34
	3.1.2	Economy Level Estimates : Econometric Approach ...	55
	3.1.3	Chitale's Comparison of Results by Both Methods (1986) ...	61
	3.1.4	Mukherjee's Estimates (1980) ...	62
	3.1.5	Panchamukhi's Behavioral Model (1983)	65
	3.1.6	Comments	69
	3.2	Sectoral Estimates ...	70
	3.3	Capital Coefficient Matrix ...	93
IV	CONCLUSIONS	... ...	114
BIBLIOGRAPHY		... ...	119

LIST OF TABLES

Table No.		Page
3.1	Uma Dutta Roy Choudhary's Estimates of ACOR and ICOR	99
3.2	Pratap Narain and Katyal's Estimates ...	100
3.3	Dholakia's Estimates of Capital-Output Ratios	101
3.4(a)	Variability of ACOR Across Sectors Using Net Capital Output Ratio at 1970-71 Prices.	102
3.4(b)	Variability of ACOR Over Time in Broad Sectors of Indian Economy ...	103
3.5	Estimates of ICOR by Regression Approach and Their Comparison with Conventional Approach	104
3.6	Estimates of ACOR for Registered Manufacture	105
3.7(a)	Temporal Variation in Net COR (1970-71 Prices) With Lag	106
3.7(b)	Cross Sectional Inter-Industry Variation for Each Year Net COR, 1970-71 Prices ...	108
3.8	Saluja's Estimates of Capital Value Added and Capital-Capacity Ratios ...	109
3.9(a)	Average Componentwise Capital-Output Ratio for Agriculture	110
3.9(b)	Componentwise Capital-Output Ratios for Railways	110
3.10	Estimates of Capital Coefficients (Total for Each Sector)	111
3.11	ICORs in Various Plans... ...	112
3.12	Confidence Interval for the Estimates of Incremental Capital-Output Ratio (ICOR) (Regression Coefficients) for the Manufacturing Branch of the Indian Economy (1973-82)	113

INTRODUCTION

Capital output ratio is a concept which has been the focal point of growth theory. Major contributors to growth theory like Harrod, Domar, Mahalanobis, Kaldor et al., used it as the prime parameter to explain the phenomenon of growth. Planners make use of it for making projections regarding investment requirements to sustain a certain level of growth or to make projections regarding feasible level of growth given the investment pattern. These projections are made both at aggregated economy level or disaggregated sectoral levels.

In formulating the plans at the national level this ratio has an important role. The particular value this ratio assumes has profound significance for the growth rate and resource mobilization. The quantification of this ratio is not an easy task, as it involves both conceptual and methodological problems in defining capital, as well as data problems. Thus in arriving at the estimate of capital output ratio a number of assumptions are to be made and different methods are used depending on one's approach to the problem. At the plan formulation stage the value used for this ratio is subject to intense debate.

The object of this thesis is to examine the problems

involved, both theoretical and empirical, in estimating this ratio and to critically review the available estimates in the Indian context.

The first chapter deals with theoretical considerations, involved in the estimation of the ratio.

Chapter II tackles some of the criticisms launched against the concept.

In Chapter III a detailed review of the estimates available in India since 1955 is given.

As the focus of the review is on India, no international comparisons are attempted in this thesis.

CHAPTER I

CAPITAL OUTPUT RATIO : THE CONCEPT

1.0 Introduction

An economy functioning at subsistence level is a stagnant economy, while growth implies change, which can be brought about only by dynamic forces. In a surplus generating economy the surplus accumulates in the form of capital. This provides the impetus for greater and greater surplus. The process of change sets in with surplus accumulation or capital formation, which in turn provides the dynamic force required for growth. Thus capital formation emerges as the main driving force behind growth.

1.1 Definition of Capital Output Ratio

To determine the growth, feasible for an economy, therefore, the necessary capital requirements have to be determined. For this the simplest measure used in various growth models [namely Harrod (1939), Domar (1946), Mahalanobis (1955) and Kaldor (1957)] is the capital-output ratio or the capital coefficient. This measure takes output to be a proportion of (or a linear function of) capital. Thus it gives the capital requirement per unit of output. Harrod was among the first to use this measure in growth theory. He describes it as "the requirement of new capital divided by the increment of output to sustain which the new capital is required" (Harrod, 1954, p. 82).

1.2 Usage in Growth Models

The models using capital-output ratio as the parameter can be classified into two. First are the aggregative or the Harrod-Domar kind of models and the second are the disaggregative Leontief kind of models.

(i) Harrod-Domar Kind: The basic framework of the Harrod-Domar kind of model is -

Let Y = income (or output)

S = saving

I = investment

$s = S/Y$

$k = I/\Delta Y$ the incremental capital-output ratio

$y = \Delta Y/Y$ rate of growth of output.

Then if the incremental capital-output ratio 'k' is assumed to be constant* and if saving equals investment (either as expost identity or equilibrium condition) it follows

$$\frac{\Delta Y}{Y} = \frac{\Delta Y}{I} \cdot \frac{S}{Y}$$

$$\text{or} \quad g = s/k$$

where g is the growth rate which is directly proportional to the saving ratio and inversely proportional to the capital coefficient.

(ii) Leontief Kind: The model making use of capital output ratio at the disaggregated level is the 'dynamic'

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* The model and usage of capital-output ratio in pragmatic planning have come under criticism due to this assumption. The implications of this are discussed later.

version of Leontief's input output model. The starting point of this dynamic version of input-output model is that to sustain growth, the capacity in each industry has to expand with time. This additional capacity creation for future requires the inclusion of investment as one of the constituents of final use.*

Let X is the total output vector. If additional capacity to be created in present time (for future use) is ΔX. Then the stock requirement to sustain it will be $B\Delta X$, where B is the capital coefficient matrix arrived at by dividing the stock requirement of each industry by the output of that industry. This gives the stock requirement per unit of output. (S_{ij} represents the stock of the good produced by ith industry held by the jth industry. Dividing this by the periodic output of the jth industry gives the capital coefficient i.e. $b_{ij} = S_{ij}/O_j$.)

$$B = \begin{matrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \vdots & & & \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{matrix}$$

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* In the static version of the input-output model there is an implicit assumption that necessary stock requirements are available. Hence final use need not include investment for capacity creation.

Therefore $(I-A)x = F$ holds where x is total output vector, A is the input cofficient matrix and F is the final demand vector.

Thus in the dynamic version the static equation of the form $(I-A)x = F$ becomes

$$(I-A)\ x = F + B\Delta X$$

$$\text{or}\quad x - Ax - B\Delta X = F$$

Let $g_i = \frac{\Delta X_i}{X_i}$ that is growth rate of the i^{th} commodity.

Therefore $\Delta x = GX$

where G is a diagonal matrix having g_i in the i^{th} row and i^{th} column.

Therefore $(I-A-BG)\ X = F$

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

or $$X = [I-BG\ (I-A)^{-1}]^{-1}\ (I-A)^{-1}\ F$$

The above equation gives an overall map of the stocks and flows of all the industries in the economy. The G matrix gives the different growth rates at which different industries are growing; $B(I-A)^{-1}$ gives the direct as well as indirect capital coefficients. That is it gives the value of the direct as well as indirect capital requirement per unit of output. For this reason, and due to the fact that the model does not aggregate heterogeneous units of capital into a single parameter, it is considered to be a more relevant specification.

1.3 Classification of Capital-Output Ratios

For the models to be applicable at the pragmatic level, for 'economic planning', the capital coefficients have to be estimated. The choice of the type of capital coefficient to be estimated depends mainly on the use to which it is to be

put. The choice is to be made between:

(i) Incremental versus Average Capital Output Ratio: Incremental is the ratio between additions to capital stock and additions to income while average is the ratio between total stock of capital and total income per unit of time.

(ii) Next comes the choice whether the estimate would be net of or gross of depreciation. Accordingly the capital output ratios can be classified into 'gross or net category'.

(iii) Depending on whether the total capacity of production is to be estimated or whether the actual output being produced is to be determined the capital capacity or the capital output ratio is estimated. In case of Leontief model output implies total output while in case of Harrod-Domar kind of model it implies value added alone.

(iv) The capital coefficient is estimated over a period of time. Accordingly if the influence of prices is to be incorporated or not, the coefficient is to be estimated at current or constant prices respectively.

(v) Yet though the capital-output ratio is estimated over a period of time distinction in the ratio can be made on the basis of the length of time over which costs and yields are estimated, as short term ratio or long term ratio. The short term ratio is more volatile due to random fluctuations. These fluctuations get smoothened out in the long run, but in the long run estimating capital becomes more difficult as the

long run phenomenon of technological change has to be incorporated.

(vi) Capital output ratio can be classified into ceteris paribus or mutatis mutandis ratio depending on the assumptions regarding technological change. The ceteris paribus ratio assumes all other things like plant and equipment, technological knowledge, tasks, attitudes towards savings, works and venture and institutions to be constant and adapted to output increases. The mutatis mutandis ratio, if it could be calculated, would take into account changes in these conditions induced by investments. However both are not pragmatic as the former does not occur and the latter cannot be estimated. Only suggestions can be made regarding the direction of the changes in tastes, attitudes, etc.

The choice of the ratio depends on the use to be made of the same. But many a times the limitations of available data guide the hand in favour of a particular estimate rather than the conceptual applicability.

1.4 Estimation

After the choice of the nature of capital output ratio has been made the problem of measurement of capital and output per se as well as according to the nature of the estimate chosen becomes crucial. In measurement there exists a trade-off between conceptual perfection and empirical feasibility. What may be ideal from conceptual point of view may not be empirically feasible and what may be feasible may fall short on conceptual grounds.

(i) Capital: The problem is more acutely felt in case of measurement of capital, because capital has certain qualities unique to it. "Capital is produced means of further production" (Bohm Bawerk,1921,p.8). "It lasts but does not last for ever; it takes time to construct; it's quality changes as improvements are incorporated; replacement and improvement are not distinct acts; it is utilized to varying degrees at different times" (Myrdal, 1968, p.337). Thus while estimating either the capital stock or the increase in it, the following have to be clearly specified: (a) Coverage of capital: that is the items being included in capital, (b) Valuation: the method of their evaluation, and (c) Capital consumption and depreciation.

(a) Coverage: There is no set of physical properties defined on the basis of which a good could be called a capital good. "A commodity is capital not by the virtue of its physical properties but by the nature of the economic function it performs" (Lachman, 1956, p. vii). "A unique definition of capital is not possible since the nature of economic process itself is not unique" (Kirzner, 1966, p.36). Different interpretations of the definitions lead to non-uniformity in the items included as capital. Notwithstanding these the items agreed upon to be part of capital by majority of studies are plant and equipment, buildings used for the process of production, inventories held by producer of new, finished and semi-finished goods and residential buildings. Improvements made on land are part of capital while land

itself is not. In short the tangible produced goods used for further production of output are part of capital. The exception being residential building. This is included because economists (Kuznets being the leading one) are of the view that even though house property serves as a consumer durable, the decision regarding its purchase or hire are similar to decisions regarding investments in other capital goods, which is not true for other consumer durables. Although the view regarding inclusion of the former and exclusion of the latter, from capital, is far from uniform. The other controversial goods are exhaustible gifts of nature like petroleum, coal and other subsoil gifts. Some of the exclusions are investment in human capital, goodwill of the firms, durable consumer goods held by consumers, etc.

(b) Valuation: Once coverage is settled upon, arises the problem of evaluating the capital goods. This has always been a much debated topic amongst economists. The theories put forward on this are (a) evaluation on the basis of income generated and (b) evaluation on the basis of cost incurred.

The first is a forward looking concept. The contention being that the value of capital is equal to the present value of the future income that can be generated by that capital. This is just a theoretical concept since measurement problems arise in face of the fact that alternative uses could be made of the same type of capital and changes in relative prices of output would lead to change in the value of capital itself.

The second evaluates capital by the cost incurred in its production. This means that "if two machines have identical production costs in an accounting year, they would be considered to represent equal amount of capital irrespective of differences in their productivity and other attributes" (Denison, 1957, pp. 222-223). Though conceptually less sound this is the method used for evaluation of capital as it is of pragmatic nature.

(c) Depreciation: The depreciation estimate is required when the capital-output ratio to be estimated is 'net' in nature. That is the ratio is net of the worn out capital which does not exist any more. Hence depreciation is to reflect the capital which is consumed through wear and tear in the process of production and should in turn be replaced if the capital stock is to be kept from diminishing. In reality depreciation not only reflects capital consumption but also capital obsolescence. Leontief (1956) is of the view that obsolescence is the major contributor to depreciation. (As capital in use is kept in good shape throughout its life span, its efficiency does not fall much.) As it is difficult to gauge the rate of change of technology and hence the rate of obsolescence, as well as to determine the exact wear and tear caused by use of capital, realistic estimates of depreciation, are difficult to arrive at. Thus economists make an assumption regarding the age of capital and assume a certain rate of depreciation which follows either a linear or

a simple curvature pattern. Many, to avoid the pitfalls of estimation of depreciation, settle for the gross estimates of capital.

(ii) The difficulties in the measurement of output arise due to the stipulation 'produced by it' in the definition of capital output ratio. Capital takes time to construct. Therefore a period of gestation between capital construction, and output ascribed to it has to be specified. Otherwise a part of the capital included in the ratio would not be participating in the production of output ascribed to it. This task is not easy as gestation lags vary from sector to sector. Normally an average period is assumed for the entire economy.

Also while capital is a stock concept to be measured at a point of time, output is a flow concept to be measured over a period of time. Thus while relating capital to output care has to be taken in choosing the relevant time period, the output of which is to be ascribed to the capital stock in any point of time.

(iii) Relation between Capital-Output: Once the capital and output estimates are obtained, they have to be related to each other to arrive at the capital-output ratio or capital coefficient. The details of the methods used are as follows.

(a) The simplest and hence most popular method of estimating the ratio is relating the capital stock (or

increment of it) to the output (or increment of it) in the same period, assuming no lag. That is C_t/O_t or $\Delta C_t/\Delta O_t$ where C_t it is capital stock in time period t and O_t is the output produced in the same period. ΔC_t and ΔO_t are increments of capital stock and output in time period 't' respectively.

The main criticism against this method was the assumption of no lag between capital and output generated. Earlier, when the average capital output ratio was more in use, new capital formed but a small part in the stock. Hence this assumption of no lag did not affect the results drastically. But with the use of incremental capital-output ratio becoming more common, improvement was brought about in the form of C_{t-n}/O_t where 'n' indicates the number of time units of lag assumed. The method obtains capital output ratio at a point of time. Hence exact value of the ratio at different points of time can be obtained.

(b) Econometric methods, using regression approach, are also used for estimation of incremental capital-output ratio. $Y_t = \alpha + \beta C_t + U_t$ where Y_t is output in time period t, C_t is capital stock in the same period, U_t is the unexplained random variation. α and β are parameters. β is the reciprocal of the estimate of incremental capital-output ratio assuming no lag. The lag is introduced as $Y_t = \alpha + \beta C_{t-n} + U_t$ where 'n' indicates the average number of time units of lag.

According to Panchamukhi, "the concept of single

gestation lag has the implied assumption that investment of a particular period would generate change in output after the period of gestation lag and all change in output that has occurred in the latter period could be fully attributed to the investment of the initial period. It is quite possible that in relating the investment of any particular period would have the effect of generating output flows of different magnitudes for the different periods thereafter. In other words there is essentially a relationship of distributed lag structure between Investment and Output" (Panchamukhi, 1986, p. 9). To incorporate the above argument in the analysis, Panchamukhi used the following specification. $Y_t = \alpha + \beta_0 I_t + \beta_1 I_t + \beta_2 I_{t-2} \ \ldots + \beta_s I_{t-s}$ where Y_t is the output generated in year 't'. I_t, I_{t-1} ... I_{t-s} are the capital formation in the current and preceding year respectively till the maximum period of lag assumed, Panchamukhi used Almon approach in his analysis* to obtain estimates of β_s. He contends that "one could therefore work out the level of effective investment relevant for the outputs of a given year as a weighted sum of investments of various previous years, the weights being the coefficients of the respective investment variables" (Panchamukhi, 1986, p. 35). Regression approach obtains a single average value of the ratio prevalent over the entire period under consideration. In case of too long a period significant changes in

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* This is discussed in Chapter III.

the economy like technological, changing demand pattern, etc., get averaged out.

(c) The method of estimation for Leontief kind model is the creation of capital coefficient matrix. This is different from earlier methods, as it is at a disaggregated level. It not only provides the capital requirements of industries (sectors) as a whole, it also splits the total stock of capital, used by any industry (sector), by its industrial origin.

As mentioned earlier S_{ij} depicts the stock of the good from i^{th} industry held by the j^{th} industry. S_{ij} can be further disaggregated to stock held in the form of fixed capital and that held in the form of inventory. So that $S_{ij} = F_{ij} + I_{ij}$ (where F denotes fixed capital and I denotes inventory). To arrive at the capital coefficient S_{ij} is divided by the output if the j^{th} industry i.e.

$$b_{ij} = \frac{S_{ij}}{O_j} = \frac{F_{ij} + F_{ij}}{O_j}$$

Thus b_{ij} is the stock requirement in the j^{th} industry of the i^{th} commodity per unit of output.

(d) The above measures study the capital-output ratio in a given period of time. But according to Panchamukhi "the dynamic behaviour of capital-output ratio over time needs to be studied to be understood in the content of planning for development. It is obvious that the level of aggregate

capital-
/output ratio is the weighted average of the capital-output ratios of the different sectors of the economy, the weights being the sectoral contribution to aggregate change in domestic product. Thus change in the aggregate capital-output ratio would have two components, (a) changes in sectoral capital-output ratios, and (b) changes in the relative weights of the different sectors, that is, changes in the sectoral contribution to the incremental domestic product" (Panchamukhi, 1986, pp. 12-13).

The formulation taking into account the decomposition of the factors contributing to changes in capital-output ratio is the following:

Let $k = \Sigma\, y_i k_i$

where k = aggregate incremental capital-output ratio (ICOR)

k_i = sectoral ICOR

y_i = share of i^{th} sector in the incremental GDP

$$\Delta k = \underset{A}{\Sigma(k_i-k)\,\Delta y_i} + \underset{B}{\Sigma y_i \Delta k_i} + \underset{C}{\Sigma \Delta y_i \Delta k_i}$$

the change in ICOR that is Δk can be brought about by

$A = \Sigma(k_i-k)\,\Delta y_i$ = contribution of the changes in the sectoral to the total incremental GDP

$B = \Sigma\, y_i \Delta k_i$ = Contribution of the changes in the sectoral ICOR to the total change in aggregate ICOR

$C = \Sigma \Delta y_i \Delta k_i$ = Gross product term, measuring the combined effect of the above two changes.

1.5 Factors Influencing the Capital-Output Ratio

The dynamic behaviour of capital-output ratio implies changes in the ratio. The change comes about when there is a change in the factors influencing the ratio. The likely factors outlined by economists from time to time are:

(i) Allocation of Investment: The overall capital-output ratio of an economy depends on the capital output ratio of individual sectors and the relative amount of investment in the different sectors. Thus when the relative importance of different sectors changes, the value of overall capital coefficient may become very different. The relative importance of different sectors in turn depends on the expected pattern of demand for different commodities.

(ii) Capacity Utilization: The level of capacity utilization is also a medium through which the demand pattern affects the capital-output ratio. It is quite possible that considerable surplus capacities in particular sectors are not utilized due to lack of sufficient demand. Lower capacity utilization implies lower output and hence higher capital output ratio.

(iii) Invention : Another factor which influences capital-output ratio, particularly in the long run, is technology. But the rate of change of technology, though slow, is unpredictable. An invention or an innovation can take place any time or not at all. It may be expensive or it may be costless (almost).

(iv) Changes Due to Number of Shifts : In case of ←

change in the number of shifts the level of capital consumption does not change in the same proportion. In case of increase in the number of shifts the user cost of capital will increase but the non-user cost will remain the same. This would lead to a fall in capital-output ratio.

(v) Labour Productivity: The capital-output ratio is connected to labour productivity via the capital to labour ratio C/L and the output to labour ratio O/L where $\frac{C/L}{O/L} = C/O$ while the productivity of labour is a function of skills, education, etc.

(vi) Rate of Interest: The value of capital depends on the rate of interest prevailing in the economy. If the rate of interest is high, the cost of capital goods produced would be high, leading to high capital-output ratio.

(vii) Similarly the cost of raw material will affect the capital-output ratio. A rise in price of raw material would not only raise the cost of making capital goods, but would also reduce the 'value added' per unit of output.

(viii) Weather by influencing agricultural production leads to a change in capital-output ratio.

Ignoring or assuming away the influence of these factors, from models using capital-output ratio renders the analysis inaccurate. The models and the empirical studies on capital-output ratio have come under criticism for these very reasons. Thus a review of the criticisms and an incorporation of the above is required in the study of capital-output ratio.

CHAPTER II

DEBATE ON THE CONCEPT OF CAPITAL-OUTPUT RATIO

2.0 Introduction

Adam Smith in his famous book 'An Enquiry into Nature and Causes of Wealth of Nation' said (though in an absolutely different context) "If the rod be bent too much one way, says the proverb, in order to make it straight, you must bend it as much the other". The concept of capital output ratio has become one such rod in growth theory. At best it has been the focal point of growth theory. As Sen says, "If there is one concept that has dominated recent discussions on growth theory and development planning, it is that of capital-output ratio or capital coefficient as it is sometimes called. It has been extensively used in various growth models e.g. those of Harrod, Domar, Kaldor and Mahalanobis" (Sen, P.K., 1960). At worst economists regard it as utterly useless. Foremost in them being Myrdal "... In the light of these difficulties and ambiguities, it is apparent that the 'capital-output ratio' can be of no assistance to the planner in deciding where, when, how and how much to invest" (Myrdal, G., 1969, p.360).

2.1 Criticism on Conceptual Grounds

In this section an attempt is made to evaluate the 'difficulties and ambiguities' involved in the application of the concept of capital-output ratios, which led Myrdal and other

economists to the above conclusion. Specially for an under-developed country like India.

While criticising the model used for planning purpose in South Asia i.e. the Harrod-Domar type model, Myrdal says, "(There are) four principal ways in which errors enter into model analysis. They are revealed by four closely interrelated assumptions, usually not made explicit. These assumptions are (1) that certain parameters, which are tacitly adapted to the development process, will stay constant or, alternatively, that they will automatically be adapted to the extent required; (2) that the number of strategic variables can be narrowed down to a single one; (3) that very dissimilar items can be analysed in terms of a single category; and (4) that certain sequences can be isolated and analysed without regard to their relationship to other sequences ... The critical discussion, therefore, proceeds under the following headings:

Adapted ceteris paribus or Automatic mutatis mutandis;

One factor analysis

Misplaced aggregation

Illegitimate isolation" (Myrdal, G., 1968, p. 310).

Although a clearcut distinction, between the four, is hard to draw, an attempt is made to study them individually, retaining Myrdal's classification with the change that illegitimate isolation takes second place, one factor analysis third and misplaced aggregation fourth.

(i) <u>Adapted ceteris paribus or Automatic mutatis mutandis Assumptions</u>: The maximum amount of criticism against the

capital-output model has been due to the assumption of constancy of the ratio. "According to classical and neo-classical theory, an increase in the use of capital per head, with no increase in technical knowledge, will sooner or later yield diminishing marginal returns. In Marx's theory, the increasing organic composition of capital can be interpreted as implying a rise in the capital output ratio. Attempt to test these theories statistically some ten to fifteen year ago indicated, however, that output has grown roughly in proportion to capital input in advanced industrial countries, over several decades. These studies seemed to substantiate the theory of a constant capital-output" (Myrdal, 1969, p. 314).

But this leads to the implicit assumption that all factors affecting the capital-output ratio as enumerated by Reddaway either do not change or adjust so that the value of the ratio remains the same. To quote Sen, "To assume that the capital-output ratio is constant over time is next to impossible. For that we need the assumptions that :

a) Allocation of investment between sectors is unchanged;
b) There is a fixed rate of utilization of capacity;
c) Innovations are absent or neutral;
d) Real wages rise as much as productivity of labour;
e) The rate of interest, which is equal to the rate of profit is stable;
f) The number of shifts worked does not change;
g) There are constant returns to scale; and
h) Foreign prices are constant" (Sen,P.K., 1960).

To assume the above is unrealistic. Also later statistical efforts have shown that the ratio does show a varying trend, even in the long run.

(ii) Illegitimate Isolation: Illegitimate isolation is a specific manifestation of the assumption that all other conditions remain constant and adapted to development. It conveys the notion that capital alone, isolated from its environment, is responsible for growth. But as Myrdal points out, "The effects of plant and equipment on output depend not only on where and how investment occurs, but also on what other policies that affect levels of living, attitudes, and institutions are pursued. In South Asian countries the two last named conditions cannot be regarded either as already adapted to development or automatically adaptable through investment. The effects of development plan with a given amount of investment will differ greatly according to what policies with regard to attitudes and institutions are pursued in conjunction with investment" (Myrdal, 1969, p. 318).

This has been proved empirically also. Leibenstien, with the help of other studies, points out that, "we know on the basis of the studies by Solow, Ankrust, Fabricant and others, that increases in capital contribute only a small proportion to total growth. The proportion is probably somewhere between ten and twenty per cent. As a consequence, most of the growth rate is accounted for by non-capital inputs" (Leibenstien, H., 1966). Solow had arrived at this conclusion,

i.e., "Gross output per man-hour doubled over the interval with $87\frac{1}{2}$ per cent of increase attributed to technical change and remaining $12\frac{1}{2}$ to increased use of capital" (Solow, R.M., 1957), while attempting to segregate variations in output per head due to technical change from those due to changes in availability of capital per head.

(iii) <u>One Factor Analysis</u>: Yet ceteris paribus and mutatis mutandis assumption lead to the impression that the sole causal factor responsible for growth of output is capital. Myrdal considers the reason for this to be in keeping with the classical and neo-classical tradition. "Of the three conventional factor groups, 'land' is defined as the 'original' and indestractible powers of the soil, and is therefore by definition of little interest for economic policy. Improvements - plowing, irrigation, drainage, fertilizers, etc. - are treated as investment. Labour is not 'man-made' in the economically relevant sense, and its supply is influenced by 'non-economic' conditions. Capital is man-made and can be augmented; it is regarded as essentially quantifiable and can thus be neatly fitted into models, it can be treated as having purely instrumental value" (Myrdal, 1969, p. 313). Thus this one factor analysis is understandable.

(iv) <u>Misplaced Aggregation</u>: But such an analysis has only two aggregates, namely, 'capital' and 'output' assuming all other influences to be given. Quoting Myrdal again, "we have only two aggregates. All other influences, whether

of productive factors or of other 'economic' conditions or of 'non-economic' conditions, are ignored on the ground of either the adapted ceteris paribus or the automatic mutatis mutandis assumptions, or some unspecified combination of the two. But neither 'output' nor 'capital' can properly be aggregated into a single category. Both certain facts - such as rigidity, immobility, differences in responses, indivisibilities - and interdependencies and certain valuations - such as desire to spread benefits and avoid increasing inequalities - make aggregation inappropriate" (Myrdal, 1969, pp. 315-316). Taking just one example, when there is excess capacity in one sector of the economy, and shortage of capital in another, but the excess capacity of one cannot be transferred to the sector facing shortage, due to specific requirements of each sector. Then the analysis of total stock of capital of the economy (capital treated as homogeneous aggregate) breaks down.

"The success and effectiveness of investment in contributing to the growth of output depend not only on it being an addition to an aggregate 'stock of capital' but on its direction (neglected by aggregation), it's composition, and present and future complementary policies with which it is packaged (neglected through isolation)" (Myrdal, 1969,p.320).

2.2 Comments

Myrdal's criticism of the capital output model does have a cautioning effect towards the capital coefficient, but it does not necessarily render the coefficient to be useless.

There are economists, whose views present the other side of the picture. Simon Kuznets is of the opinion that capital stock is indispensable to adequately high levels of economic productivity. Although without the accumulated body of knowledge and a healthy labour force, such stock of capital is superfluous. Yet if knowledge does exist and human labour is available to apply it, effective use of these resources requires material capital goods. One persistent bottleneck in the use of knowledge in economic production has been the scarcity of the resources for the production of capital goods. Capital formation is, therefore, of primary interest, as it is essential to economic productivity and economic growth. The problem of extreme aggregation to some extent has been rectified by Leontief's model. William J. Fellner's analysis 'long term growth of private capital formation' gives an answer to criticism on adapted ceteris paribus or Automatic mutatis mutandis assumptions. While he gives greatest importance to 'capital' for explaining growth, at the same time he acknowledges that other factors have their role. According to Fellner all economic theory is based on ceteris paribus assumptions, and hence it requires informal appraisal of how reality is likely to accord with or deviate from them. In other words economic theories are established for given 'environments'. Hence their logical structure is valid for a specific environment. Given these limitations the usefulness of theory depends in a large measure on the logical separation of formal 'framework' from 'environment'. The

formal framework must enable the economist to collect information and draw rigorous conclusions for given environmental conditions (that is ceteris paribus assumptions). At the same time, the 'environment' in which this logical structure operates must be so defined that the problem of 'environmental' change should appear articulate and meaningful so that at least by subjective judgement an appraisal of its changes could be made.

Estimating marginal capital-output ratio on the basis of past experience requires readiness to make an informal (largely non-technical) judgement on how the deviation from the assumptions say (a) unchanging degree of employment, (b) unchanging price ratios between capital and output, (c) consistent shift in functional relation indicating technical progress and so on.

Although Fellner concedes that this particular method of approach may not qualify as a method of 'projection' of capital coefficient in a true sense, but as a method of guidance towards informed analysis it seems superior to its potential alternatives. Thus analysis in which relationships expressed in equations are accompanied by proper discussion of factors that stay in background of the equation (that is the ceteris paribus assumptions) may contribute to the understanding of investment process.

2.3 Discussion of Limitation due to Methodology Used in Estimation

(i) Capital: Although Myrdal believes that capital-

output models came into such wide use because among the factors of production capital is considered easily quantifiable, "... Capital is man-made and can be augmented; it is regarded as easily quantifiable" (Myrdal, 1968, p. 313). But many limitations in the model crop up due to the limited measurability of capital. The three major components into which capital is broken, for the purpose of measurement of capital stock, are (a) plant and equipment, (b) residential construction, and (c) changes in inventories. A number of components are left out due either to data non-availability or to limited quantifiability. Investment in 'human capital' and goodwill of the firm are two such components. The exclusion of consumer durables follows from that of exclusion of investment in 'human capital'. A brief description of the exclusions follows.

(a) Human Capital: The term 'human capital' formation denotes the process of acquiring and increasing the number of persons, who have the skills, education, experience as well as mental and physical fitness which are essential for the development of a country. Malhotra and Minocha point out that "the process of economic growth requires a spectrum of skills ranging from simple manual labour to the works of the specialist and highly trained scientists. Innovations, technology and human skills are as important as machinery, equipment and inventories. The process of change from a static or traditional society requires very large 'doses' of strategic human capital" (Malhotra, P.C. and Minocha, A.C., 1971). Also Adiseshiah said "so my thesis is that accelerated

economic growth is, to a large degree, a function of adequate and commensurate development of human resources" (Adiseshiah, M.S., 1962).

Thus the customary measure of capital formation, which regard it as addition to a country's physical capital stock and producer's inventories, tend to under-estimate the true value of capital formation. It excludes investment by society in education, by employers in training and investment by individuals of time and energy in their mental and physical development. Future production is increased not only by net addition to a country's tangible reproducible capital stock but also by non-physical development expenditure on 'human capital' or 'human resource development'.

This realization led to attempts at estimation of human capital. The pioneers in this field have been Denison (1962), Schultz (1961), Tinbergen (1964), et al. But these measures have still not been incorporated as part of the measure of capital stock.

Kuznets, whose estimates of capital formation are still widely quoted, though acknowledges the need for considering the scope of capital stock, (specially while studying growth prospects in the long run), does not include 'human capital' in his estimate. He gives two reasons for doing so. "First, it is hard to draw the line between uses of such goods (education, health facilities, etc.) for the purpose of adding to productive capacity and their uses for

a richer life. Second these investments by ultimate consumers, unlike the components of capital formation, (limited sense) ... are not part and parcel of the complicated mechanism of capital investment and financing." He at the same time justifies his inclusion of only physical capital in capital formation as "Granted that, without the accumulated body of knowledge and a healthy and educated labour force, such stock of capital is useless. Yet, if knowledge does exist and human labour is available to apply it, effective use of these resources requires material capital goods. ... One persistent bottleneck in the use of knowledge in economic production has been the scarcity of the resources for the production of capital goods needed for the application of new knowledge" (Kuznets, S., 1961, pp. 390-391).

(b) Consumer Durables: Consumer durables other than housing are also excluded from the capital stock. This logically follows from the exclusion of 'human capital'. "The basic distinction between ultimate consumption and economic production, which defines the former as the disposal of goods by households and the latter as the use of goods to produce other goods, largely for the market. Since, capital is conceived as a productive factor the stock of consumer goods within households must be excluded.. Otherwise the disposition of these goods within households would have to be classified as economic production" (Kuznets, S., 1961,

p. 16). This could only happen if 'human capital' is part of capital so that the disposition of consumer durables, which adds to the comfort of human beings, would lead to enhancement of efficiency of human beings and contribute to 'economic production'.

The inclusion of dwellings is justified by Kuznets because "the wide choice between ownership and rental of dwellings, and the very magnitude of outlays involve decisions that are akin to economic behaviour in business capital investment" (Kuznets, p. 16).

(c) Depreciation: Another aspect of the limitations in measurement arises due to depreciation. This problem actually arises only when net capital-output ratio is required. Vanek and Studenmund are of the opinion that "For empirical purposes the ratio is almost invariably conceived of as one involving gross rather than net, investment in the numerator. The two main reasons for this substitution of gross for the 'purer' net ICOR when dealing with real situations are (1) data availability and (2) conceptual and definitional problems involved in measuring net physical investment" (Vanek, J. and Studenmund, A.H., 1968). The problem involved in measuring net physical investment are those of measuring capital consumption or depreciation.

For the purpose of measurement of capital consumption assumptions have to be made regarding (i) average life of the capital asset and (ii) the rate at which it is likely to

depreciate with time. As Barna points out "The great majority of firms follow the straight line depreciation method in their own accounts (although they may follow reducing balance method for tax purposes). The depreciation rates adopted invariably imply a shorter life than those obtained by historical data ... (Thus) company depreciation policies are not suitable to deduce from them the shape of a realistic depreciation curve" (Barna, T., 1961).

Another problem in the estimation of depreciation is the cost of the capital asset. The price of an asset does not remain constant. Hence depreciation estimates worked out on the basis of original cost do not reflect the true value.

(ii) Output: Other than measurement limitations of capital there are certain limitations in measurement of output. These creep in because of the expression 'produced by it' in the definition of the capital-output ratio. Mainly they are of two types (1) determination of gestation lags and (2) non-measurability of certain outputs.

(a) Lags: In analysing the relationship between capital and output arises the difficulty of identifying the domestic product which could be rightfully associated with the capital formation of any given year. As Panchamukhi points out "In view of the diversity of the investment and production activities it is extremely difficult to identify an average gestation lag for the economy as a whole. ... In most of the studies on capital-output ratio the problem

of gestation lag is taken care of only in an indirect manner by using the average of investment and outputs for three year or five year period. Of course it is possible that this approach may introduce new spacious biases instead of cancelling them out" (Panchamukhi, V.R., 1976, p. 7).

(b) Non-measurability of Certain Outputs: Domar is of the opinion that "stock of capital should include all capital needed to produce a given output, while the latter should contain all output produced by a given stock". In most cases this is possible, but in certain cases application of this role is not easy. Domar (1961) himself gives the example of such a case. "The inclusion of a public highway in the stock of capital seems perfectly proper, we do not however, impute its services to consumers as a part of output (though maintenance expenses may partially compensate for this)." The same holds true for a number of public owned capital services.

2.4 Conclusion

This section enumerated the problems arising in the usage of capital-output models at conceptual as well as measurement level. These shortcomings arise mainly due to limited quantifiability of some economic concepts and non-quantifiability of others. In case of limitedly quantifiable concepts approximations have to be used in place of true values. As Kuznets says, "all concepts in economic theory (in their absolute form) are non-operational, since they are goals that forever elude measurement and for which measurable

approximates are substituted". While in case of non-quantifiable concepts, assumption regarding their behaviour have to be made, which cannot always be verified. This leads to an element of abstraction seeping into the analysis keeping in mind this limitations of economic theory itself the concept of capital-output ratio should not be rejected outright, due to the criticisms against it. But some caution has to be exercised against the pitfalls in the analysis.

CHAPTER III

ESTIMATES OF CAPITAL OUTPUT RATIOS IN INDIA

3.0 Introduction

Notwithstanding its limitations the concept of capital-output ratio is widely used for the purpose of 'economic planning', especially in India as it is a simple and practical tool to estimate investment requirements for planned growth. Therefore efforts have been made to arrive at reliable estimates of capital-output ratios for the Indian Economy. But due to non-uniqueness of conceptual definitions of capital and output, estimates derived from time to time are non-uniform. This introduces a subjectivity into projections made, using capital-output ratio as parameter. Thus appropriate choice of estimate of capital-output ratio, for plan projections requires a review of the various estimates of capital-output ratios available for the Indian Economy.

The focus, in this review, is on the method of estimation of capital-output ratio. Thus the studies covered in this review are those which are representative of different methods of estimation. There are some studies using capital-output ratio as one of the tools to study productivity patterns of various sectors in Indian Economy. These studies use the crude methods to estimate capital-output ratios

without examining the definitions of capital and output. Such studies are not included in the review.

The studies included in this review can be broadly classified as those estimating capital-output ratios appropriate for Harrod-Domar framework and those appropriate for Leontief framework. Although Leontief framework provides a clearer picture regarding capital requirements, these estimates require detailed data at highly disaggregative level. In the absence of availability of such detailed data, most estimates of capital-output ratio obtained for the Indian economy are appropriate for Harrod-Domar framework. Such estimates obtained for the Indian economy as a whole are discussed in Section I of this chapter. The economy level estimates are considered too aggregative. Some attempts are made to study the different sectors of the economy individually at a greater level of disaggregation. These attempts are also restricted by paucity of data. For the sector to be studied, reliable data at a disaggregated level has to be available. Within India, only industrial sector provides this data with a reasonable reliability. Thus most sectoral studies available are for the industrial sector. These sectoral studies are reviewed in Section II. While Section III deals with the few, available, estimates of capital coefficient matrix, useful for Leontief framework. These are also restricted to registered manufacturing sector of the Indian Economy.

I

3.1 Economy Level Estimates

Most of the economy level estimates are derived by dividing the economy into different sectors, treating each sector as a single homogeneous unit and obtaining the values of capital and output and then the ratio for each sector. Then estimating the ratio for the entire economy as the weighted average of the sectoral estimates.

3.1.1 Economy Level Estimates by Simple Method

(i) Mahalanobis (1955) was the one who provided this guideline to estimate the economy level ratios, when he created his four sector model for the Indian Economy. The four sectors being Capital goods manufacturing sector, Consumer goods manufacturing sector, Agricultural sector and Service sector. Instead of capital-output ratio, Mahalanobis used, what can be called as 'output-capital ratio' (that is output produced per unit of capital used) as a parameter. He called it as "the income coefficient of investment" and termed it as 'β'. This β is an inverse of 'Incremental Capital Output Ratio'. was estimated as $\beta = \lambda_k \beta_k + \lambda_1 \beta_1 + \lambda_2 \beta_2 + \lambda_3 \beta_3$, where β_k, β_1, β_2 and β_3 are income coefficients for investment for capital goods manufacturing sector, consumer goods manufacturing sector, agricultural sector and service sector respectively; while λ s are the respective sectoral share of capital formation to total capital formation.

Due to lack of adequate data the actual estimates

derived by Mahalanobis were largely notional in nature based either on the experience of other countries or on the limited experience of the First Plan performance. The overall value of β was determined at 0.5, a little higher than that of other countries during the same phase, assuming that capital resource planning would lead to high efficiency in India. Success of the First Five Year Plan added to the optimism.

Sectoral estimates were obtained with the help of data on First Plan performance, keeping in view overall value of to be 0.5. Adjustments were made to moderate the influence of exceptional occurrences. For example, the sectoral β_2 value of agricultural sector was scaled down from 1.5 to 1.25 as very high value during First Plan was attributed to exceptionally good monsoons and statistical corrections.

For manufacturing sectors (both capital and consumer) Mahalanobis stressed on the need to adjust estimates to obtain replacement value of capital. In the absence of detailed information regarding age structure and depreciation rates used, of the net depreciated book value of capital stock, he devised a simple relation between replacement value and depreciated book value in the following way: Every type of capital good has a certain life say 'T' years, after which it has to be replaced. A particular item of this given type of asset may have been in use for 't' years with (T-t) years of useful life remaining. For a large capital stock there is likely to be one item of the given type of capital with

't' year of useful life remaining. Pairing them off the combined useful life left is T-t+t = T years, that is an average life of T/2 years per item. Hence at first approximation current book value can be taken as half of replacement value. When empirically tested for a limited sample, this relation was found to hold on an average, with some industries having depreciated book value more than half the replacement value and others less than half. Accordingly the sectoral values of β_k and β_1 obtained as 0.43 and 0.70 for depreciated book value, were scaled down to 0.21 and 0.35 respectively.

Though, due to data limitations, Mahalanobis' estimates were notional in nature, yet the study provides the guidelines to later empirical studies. It brings out the importance of quantitative analysis at the same time indicates that the influence of non-quantifiable factors, e.g. weather in Agriculture, should not be ignored in empirical studies.

(ii) The paucity of data was somewhat reduced when CSO started the publication of National Accounts Statistics (NAS). NAS publishes data on national income and related aggregate for the Indian economy. Most empirical studies reviewed here use this as the major data source. Hence the definitions of capital and output used by NAS are automatically adopted by these studies. The method of estimation followed by CSO to obtain national income estimates is a combination of product and income approaches. The estimates of income for a parti-

cular year is obtained by aggregating the contribution to domestic product by a number of industrial sectors and then adjusting the total for net factor income flows from abroad to arrive at national product. For this purpose the economy is divided in fourteen sectors. While the contributions of six sectors, namely, Agriculture, Mining and quarrying, Forestry and logging, Fishing, Manufacturing and Construction, are estimated through the product method; the contributions of the remaining sectors, namely, electricity, railways, communication, other transport, trade, hotels and restaurants, banking and insurance, public administration and defence and other services are obtained through income approach. The capital formation estimates for each of the sectors are estimated through commodity flow approach. An entire series of capital formation is available year 1960-61 onwards. All estimates are made available at current and constant base year (first year of every decade) prices. In the process making available the necessary price indices. Estimates are available both gross and net of depreciation, providing sectoral rates of depreciation.

Although NAS provides information which is extremely useful in empirical research the data provided is not without limitations rendering the estimates obtained from this data not totally inaccuracy free. A genuine problem faced by CSO while collecting information is a large non-monetized sector in rural India. This and other under-reportings of economic activity lead to distortions in estimation.

V.K.R.V. Rao points out some of the limitations of NAS data. Firstly, "an examination of sectorwise estimates indicates that only sixty per cent of the estimates of NDP for a particular year depends on direct information relating to that year, the estimates of remaining forty per cent is obtained through indirect approaches, involving intrapolation of benchmark information" (V.K.R.V. Rao, 1983, p.5). Secondly, "the data on capital formation given in NAS is not based on functional concept of capital as it includes residential construction" and lastly "NAS do not give figures of capital stock". But he further mentions that "in spite of these limitations the data on fixed capital formation given in NAS represent the major production in the economy and as such constitute a crucial element in the analysis of economic growth as represented by NDP or other national magnitudes of output of goods and services" (V.K.R.V. Rao, 1983, pp.151-152).

Since capital stock estimates are not directly available it is not possible to obtain the 'average capital-output ratio' (ACOR) unless capital stock estimates are obtained first. Also regression method of estimating 'incremental capital-output ratio' (ICOR) requires capital stock estimates. As official estimates are not available, individual attempts at estimating capital stock have to be relied upon. Among the most widely quoted studies on capital stock estimates for the Indian economy are by Uma Dutta Roy Choudhry and Vinod Prakash (1960);* Mukherjee and Sastri (1959); Reserve Bank

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* Although the year of publication of this study is later than that of Mukherjee and Sastri's, it is in fact an earlier study.

of India studies on 'Estimates of Tangible Wealth in India' for years 1960-61 and 1965-66 in years 1963 and 1972 respectively and Uma Dutta Roy Choudhary (1977).

Uma Dutta Roy Choudhary and Vinod Prakash (1960), and Mukherjee and Sastri (1959), in their studies estimate capital stock as well as ACOR for the year 1949-50. The latter is an improvement on the former and is widely used by later date studies to provide benchmark estimates. Uma Dutta Roy Choudhary (1977) also incorporates these estimates in her study in their original form as well as for benchmark purpose. She points out that for earlier periods not much information is available. Hence this study should be considered to be the most representative for that period. Hence only Mukherjee and Sastri's study is reviewed.

(iii) Mukherjee and Sastri (1959) estimates have been obtained for the year 1949-50. They relate to the net current value of capital stock. As these were among the earliest estimates little or no benchmark information was available. For obtaining the estimates the authors divided the economy into different sectors and obtained estimates separately for each sector. Information for different sectors was gathered as and where available. Adjustments were made, as far as possible to homogenize the data.

The methods used to obtain sectoral estimates can be broadly classified in following way: (a) Estimates obtained by nationwide surveys - This method covered the entire agri-

culture and allied activity sector, amounting to thirty-three per cent of reproducible tangible wealth. Estimates were obtained separately for different types of agricultural assets and aggregated for the sector. Where the information was limited to certain States, it was inflated to all India level. Adjustments were made for depreciation and price changes where necessary. (b) Estimates obtained from data on capital stocks - Some public sector enterprises like railways and communication keep an account of gross or net assets added to capital stock each year. For these only price adjustments were required to bring the capital to current value. (c) Estimates on basis of paid-up capital - Sectors where actual expenditure on capital was not available, a proxy for the same was used. The most readily available series being that of paid-up capital, it was made use of. Though the authors acknowledge that theoretically there is no reason for a steady relationship to exist between the two. But they found that for a limited sample a steady relationship did exist between paid-up-capital and actual capital stock. Hence paid-up-capital series was made use of with necessary price changes. (d) Miscellaneous - Where none of the above methods were applicable estimates were obtained from any method applicable, for example through quantity price adjustments, overall expenditure method, etc.

For price adjustments a single investment cost index was obtained for all sectors. This was obtained by combining

the index of unit value of all imports and the index of construction cost making use of price quotations relating to steel, cement, brick and timber as well as wages of construction workers. This procedure was adopted as the then investment pattern indicated that nearly one-fourth of gross investment consisted of imports and of the remaining three-fourth a large part consisted of construction. The price adjustment has been done 1938-39 onwards, as prior to that, according to the authors, the general price index was more or less constant. The estimates are aggregated into ten sectors, namely, Agriculture, Animal Husbandry and allied activities, Mining, Factory establishment, Small enterprise, Communications, Railways, Other transport, Trade and Commerce, House property and Government services. These sectoral estimates of net capital stock at current prices are related to the net domestic product for year 1950-51 to obtain ACORs assuming an average gestation lag of one year. Presented in Table 3.1.

Mukherjee and Sastri's estimates are drawn from data as and where available. This requires a large number of adjustments and assumptions causing inexactness in estimation. As the authors themselves point out "Knowing the reliability of our estimates, we do not think it will be desirable to read too much into them (Mukherjee and Sastri, 1959, p. 387). Yet in absence of any further information available, for this period, these estimates are used in later studies.

(iv) RBI Estimates: The RBI estimates of capital stock

are also a source from which later date studies draw information. RBI estimates for the year 1960-61 were obtained by two methods. First method was similar to Mukherjee and Sastri. Estimates were obtained separately for different sectors from different sources. In the second method the 'Perpetual Inventory Method' (PIM)* was followed. Mukherjee and Sastri's estimates were used as benchmark estimates. Price adjustments and adjustments for depreciation were made to arrive at replacement value of Net capital stock at 1960-61 prices. The two series were not significantly different.

The investment cost index prepared for the RBI (1963) estimate was a vast improvement on Mukherjee and Sastri's index. This investment cost index was a combination of (a) index of building costs and (b) index of machinery and equipment. The index of building costs was prepared as a weighted average of price of cement, iron and steel, logs and timber, bricks and tiles, lime, sand and index number of wage rates of rural skilled workers. The price index of machinery and other equipment has been compiled by using index number of

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* The perpetual inventory method was first introduced by R.W. Goldsmith. In this method to obtain capital stock for any year, capital stock estimates of one particular year, known as benchmark year, are required. For years before benchmark year capital stocks can be obtained by subtracting capital formation and for years after the benchmark year by adding capital formation taking place each year, with adjustments for capital consumption. As capital formation series are more easily available, this method simplifies capital stock estimation to a large extent.

wholesale prices of machinery for years 1949-50 to 1950-51 and Machinery and transport equipment for years 1951-52 to 1960-61. The weights assigned to the two indices vary from sector to sector.

The RBI (1972) estimates for year 1965-66 were prepared along same lines with some improvements. Agricultural sector estimates for year 1960-61 showed significant differences from All India Rural Debt and Investment Survey (AIRDIS) conducted by RBI for rural areas. Since AIRDIS showed wider coverage these estimates were considered more reliable. Coverage in the Manufacturing sector was also widened. Also a more detailed method of depreciation used. The improvements were also brought on the 1960-61 estimates. (Both 1960-61 and 1965-66 estimates presented in Table 3.1.)

(v) Uma Dutta Roy Choudhary (1977) estimates capital stock for year 1971. She also incorporates Mukherjee and Sastri's and RBI estimates to study the pattern of change in Investment and resulting output. Her study provides, in a consolidated form, most of the information on reproducible tangible wealth, available for India. Mukherjee and Sastri's estimates are presented in their original form. The only adjustments made are to convert them into 1960-61 prices for constant price estimates and to reclassify the data from ten to fourteen sectors. As Uma Dutta has NAS data at her disposal she uses the fourteen sector classification of CSO.

The RBI estimates for years 1960-61 and 1965-66 are

presented with some adjustments, as further information could be derived from NAS and other sources for these years. The estimates were revised where substantial discrepancies were observed. For example, the values of inventories were found to be over-estimates in RBI studies. Hence they were revised by Uma Dutta. Also the RBI studies did not include capital estimates for forestry sector. These were prepared by Uma Dutta for 1960-61 and 1965-66 as well.

While Mukherjee and Sastri had to start from scratch, Uma Dutta had a number of studies to fall back upon. Hence for most sectors she could obtain capital stock estimates by 'perpetual inventory method' (PIM). The benchmark estimates are obtained either from Mukherjee and Sastri or the RBI estimates. Only in a few sectors like fishing, unorganized manufacturing, and road and water transport some other sources were considered more accurate and benchmark information taken from them. The net annual additions to capital obtained either from NAS or from sector relevant data sources.

For price adjustment two types of indices were required. The current price series to obtain replacement value of capital at current prices, and constant price series to convert all values in 1960-61 prices. For converting historical cost to current value Mukherjee and Sastri had obtained a single price index for all sectors (also this index included only construction part of capital produced domestically. At the same time it included index of all imports, a small part of which

was consumption goods as well. Thus the index was not representative of changes in capital good prices.) Uma Dutta on the other hand obtained a series of investment cost indices for different sectors. This was done by using indices of urban and rural type construction prepared by CSO, wholesale price indices of machinery and transport equipment and vehicle issued by the 'Office of Economic Adviser' and price indices of livestock. Relevant indices were combined with current weights of different components of capital formation for obtaining combined investment cost index series. The price indices for constant price series obtained directly from NAS.

With the help of the above net capital stock estimates ACORs have been worked out for all sectors at current as well as constant (1960-61) prices and ICORs for 1960-61 prices for all sectors. Net value added estimates are obtained from NAS, and related to capital with one year lag. In case of ACORs at current prices the value added figures have been adjusted for the previous years prices to match those of the capital stock estimates. In case of agriculture sector three years average output has been used to take account of fluctuations due to weather. In case of ICORs the ratios have not been estimated where either capital or output registered a fall between two points. The ACORs and ICORs have also been obtained by classifying the economy into public and private sectors. (Results presented in Table 3.1.)

The conclusions that Uma Dutta draws from the above

study are that firstly during the period under study the capital requirements per unit of output have shown an overall rising tendency. But this has neither been uniform nor true for all sectors. Secondly the investment pattern has also changed in the two decades. The first showing a definite increase in capital requirements in manufacturing, railways, communications, house property and public administration; while the second showing advances in sectors like agriculture (specially multipurpose river valley projects), social and community services, etc. The ICORs of sectors, showing large increases in ACORs in the first decade and a petering off in the second, show a tendency to decline in the second decade, for example, railways and communications. According to Uma Dutta the investment pattern depicted in the results is compatible with the policy of the government. Rapid industrialization in the fifties and green revolution in the sixties. Hence the tendency towards higher capital-output ratio is natural in a country on path of development. At the same time she points out that it is "necessary to examine the diverse conditions that influence the rate of return from capital". She enumerates these factors as relative supply of capital and labour, technological peculiarities, organizational structure, changes in productivity of labour due to better training, under-utilization of capital, etc.

Though Uma Dutta enumerates the positive as well as negative factors influencing behaviour of capital-output

ratios, she does not make any attempt to show exactly the influence of these factors on the ratios. Further although the influence of gestation lags is acknowledged, a blanket rate of one year is assumed for all sectors. This is unrealistic where a multipurpose river valley project could take years of lag, while a small enterprise could start generating output in a couple of months. Finally although the study spans over a period of twenty years, a meaningful trend for the behaviour of capital-output ratios cannot be drawn, as it estimates the ratio only at given points of time namely 1949-50, 1960-61, 1965-66 and 1970-71.

(vi) Pratap Narain and R.P. Katyal (1980) made a study of capital-output ratios over a period of twenty-seven years by obtaining a time series of capital stock. The method of estimation, of capital stock, followed is the same as that by Uma Dutta. The same CSO sectoral classification is used. stocks are estimated for each year, at constant 1970-71 prices, using 'perpetual inventory method'. These are then averaged for year endings 1951, 1956, 1961, 1966, 1969, 1974 and 1977, to correspond with plan periods. The benchmark estimates are obtained from Uma Dutta (1977) and Mukherjee and Sastri (1959) estimates, for all sectors with the exception of fishing and agriculture.

For fishing earlier estimates were found weak by the authors, hence, benchmark estimates for this sector were obtained from Indian Livestock Census. For agriculture instead

of using one particular estimate for benchmark purpose estimates are obtained for years 1951, 1961 and 1971 from Mukherjee and Sastri (1959), RBI (1961) and Uma Dutta (1977) respectively. Further using 'perpetual inventory method' 1951 estimates have been brought forward to 1956 and 1961 estimates backwards to the same year. The average of the two is taken as the actual estimate for year 1956. Estimates of other intervening years have been obtained similarly. The authors are of the view that "firstly a major portion of the estimates of capital formation in this sector is based on indirect indicators and secondly the estimate of depreciation are also not based on direct data". Hence for lesser possibility of error this method is adopted.

Data on yearly net capital formation and for value added are obtained from NAS at constant (1970-71) prices. Hence no price adjustment is required. The capital-output ratios have been estimated for each year by relating net capital stock estimates to gross value added with a lag of one year. Ratios are separately obtained as fixed-capital-output ratio and inventory-capital-output ratio. The yearly ratios are averaged to correspond with years of beginning and ending of plan years.

The overall results (presented in Table 3.2) obtained by Pratap Narain and R.P. Katyal are consistent, as far as direction of change of the ratio is concerned, with those obtained by Uma Dutta which is not surprising as the data

source is the same for the two. Yet there is an exception in the form of public administration and defence sector. This ratio shows an increase in Uma Dutta's study and a decline in Pratap Narain's study. For the purpose of analysis the authors also obtained capital-output ratios of sub-sectors within a sector. For example in transport by other means a distinction between incomes originating in organized and unorganized sectors show that within the sector itself different sub-sectors require different amount of capital per unit of output. Also within public administration and defence, although the overall ratio shows wide fluctuations, these are almost eliminated when ratio of fixed capital to value added is taken suggesting that fluctuations are mainly due to inventories.

A peculiarity of Pratap Narain and R.P. Katyal's estimates of capital-output ratios is that the capital stock is estimated net of depreciation, while the value added figures used are gross of depreciation. Thus estimates are likely to be under-estimates. This study also assumes an average lag of one year for all sectors.

(vii) Bakul Dholakia's (1983) is another study of capital-output ratios on the same lines as Pratap Narain and R.P. Katyal. It spans over the longer period viz. 1948-49 to 1980-81, and is a part of his major study on 'Behaviour of Capital Output Ratios'. He not only obtained economy level estimates but also did a detailed study of capital-

output ratios in manufacturing sector alone.*

The method of estimation for economy level estimates is similar to Pratap Narain and R.P. Katyal. This study is also at constant 1970-71 prices. Capital stocks are obtained through 'perpetual inventory method'. Benchmark estimates were obtained from Uma Dutta and Mukherjee and Sastri, even for agriculture sector. The two sectors where benchmarks were obtained from sources different from above-mentioned, were registered manufacture and housing. For the former they were obtained from his own present study and for the latter from a study on economic housing by Dholakia (1982). Wherever price adjustment was required, the indices were obtained from Uma Dutta's estimates at current and constant prices.

The ratios were obtained by relating net capital stock to 'net domestic product'. Dholakia derived two series of ACORs, one without any time lag and one with an average lag of two years. He also obtained two time series of ICORs at constant prices. One by relating change in net capital stock to change in NDP in the same year and the other with a lag of two years. (Presented in Table 3.3.)

Dholakia also observes that overall capital-output ratio has a tendency to rise, but with large variations between sectors. The sectors which show a declining tendency are communications and railways. This result is consistent

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* This is discussed in the subsequent section.

with earlier studies, but again the data source is the same. The behaviour of ICORs is observed to be compatible with ACORs. A notable fact is that though the ratios (both ICORs and ACORs) show a tendency to increase, in case of no lag as well as in case of two year lag, the ratios are comparatively lower and more stable for the series with lag.

Unlike the earlier authors Dholakia made some attempt to formally analyse the pattern of changes in the ratios. He studied the pattern of change both across sectors and over time. For studying across the sectors variability he obtained the standard deviation of sectoral ACORs from the aggregate mean value and the coefficient of variation. The results [presented in Table 3.4(a)] show that for all fourteen sectors the variation shows a steady decline. But for the same analysis excluding house property though the variation reduces in absolute value, it shows a small tendency to increase.

To study the change in ACORs over time, Dholakia regressed the estimated values of ACORs on time through the equation $ACOR_{i,t} = a + b_t$ where $ACOR_{i,t}$ is the ACOR of the i^{th} sector in the t^{th} year. Even though by this method only a linear trend can be discerned the results obtained were highly encouraging. Nine out of fourteen sectors showed a positive trend while four showed a negative trend. Only for one sector the coefficient was insignificant in case of ACORs without time lag. In case of ACORs with two year lag the results were consistent for all sectors with the exception of

trade, construction and railways. While trade has an insignificant time trend when measured for ACOR without time lag it shows a significant positive trend for ACOR with two year lag. The reverse is the situation in case of construction. Though railways shows a negative trend in both cases the coefficient of time is not significant for ACOR with two year lag.

To study intersectoral dependence of the ratio, Dholakia obtained coefficient of correlation between various sectoral ACORs. From which Dholakia concludes that "the time series of capital-output ratio for each of the 14 sectors, with the only exception of trade, hotels and restaurants, show a statistically significant correlation with at least eight other sectors; and in some cases, this number is as high as 12 or 13" (Dholakia, 1983, p. 331).

Finally, Dholakia attempted to measure the influence of various factors causing variation in ACORs. The factors influencing sectoral ACORs were enumerated by him as (a) changes in technology in each sector indicated by corresponding changes in capital intensity, (b) changes in overall efficiency of resource utilization, indicated by changes in labour productivity, and (c) changes in overall cost of capital, as indicated by corresponding changes in the ratio of interest payments and profit to total capital employed. However due to non-availability of required time series for each of fourteen sectors the influence of factors causing changes in sectoral capital-output ratio could not be measured. The analysis was restricted to aggregate economy level ACOR.

The economy level ACOR in time period 't' is $ACOR_t = \Sigma W_{i.t} ACOR_{i.t}$, where $ACOR_{i.t}$ is the sectoral ACOR of the i^{th} sector in the t^{th} year and $W_{i.t}$, the weight attached, is the ratio of the value added generated in the i^{th} sector to value added generated in the entire economy. Hence change in either of the two can cause a change in $ACOR_t$.

To isolate the influence of these two factors, namely, changes due to changing sectoral ACORs and changes due to changing weights (indicating structural changes in the economy), Dholakia obtained a series of $ACOR_t^*$, keeping the weights constant (for base year 1970-71) and changing the $ACOR_i$s as observed such that $ACOR_t^* = \Sigma W_{i.b} ACOR_{i.t}$ and a second series as $ACOR_t^{**}$ by changing the weights and keeping the sectoral $ACOR_i$s constant as $ACOR_t^{**} = W_{i.t}\ ACOR_{b.t}$. Both $ACOR_t^*$ and $ACOR_t^{**}$ are obtained for two year lag as well. This exercise is also done for the three broad sectors of the economy, namely, Agriculture, Industry and Services.

At this juncture Dholakia tries to incorporate the influence of time lag to study the net partial effect of (a) time lag, (b) structural change reflected by change in weights, (c) change in sectoral ACORs and (d) the interaction effect of the three. Although the isolated influence of structural change and changing sectoral ACORs and their interaction effect becomes apparent,[@] that of time lag does not become clear from the analysis.

@ $ACOR_t = ACOR^* + ACOR^{**}$ + Gross product team indicating the combined effect of the two.

The results [presented in Table 3.4(b)] of this analysis indicate that as both $ACOR_t^*$ and $ACOR_t^{**}$ series show an increasing linear trend, both factors have been responsible for the increasing aggregate ACOR. The relative contribution varies within the three broad sectors of the economy. For example in primary sector changes in sectoral capital-output ratios account for 80 per cent of observed variation, while in secondary sector they account for only 57 per cent of the observed overall variation and structural change a significant 28 per cent. In the tertiary sector changes in sectoral ACORs account for 84 per cent of variation if house property is included in the analysis whereas it drops to 39 per cent if house property is excluded. House property influences the results significantly in case of overall ACOR as well. To study the pattern of change in the relative contributions of factors, Dholakia divides the entire period into two halves. In the first half (1948-65) changes in sectoral ACOR make a significant negative contribution and changes in structure a more or less similar positive contribution while in the second half (1965-81) both make an equal and significant positive contribution of 47 per cent. This variation is also different for the three broad sectors. Dholakia also mentions that time lag plays a significant role in the industrial sector in particular. But as mentioned earlier, it does not become clear how this conclusion can be drawn from the analysis.

Further although Dholakia's attempt to expand his analysis to study the causes of changes and pattern of changes

taking place in ACORs is noteworthy, the methods used in the analysis were not always fault-free. For example, to study the time trend he regressed the ACORs and ICORs on time. Though he got encouraging results, normally in this method the results are greatly influenced by the first year values. Also to study the interdependence of sectors he estimates the coefficient of correlation of each sector with every other sector. But though the interdependence of sectors is logically accepted, inferring the same from coefficient of correlation of ACOR series already showing time trend in the same direction does not seem appropriate.

3.1.2 Economy Level Estimates: Econometric Approach

In the studies reviewed till now, the method of estimation used was, dividing capital or change of it by output or change of it to obtain ACORs and ICORs respectively. For the Sixth and the Seventh Plans* regression approach was used to obtain estimates of ICOR. These are reviewed next.

(i) The estimates for the Sixth Plan for the different sectors of the economy were estimated by S. Gupta, R. Mehta, C. Pant and P. Singh (1981). The authors are of the view that "a ratio of change in capital stock to change in output may not give an appropriate average gestation lag required for a particular sector. In case the lag distribution structure is

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* Detailed information regarding estimation of ICOR for earlier plans, with the exception of Second Plan, was not available. But the ratios used in various plans are presented in Table 3.11.

not taken, the value of estimated ICOR will generally be higher than actual." Thus the specification of the model used, by them, is such that, the value of gestation lag for each sector is obtained individually from the model itself.

Specification of the model - Assumptions : (i) Each sector has an investment to output lag of 'L' years, which varies from sector to sector.

(ii) Investment is equally spread over the gestation period,* and in any period, total extension investment consists of some on-going investment initiated in the past ranging from -1 to (-L+1) year and first year disbursement of new activity. In symbols let it be TI_t.

(iii) Output in a year is a result of all investments made on projects completed currently, say U(t).

If $T_t(S_t - 1)$ = Disbursed investment outlay in year 't' on investment activity started in $(t-1)^{th}$ year where $1 = 0,1, \ldots (L-1)$ and $t = 1, 2, \ldots T$.

Then $TI_t = I_t(S_t-L+1) + I_t(S_t-L+2) + \ldots + I_tS_t$ ...(1)

$\Delta O_t = O(t) - O(t-1)$ ...(2)

and $\Delta O_t = \beta[I_{t-1}S(t-L) + I_{(t-2)}(S_t-L) + \ldots + I_t - L(S_t-L)]$ ...(3)

i.e. change in output in 't' year is an outcome of all investment in the sector on projects started L years ago, as the

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* Though this assumption seems unrealistic, it was made due to data limitations. As investment outlay of various sectors does not mention the disbursement among various projects.

gestation period has come to an end. Here β is the inverse of incremental capital-output ratio for the relevant sector, here ICOR cannot be obtained directly through eq.(3) as data is not available for investment pattern as required in the equation. The only time series available is that of TI_t, thus ICOR has to be estimated with the help of the same. For this further specification is required. Eq.(3) can represent incremental output for t+1 to $(t+L)^{th}$ year. For $(t+1)^{th}$ year it will be

$$O(t+1) = \beta[I_t(S_{t-L+1}) + I_{t-1}(S_{t-L+1}) + \ldots + I_{t-L+1}(S_{t-L+1})] \quad \ldots (4)$$

Making use of assumption (ii), i.e. investment is equally spread over gestation period eq.(4) can be re-written as:

$$O(t+1) = \beta.L[I_t(S_{t-L+1})]; \text{ as } I_t(S_{t-L+1}) = I_{t-1}(S_{t-L+1}) = \ldots$$

Similarly $O(t+2) = \beta.L[I_t(S_{t-L+2})]$

$$\vdots$$

$$O(t+L) = \beta.L[I_tS_t]$$

$$\therefore O(t+1) + O(t+2) + \ldots + O(t+L) = \beta.L[I_t.S_{t-L+1} + I_tS_{t-L+2} + \ldots + I_tS_t] = \beta.L[TI_t]$$

or $O(t+L) - O_t = L.\beta.TI_t$

or $$TI_t = \beta^{-1}\left[\frac{O(t+L) - O(t)}{L}\right] \quad \ldots (5)$$

Making use of eq. (5) the ICORs were directly obtained by regressing Gross Capital formation in 't' year on change in

value added between (t+L) and 't'th year. L is obtained through iteration where the regression equation gives best fit. The exercise is done for the period 1950-51 to 1979-80. The time series of Gross Capital formation and Gross value added at 1970-71 prices is obtained from the NAS.* Capital formation series was taken at market prices and value added series at factor cost. The regression equation used was $GCF(t) = a + b [V(t+L) - V(t) / L]$. The value of the regression coefficient 'b' directly gives the sectoral ICOR.

The results (presented in Table 3.5) obtained show the regression coefficient to be significant in almost all sectors. For comparison the authors have shown that ICORs obtained by their method work out to be lower than the ICORs obtained by the simple method not taking into consideration the lag period. Also this method has the advantage of not requiring capital stock estimates.

But although the authors mention that certain adjustments have been made in case of regression coefficient to arrive at ICOR values used in the plan, on basis of a priori information, the adjustments seem many times larger than the actual values for example when a significant coefficient value was obtained as .66. The ICOR used for the plan was 8.8324.

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* Although net series of capital formation and value added as well as both gross and net series at 1979-80 prices were tried. But gross series at 1970-71 prices gave the best results hence were retained.

(ii) Although for the Seventh Plan also, for estimating capital output ratio, regression method was used, by a Working Group appointed by the Planning Commission, under the chairmanship of S.P. Gupta (1985), their specification was much simpler. The specification used was $CI_t = a + b \not\parallel V_t$ where CI_t is cumulative investment upto year 't' and V_t is value added in year t. According to the authors the advantages of this specification are that firstly the ICOR is obtained directly as the regression coefficient, and secondly this specification possesses the property that ICOR estimates are invariant to initial capital stock consumption. The time period of the study is 1960-61 to 1980-81. For cumulative investment data on Gross Capital stock at market prices and for value added data on gross value added at factor cost is used. Both series at (1970-71) constant prices. The time lag is implicitly assumed to be absent. Since the study is an official one, capital stock estimates were specially made available by CSO. For the subsequent years they were obtained by adding the Gross Capital formation values obtained from NAS.

For studying behaviour of ICOR over time regression coefficients were obtained separately for periods 1960-61 to 1970-71 and 1970-71 to 1980-81, and the significance of the difference in the coefficient in the two periods have been tested. Not only are ICORs estimated at sectoral level, but within each sector they are estimated separately for public and private sector. This clearly brings out the differences in private and public sector within each of the 14 sectors.

The results (presented in Table 3.5) on the whole indicate higher ICOR values for public sector within each sector. But as the authors point out, "the activities in public and private sectors under same head/sector are different and, therefore, the ICOR estimates should not be taken as the exclusive index for comparing relative efficiency of public and private sector" (p. 6). For example in agriculture the ICOR for private sector in the seventies is 2.02 and in public sector is 15.71. High value in public sector is indicative of investments in multi-river valley projects, etc. This shows the complementary role of public sector to private sector. On the basis of the test of significance applied to the change in ICOR from the decade of sixties to seventies the Committee concludes that the ICOR for public sector shows a declining trend while for the private sector it shows constancy. The combined ICOR for the economy also remains the same. This conclusion does not coincide with that of earlier studies. At sectoral level a decline in ICOR in railways coincides with the results of earlier studies.

The factor causing some reserve in the acceptance of the above results is the absence of time lag. Earlier studies, also, either assumed away the time lag or considered a constant time lag for all sectors, but their emphasis was on ACORs, where new capital and the time lag involved in generation of output by it, is a small part of the entire capital stock and the resultant output. Thus these results are not largely influenced by the omission. In case of ICORs, which

are considering only investment and change in output caused by the investment, the role of time lag takes a greater place of importance.

3.1.3 Chitale's Comparison of Results by Both Methods (1986)

Chitale (1986) in a study of capital-output ratio tries to compare the ICOR estimates arrived at through regression and ICOR estimates arrived at through what he calls the 'conventional method' namely by simply dividing change in capital by the change in output. The regression estimates are taken from the Working Group Committee's Report, while the conventional estimates are obtained from P.R.Brahmananda's (1982) study. He in turn obtains the estimates by simply dividing Gross domestic capital formation by change in gross domestic product at 1970-71 prices, without any time lag. The time period under consideration is the same.

Chitale from the comparison concludes (results presented in Table 3.5) that though for sectoral ICOR, the two types of estimates show substantially varying proportions, in case of aggregate ICOR, the increase is very sharp, that is nearly 40 per cent under conventional method and almost insignificant, namely 6 per cent, under the regression method.

He also obtains wide fluctuations in aggregate ICOR for the economy as a whole, while estimating ACORs and ICORs, by the conventional method, himself. He relates gross capital stock to gross domestic product at constant (1970-71) prices, without time lag, for obtaining ACORs and the yearly changes

in the two, again at constant (1970-71) prices, without time lag for obtaining ICORs. To estimate Gross capital stock benchmark estimates are obtained from Pratap Narain and R.P. Katyals (1980) study. He opines that "annual ICORs are prone to wide fluctuations ranging from 28.54 in 1976-77 to -17.55 in 1973-74, and it is difficult to trace a secular pattern in its behaviour through annual figures. A three year moving average merely smoothens out the series without displaying any meaningful relationship between investment and output" (p.11). Further "A definite trend, however, emerges by taking a five year averages of these ratios" (p.12). That is to study the long term trend of capital output ratio a certain amount of siphoning out of yearly random fluctuations from the analysis is required. But at the same time the assumptions of the analysis should not be so restrictive as to put a straight jacket on all variations, random or otherwise, to obtain a well-behaved stable estimate.

3.1.4 Mukherjee's Estimates (1980)

One study which obtains constant estimates from the specification itself is that by M.Mukherjee (1980). In this study the method for obtaining capital stock is based on Simon Kuznets (1956) study. Here the data requirements are simply that of Gross National Product of current year Y_o; proportion of Gross capital formation to GNP 'f'; Gross capital formation in fixed assets which is 'a' per cent of 'f' and the long run growth rate of the economy 'r'. The underlying assumptions

are that (i) 'f', 'a' and 'r' remain constant throughout the period of analysis namely 'n' years. (ii) 'n' in turn is equal to the average life of fixed assets. (iii) The depreciation follows the straight line rule; and (iv) gestation lag is six months i.e. GNP is related to middle of the year while capital stock Co to the beginning of the same year.

Now if the GNP in current year is Y_o, the GNP 'n' years ago must have been $Y_o(1+r)^{-n}$. The part of GNP going into fixed capital formation in current year is afY_o. As Co relates to beginning of current year the capital stock does not include the value afY_o. But the part of $O\text{-}1^{th}$ year GNP gone into fixed capital formation would be $afY_o(1+r)^{-1}$ and the year before that $afY_o(1+r)^{-2} \cdot \frac{n-1}{n}$ due to straight line rule of depreciation, and for two years before it will be $afY_o(1+r)^{-3} \cdot \frac{n-2}{n}$ and so on till n year ago, the part of GNP constituting fixed capital stock would be $afY_o(1+r)^{-n} \frac{1}{n}$. For the year before 'n' the fixed capital stock would be discarded hence need not be considered.

Summing up for all years the value of fixed capital stock can be obtained as

$$Co = \frac{afY_o}{n}\left[n(1+r)^{-1} + (n-1)(1+r)^{-2} + \ldots + 2(1+r)^{-(n-1)} + (1+r)^{-n}\right]$$

$$= \frac{afY_o}{r}\left[\frac{nr-1 + (1+r)^{-n}}{nr}\right]$$

The depreciation rate alone can be obtained as :

$$Do = \frac{afY_o}{n}\left[(1+r)^{-1} + (1+r)^{-2} + (1+r)^{-3} + \ldots + (1+r)^{-(n-1)-n} + (1+r)\right]$$

$$= \frac{afY_o}{n}\left[1 - (1+r)^{-n}\right].$$

Similarly estimates for working capital can be obtained as

$$So = (1-a)f\ Y_o[(1+r)^{-1} + (1+r)^{-2} + \ldots + (1+r)^{-n}],$$

as n in case of working capital

$$So = \frac{(1-a)fYo}{n}$$

Estimates of capital output ratios can be obtained as Co/Yo in case of fixed capital gross output ratio and Co+So/Yo in case of total capital gross output ratio and Co+So/Yo-Do in case of total capital to net domestic product ratio.

$$\text{Now } \frac{Co}{Yo} = \frac{afYo}{r.Yo}\left[\frac{nr-1 + (1+r)^{-n}}{nr}\right]$$

$$= \frac{af}{r}\left[\frac{nr-1 + (1+r)^{-n}}{nr}\right]$$

Thus ultimately the capital output ratio depends on the rate of growth of national income, age of fixed capital assets and proportion of GNP going for capital formation.

Mukherjee using f to be 17.5 and 'a' to be 87.5 on the basis of Indian economy obtains ratios using different growth rates and different values of 'n'. He concludes that a higher growth rate leads to a fall in capital output ratio while higher average life of fixed assets tends to push the ratio upwards. Further, while obtaining values of depreciation according to his method he concludes that depreciation rates used in official statistics in India are too low.

This method has the advantage of requiring very little data. Quick results can be obtained by this method. Also as mentioned earlier in case of most estimates the quality of data largely influences the quality of estimates. Thus in case of non-availability of reliable data, this method is useful. But by its too restrictive assumptions, this method puts a straight jacket on capital-output ratios. A constant ratio is not pragmatic, so instead of striving for a well behaved constant, the method of estimation should incorporate into the analysis tools to gauge the movement of capital-output ratio.

3.1.5 Panchamukhi's Behavioral Model (1983)

The efforts to formally analyse the factors influencing the behaviour of capital-output ratio get thwarted by lack of data, but some efforts to study the behaviour in a systematic manner were carried out by V.R. Panchamukhi (1985) in his work titled 'Capital Formation and Output in the Third World'. His study spans over a period of twenty years from 1960-61 to 1979-80. To start with, he obtains the time series of Incremental capital-output ratios for the economy as a whole by the simple method, with gross values assuming no lag, an average lag of three years and an average lag of five years for both current and constant prices. Capital-output ratio without lag shows very erratic behaviour, even with average lag of three years the fluctuations remain but for a five year lag the fluctuations are less wide. The ratios are higher for constant prices than for current ones.

To study the causes of fluctuations in ICOR, Panchamukhi does a similar analysis for aggregate ICOR as what Dholakia did for aggregate economy level ACORs, i.e. since economy level ICOR constitutes of a weighted average of sectoral ICOR, it can change due to a change in sectoral ICORs or due to a change in weights or due to the combined influence of the two. The analysis is carried out on gross ICOR with zero gestation lag. The entire time period is divided intc four segments of five years each. The ICORs of these five years are averaged out and then compared with those of adjacent periods. In comparing the ICOR of 1961-65 to 1966-70 change in sectoral share is the most dominant influence removing the influence of the other two factors which are not insignificant. But in the later years the influence of sectoral ICORs increases and becomes most dominant. But the influences of the other two are also significantly large.

Panchamukhi, unlike Dholakia does not ambiguously incorporate the influence of gestation lags in the above analysis. He studies their influence in an elaborate manner separately. He is of the view that "In a highly diversified continental economy like India, lags between investment and output could vary in a considerable manner from one sector to the other. Even within a sector lags could be different for different types of investment" (Panchamukhi, 1983, p. 33). Further, he adds "Normally, the concept of gestation lag refers to a lag of specified period between investment and

output. However, in reality the effectiveness of investment made in a particular year could be spread over different years in different degrees" (Panchamukhi, 1983, p. 33). To capture this he uses the Almon method of lagged variables. In this gross output is postulated to be a function of gross capital formation of the current period as also that of a number of previous periods. The coefficient in the Almon scheme is postulated to follow approximately a polynomial relationship in parameter 'z'. The degree of polynomial could be taken as 'r'. The method provides for to trying different values of r and z. Panchamukhi applied the Almon scheme to data on aggregate gross capital formation and gross domestic product for period 1960 to 1979. Third degree polynomial with lag of seven years according to him gave good insight into nature of lag structure between investment and output. The equation was as follows.

$$Y_t = 9976.23 + 1.091\ I_t - 0.039\ I_{t-1} - 0.144\ I_{t-2} + 0.344\ I_{t-3} + 0.991\ I_{t-4} + 1.363\ I_{t-5} + 1.027\ I_{t-6} - 0.450\ I_{t-7}.$$

The coefficients show an interesting pattern, with coefficient of unlagged variable quite large, whereas immediately thereafter quite small and also negative until two years. Thereafter values of coefficient rise for the next five years and then decline sharply. Values of the coefficients bring out the inverted V type of relationship between investment of different periods and gross output. According to Panchamukhi from this the level of effective investment relevant for the outputs of

a given year could be worked out as a weighted sum of investments of various previous years, the weights being the coefficients of respective investment variables. Although he himself does not work it out.

In the absence of relevant time series data, the extent of each factor's influence in the behaviour of capital-output ratio is difficult to measure. Panchamukhi in an alternative suggests that though the influence of, say, capacity utilization, power failures, failure of complementary government policy could not be measured, the extent of discrepancy between the postulated output figure and the realized one, caused by the above factors can be measured. For this he gives a behavioural model as follows:

$$X_t^* = \alpha + \beta \Sigma I_{t-1} + U_t \qquad \ldots \text{(i)}$$

where X_t^* is postulated output and I_{t-1} is the actual investment.

Now $$X_t - X_{t-1} = \lambda (X_t^* - X_{t-1}) + v_t \qquad \ldots \text{(ii)}$$

where X_t is actual realized output and

λ is speed of adjustment of actual output to potential.

Substituting (i) in (ii)

$$X_t = \alpha\lambda + (1-\lambda)X_{t-1} + \beta\lambda K_t + (u_t + \lambda v_t)$$

where $K_t = \Sigma I_{t-1}$.

The results show that the fits are significant for most of the sectors except agriculture and industry. Rates of adjustment vary significantly among different sectors. In general, the rate of adjustment of output to its potential, for most sectors is higher in private sector than in public sector.

3.1.6 Comments

A conclusion that can be safely drawn, after reviewing all the studies at the economy level, is that the ACORs and ICORs for the Indian economy are showing an increasing trend. The trend is not uniform for each sector in the economy. Also there are large inter-sectoral variations in the values of ACORs and ICOR, irrespective of the method used. A later date study by Krishnamurti and Sharma (1989) on the behaviour of ICOR comes up with different conclusions. They calculated ICOR using three year moving average of real GDP with one year lag in gross investment. From their study they concluded that ICOR for the economy showed a steady rise till the Fourth Plan and thereafter a perceptible decline with a temporary reversal during the second oil shock. Since the studies of capital-output ratio available do not go beyond year 1981, the post-oil shock decline is not perceived by them. While the values of ICORs used in various plans conform with Krishnamurti and Sharma's results.

Secondly, most studies show a consistency in results, at least as far as the direction of change in capital-output ratio is concerned, e.g. railways showed a declining trend in all studies. But this is likely because the data source for all studies is the same which automatically leads to same capital definitions at least as far as coverage is concerned.

Uma Dutta, Chitale and others outline the various factors likely to influence the behaviour of capital-output

ratio as under-utilization of capital, relative supply of capital and labour, technological peculiarities, government policy, organizational structure, productivity of labour, but very little is done to measure the influence of these factors on capital-output ratios. Of course non-availability of adequate data is the reason for this.

The economy level estimates are too aggregative in nature. A single ratio for the entire industrial sector which holds the most capital intensive sector like iron and steel as well as very highly labour intensive sectors like cottage industries as well seems slightly far-fetched.

II

3.2 Sectoral Estimates

Economy level estimates are too aggregative in nature. Pratap Narain and R.P. Katyal had pointed out that there could be large variations in the values of capital coefficients within a single sector. Therefore treating an entire sector as a single unit becomes unrealistic. But attempts at disaggregation are restricted by the availability of data. Most of available, disaggregated sectoral studies are done for the industrial sector. As data is more easily available for this sector. The method is similar to that of the economy level estimates i.e. treating the sub-sector, upto which disaggregation takes place, as the homogeneous unit. First capital-output ratios for these units is obtained and then the entire sector is treated as a weighted average of units.

(i) The main source of data for the manufacturing sector at a disaggregated level is the Annual Survey of Industries (ASI). The publication of ASI started in 1959-60. This year onwards ASI publishes information of the output produced, the value added, the componentwise book values of assets, rates of depreciations in the industries, etc. For componentwise asset values, the break-up is given as (a) Buildings, (b) Improvement in land and other construction, (c) Plant and machinery, (d) Tools, transport equipment and other fixed assets and (e) Inventories. For industrywise reporting, first the industrial sector is divided into Census and Sample sectors, where the Census sector is defined as one where fifty or more workers are employed and power is used, or hundred or more workers are employed if power is not used. Secondly, the industries are classified into basic twenty industries forming a two digit level of classification. Further classifications within the industries lead to higher digit classifications.

For data for years prior to ASI publication, there was Census of Manufacturing Industries (CMI) for the years 1946 till 1960. As ASI took over the publication from CMI the pattern of reportage is more or less similar. A few discrepancies arise if more than two digit level classification is used.

Both ASI and CMI data have some limitations. Firstly they report only the depreciated book value of fixed assets and as depreciation rates are not reported componentwise estimating gross values becomes difficult. Further though

reporting of Census sector is reasonably consistent same cannot be said about the Sample sector. Also the reporting becomes inconsistent when higher than two digit level of classification of industries is used. Lastly, for information regarding years earlier to 1946 not much can be obtained from these official sources. Later studies have to rely on individual studies made in the earlier years.

(ii) Antony (1962) is one such study of capital stock in industrial sector for the year 1958-59. These estimates, like all early studies, have very little benchmark information to fall back upon. For obtaining capital stock estimates Antony divides the industrial sector in (i) Private Sector - consisting of (a) Public limited joint stock companies, (b) private limited companies, (c) branches of foreign companies, (d) partnerships and proprietary concerns, and (e) industrial cooperatives and (ii) Public sector industries.

For public limited companies, private limited companies in private sector and public sector industries Antony could obtain estimates for companies accounting for certain percentage of the sector. The figures were inflated for the entire sector. For branches of foreign companies only data on 'net worth' was available. Since the author observed a direct relationship to exist between paid-up-capital and capital stock for the industrial sector as a whole the former was used as estimate of latter. For partnership and proprietary, due to lack of any other data, share of contribution to total

output in the industrial sector was assumed to be the same as share of capital in entire capital used in industrial sector. Information on co-operative was obtained directly.

Like Mahalanobis, Antony also obtained the replacement value for capital. For this information on the age structure of capital was required and an appropriate price index was required. For determining the age structure the assets were divided into four categories: (a) Those acquired prior to 1946 and existing in 1958 : To estimate this help was taken of 'Taxation Enquiry Commission' report. According to which, of total fixed assets (gross) at the end of 1951, 57 per cent were acquired prior to 1946. Further from a study on discarding obsolete technology from joint stock companies, revealed that in three years ending 1958-59, discarding rates of assets was Rs.12 crores per annum. Antony assumed a slightly lower rate of Rs.10 crores per annum of the years 1951-1956. This provides information on assets discarded during the period after 1946, and estimate of assets acquired prior to 1946 and in existence in 1958 could be worked out. For the remaining categories, namely (b) between 1946-50, (c) during the First Plan (1951-56) and (d) three years of Second Plan estimates were worked out simply for each year and added.

The price indices used were the 'wholesale price index' for the corresponding years. This was done as the author found the values of wholesale price index were in close proximity of export price index of capital goods and no better alternative data was available.

Like all works of earlier years Antony's estimates also have to be reviewed keeping in mind the paucity of data. Under the circumstance they provide a reasonable idea of capital stocks existing prior to year 1946. For which the estimates are used by a later date study by Hashim and Dadi on behaviour of 'capital-output ratio in registered manufacturing'.

(iii) Hashim and Dadi's (1973) study spans over a period of eighteen years (1946-1964). They obtained a time series of Gross capital stock estimates at current prices for the industrial sector as a whole as well as the capital-output ratio series. The data of ASI and CMI was combined to arrive at the estimates. Estimates were first obtained for twenty industry group making use of 2-digit ASI classification and then aggregated together to arrive at the estimate for the sector as a whole. Within the industry group capital stock was estimated assetwise. The categories used were (a) building and construction, (b) plant and machinery, (c) other equipment, and (d) inventories. The first three forming the fixed capital component which being depreciable causes the difficulties in estimation. Inventory component is directly obtained.

For fixed assets the authors are of the view that "gross value" or "purchase price" (suitably adjusted for price variations) is the most useful concept and also closest to the concept of capital in theory (Hashim and Dadi, 1972, p. 10). As gross value when adjusted for price comes close

to replacement value. But the data available is that of net depreciated book value of capital. Thus to arrive at gross value the authors first derived the gross value of capital stock at its original price and then using suitable price indices, the adjustment for prices was made.

The gross value of any present day depreciated asset depends on its age and the rates of depreciation used. In the absence of complete age structure of the depreciated fixed assets the authors obtained a gross value of asset to net value of asset for one year 1960, for all industries. These assetwise ratios were estimated making use of the combined balance sheet of 1001 firms published by RBI for the year 1960. First these firms were classified according to ASI classification then ratios were obtained assetwise for each industry group. From the Gross to Net value ratios the book values of assets were converted in gross values as :

$G_i^{63} = N_i^{60}(r) + A_i^{61} + A_i^{62} + A_i^{63}$ and $A_i^{63} = N_i^{63} - N_i^{62} + d_i^{63}$

where N_i is Net depreciated book value of i^{th} asset in a given year,

A_i is gross capital formation of i^{th} asset in given year,

d_i is rate of depreciation of i^{th} asset in given year, and

G_i is the gross value of i^{th} asset in given year.

As depreciation rates are not reported assetwise they have to be obtained from a different source too. Again the combined balance sheet data provided the information. It revealed that on an average the rate of depreciation of

building and construction should be around 7 per cent, plant and machinery 9 per cent and other assets 20 per cent. However the authors found the rates to be more stable in case of building and construction and other assets, so they were retained. For plant and machinery, the depreciation rates were found less stable so they were obtained as residual from the reported actual rate for the industry as a whole in ASI. In this way the time series of gross fixed capital stock was obtained.

For price adjustments two methods are adopted by the authors. One for capital acquired within the period of study i.e. 1946-64 and another for capital acquired prior to 1946. For the capital acquired year 1946 onwards capital stock estimates could be made as

$$K_t = \sum_{i=1}^{19} A_i \left(\frac{P_t}{P_i}\right)$$

where A_1 is stock existing in 1946 and $A_2 \ldots A_{19}$ are additions made in the subsequent years, P_i is the price index of i^{th} year and P_t that of t^{th} year.

For obtaining value of assets prior to 1946 it was assumed that additions to capital for year 1946 was same as that of 1947. Subtracting this value from capital stock of 1946, the value of stock acquired prior to 1946 could be obtained. With help of Antony's estimate of stock obtained prior to 1946 and existing in 1958 the value of capital stock obtained before 1946 and discarded by 1958 could be obtained.

Assuming a linear rate of discarding the rate of discarding of assets was obtained as 4.47 per cent per annum. Another assumption was made that all assets discarded were those obtained prior to 1946. A single price inflator was derived for all assets prior to 1946. This was obtained as a simple average of price indices of years 1919 to 1929 and 1940-45. As these were the years that major investments took place and any capital purchased prior to 1919 would not be in existence in 1946. In this way the time series of fixed capital stock at current prices is obtained. Both gross fixed capital estimates and inventory estimates were related to gross value added to arrive at fixed capital output and inventory capital output ratios. Also the series capital-output ratios of entire capital stock in industrial sector were obtained by adding the two for each year.

Year 1960 onwards data for all industry groups was obtained from ASI. Thus for the years 1960-64 capital-output ratios were reported separately for each industry group for fixed and inventory capital as well as for entire capital stock of each industry group. (Presented in Table 3.6.)

For comparison purpose, the capital-output ratios for the industry were also obtained directly for net depreciated book value as reported in ASI. Also the coefficient of variation of ratio for each year was obtained and the industry ranked according to the value of capital-output ratio in case of industrywise reporting.

For the industrial sector as a whole the authors conclude that if capital-output ratios are estimated directly from ASI data the ratios show a large tendency to rise over the years. But with adjusted value of capital the same does not hold true. The whole period could be clearly divided into two, namely, 1946-52 for which the simple average of the ratio works out to be 6.54 and 1954-64 for which it works out to be 5.13. The authors conclude that "Within each period the value is stable and between the two periods the shift is significant". They attribute it to the change in industrial mix after year 1952 without elaborating any further. But this conclusion does not tally with the major increase in investment, during Second Plan in long gestation projects. Yet the results do indicate a marginal increase from 4.82 in 1946 to 5.26 in 1947.

From industrywise estimates the conclusion that is drawn by the authors is that inter-industry variation in capital-output ratios is very large, which only justifies the disaggregated sectoral analysis. At the same time the inter-industry variation is showing a reducing trend over time. The results further showed that inter-industry variations as well as variation over time in the ratio were caused by fluctuations in fixed capital-output ratios. Inventory coefficients show small variations within industries and even the small variation shows a tendency to move towards averages over time.

The overall ratio for industrial sector remained stable, while the behaviour of different industry groups was varied. The industries that showed a rising ratio were textiles, wood and cork products, rubber products, products of petroleum and coal, non-electrical machinery and electrical machinery. Two industries showed a falling ratio footwear and apparel and iron and steel. Rest all showed a stable ratio. Although the study spans over a period of eighteen years, industrywise disaggregated estimates are obtained only for four years, 1960-61 to 1963-64. For the earlier period it is an estimation of capital stock for the industrial sector as a whole.

(iv) Dholakia's (1983) study more or less seems to take off from the above study and carry the analysis further. To start with his methodology is quite similar to that of Hashim and Dadi, though the analysis is slightly more elaborate. But where Hashim and Dadi estimated capital stock at current prices Dholakia did it at constant 1970-71 prices. Like Hashim and Dadi he also obtained the time series of capital-output ratios using the reported net depreciated book value of capital and relating it to net value added but at the same time he also obtained the net capital-output ratio at constant (1970-71) prices. Dholaki's study spans over a period of seventeen years starting from 1959-60 upto 1977-78. His reporting of the ratio at disaggregated industry level, for the same two-digit level classification, is done for the

entire period as the starting year of his study corresponds with the starting of publication of ASI.

For obtaining estimates of gross fixed capital stock at constant 1970-71 prices, he also first obtained the gross-net ratio for year 1960, using the same fixed asset categories. Using this as benchmark, Dholakia estimated the fixed capital stock for the rest of the years in the same way as Hashim and Dadi. For depreciation he retained the rate of 9 per cent for plant and machinery, unlike Hashim and Dadi who obtained it as residual. The rate of discarding of assets was obtained in a slightly different fashion. Some information regarding rate of discarding of assets was available in ASI for period 1963 to 1971. From this Dholakia worked out a ratio of asset discarding to rate of depreciation and used the same for the entire period.

For price adjustments he obtained price indices directly from NAS and from a study by M. Mukherjee on 'National Income of India : Trends and Structure'. But it does not become clear from the study as to how exactly the price adjustments were made.

Dholakia also introduces time lag in his analysis. He obtains all the three types of estimates without time lag as well as with an average lag of two years. In this way he obtains time series of fixed capital (both gross and net) output ratio with and without two year lags, inventory capital-output ratios and total capital (gross and net) output

ratios with and without two year lag. To estimate the inter-industry variation he obtains the coefficient of variation for each year.

Dholakia also obtains the Incremental Capital-Output Ratios (ICORs) for the same industries for a five year period with and without two year lags. Without lag they are obtained as say $(K_{70-71} - K_{65-66})/(Y_{70-71} - Y_{65-66})$ and with a two year lag as $(K_{68-69} - K_{63-64})/(Y_{70-71} - Y_{65-66})$.

From his analysis (results presented in Table 3.6) Dholakia concludes that the inter-industry variations are large but are reducing. But for determining the trend in the ratios for different industry groups unlike Hashim and Dadi, Dholakia carries out a trend analysis as $ACOR_{i.t} = a + b.t$ where $ACOR_{i.t}$ is the ratio of the i^{th} industry in the t^{th} year. He concludes that trend analysis varies from series to series. But if the series of gross capital to gross value added is studied a comparison with Hashim and Dadi's results could be possible. The time trend analysis indicates that twelve industry groups show a positive trend if no lag series is taken and fourteen industries if two year lag series is taken into consideration. While two industries show a negative trend with no lag series and only one when two year lag series is considered. But they are not the same as the industries showing negative trend in Hashim and Dadi's study. But since the time period is extended way beyond the four years of Hashim and Dadi's study a change in trend is possible.

Further in the above time trend analysis, the direction of trend gets largely influenced by the observation of the first year. But overall for the industrial sector a definite positive trend was observed.

Dholakia further tries to incorporate in his analysis the likely causes of the trends shown by the ratio both at the industry level and the sector level. For the different industry groups he considers three factors to be major influences of variation in the ratio. (a) Degree of capital intensity, as indicated by the ratio of capital to labour (X_1), (b) level of labour productivity, as indicated by ratio of value added to labour employed (X_2), and (c) Degree of profitability measured as ratio of interest payments plus profits before tax to total capital employed (X_3). By regressing the ACOR of each industry on X_1, X_2 and X_3 separately and jointly he shows the relative influence of the three in bringing about change in ACORs. To make the regression coefficients comparable the final coefficient is obtained as

$$\beta_i = b_i \left[\frac{SD_{xi}}{SD_y} \right]$$

where b_i is estimated regression coefficient of i^{th} explanatory variable, SD_{xi} is standard deviation of variable X_i and SD_y is standard deviation of explained variable in this case ACOR. This method was adopted as otherwise according to the author the size of coefficient would be influenced by the

units and actual scale in which each variable is measured. From the values of R^2 the author concludes that the three variables together show a very high degree of explanatory power. (Results presented in Table 3.7) The ranking of variables showing the relative contributions of each varies from one industry group to another and from measure to measure. But for the industrial sector as a whole the rankings turn out to be uniform for different measures of ACORs. Capital intensity getting first rank followed by labour productivity and profitability getting third rank.

By regressing ACORs of all industries in a particular year on the three variables for the corresponding industries, Dholakia tries to estimate the major contributors to inter-industry variation in ACORs in a cross sectional analysis. The results (presented in Table 3.7) indicate that the degree of capital intensity is most important variable accounting for inter-industry variation especially during sixties regardless of the measure of ACOR used. The degree of profitability comes next while labour productivity is insignificant.

For studying the cause of the trend seen for the sectoral estimate as a whole the analysis is similar to the one done for the Indian economy as a whole.* Since the method of estimating the sectoral value of ACOR is similar to obtaining the value for the economy as a whole i.e. as a

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* Discussed in Section I of this chapter.

weighted average of the ACORs of the units. He concludes that the changing industry specific ACOR is the main cause for the trend in ACOR for the industrial sector as a whole. Though Dholakia's is an elaborate study of COR with a number of series of the ratio being obtained. No concrete observation regarding the usefulness of various series or the superiority of any one over the others is made.

(v) M.R. Saluja's (1980) is another important study on capital-output ratios. He not only obtains the ratio for Manufacturing sector but also for Agriculture and Railways. This study reports the capital-output ratios componentwise, which was not done either by Hashim and Dadi or by Dholakia. Further for the manufacturing sector he tries to obtain the capital-capacity-output ratios as well.

For the manufacturing sector Saluja obtains the ICOR estimates in two ways. One by the simple method of estimating the additional capital employed during a single period and relating it to the output at end of period less the output at beginning of period. He provides estimates at constant (1960-61) prices at three digit level of ASI classification. He assumes an average lag of two years. Since this exercise is done for a single time period, not much can be said about the behaviour of ICORs.

He uses regression technique as the second method to estimate ICORs for the industrial sector. The specification is: Let x_1, x_2 ..., x_n be the capital stock of certain type at end

of different years at constant price of base year 1960. Let $y_1, y_2 \ldots y_n$ be the corresponding values of output. Then for $y = a + bx$, b will provide the rate of increase in output per unit increase in capital, which is nothing but inverse of ICOR.

The time period of the study is 1959 to 1968. The componentwise ratios are obtained only for fixed capital the components being (1) building, (2) plant and machinery, and (3) tools and other equipments. Since the data source is ASI and value of assets reported is the depreciated book value, they are converted to gross values at 1960 prices. A two step method for this is outlined. (a) To convert the book value Z_1 to value X_1 at base year price for the first year 1959. (b) After which $X_2, X_3 \ldots X_n$ to be calculated by successively adding the investments made during year 2, 3 ... n after the adjusting for price changes.

Second step is tackled first. The gross investments for each successive year is estimated as $I'_{it} = Z_{it} + d_{it} - Z_{it-1}$ where Z_{it} is the book value of i^{th} asset in t^{th} year, d_{it} is rate of depreciation on i^{th} asset in t^{th} year and I'_{it} is gross investment at current prices on i^{th} asset in t^{th} year. The price deflator is obtained from Uma Dutta Roy Choudhary (1977). The componentwise depreciation was made available to the author for year 1968 from the Computer Center, Planning Commission. From which he obtained the rates for remaining years as

$$d_{it} = d_t \frac{d'_{it}}{\Sigma d_{it}'}$$

where $d'_{it} = \frac{d_{i.68}}{Z_{i.68}} \cdot Z_{it}$

Making the assumption that the proportion of depreciation rate of assets to its net value remains the same for all years.

The problem of converting Z_1 to X_1 is solved by the regression method itself. If the difference between the first years book value Z_1 and the value at a particular years price X_1 is C then $X_1 = Z_1 + C = u_1 + C$ (say) then $X_2 = X_1 + I_2 = Z_1 + I_2 + C = u_2 + C$ and $X_3 = X_2 + I_3 = u_2 + I_3 + C = u_3 + C$ ... $X_n = u_n + C$.

Since Z_1, I_2, I_3 ... I_n are known, u_2, u_3 ... u_n can be calculated. As Z_1 is known $X_1 - C$, $X_2 - C$ ... X_n C can be calculated. When regressions are fitted between u and y they are same as regression between x and y. Thus finding the actual value of x_1 is not required. To check against the possibility of autocorrelation the 'search procedure'* as suggested by Hildreth and Lu was applied by the author.

For capital-capacity valuation ratio of capacity and actual output is estimated from figures published in the 'Monthly statistics of the Production of Selected Industries

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* The method consists of (i) calculating $y^*_t = y_t - Py_{t-1}$ and $x^*_t = x_t - Px_{t-1}$ for different values of P interval of 0.1 in the range $-1 < P < 1$ (ii) estimating the regression of y^*_t and x^*_t and calculating residual sum of square (RSS) in each case (iii) choosing that value of P for which RSS is minimum (iv) again repeating this procedure for smaller values of P around this value.

in India'. The ratios are applied to ASI output figures to get corresponding capacity ratios for different industries. (Presented in Table 3.8.)

For the agricultural sector Saluja obtains componentwise ACORs for years 1960-61, 1965-66 and 1970-71 all at 1960-61 prices. In this Saluja has done more of a compilation job. Estimates of capital stock in agriculture were available at current prices for years 1960-61 and 1965-66 under the heads (a) agricultural implements, (b) livestock on farm, (c) land improvements and irrigation works, (d) fisheries, (e) plantation, and (f) rural non-residential construction (sheds, barns, etc.). These were published by the Reserve Bank of India. Saluja deflated the 1965-66 estimates to 1960-61 prices with help of price indices given by Narain and Khera. For year 1970-71 Uma Dutta's estimates do not provide a componentwise break-up of capital stock in Agriculture. Thus the estimate is allocated among different components on the basis of 1965-66 proportions. Further break-up within components is given where break-up is possible. [Results presented in Table 3.9(a).]

The study does not provide information on the type of value added estimates used to obtain the ACORs. Also assuming that the proportion of components to be same in 1970-71 as in 1965-66 is unrealistic. Still the study provides a more detailed information of the investment pattern in agriculture which is much needed. As the agri-

cultural sector being unorganized gathering information regarding capital investments is a difficult task.

Another unique feature of Saluja's study is the estimation of componentwise ratios in railways. As both the output estimation and capital employed are estimated differently. The output (earnings) were obtained at 1960-61 prices by multiplying goods tonne kilometres and passenger kilometres with the respective rates for year 1960-61.

The different components of capital in railways are first rolling stock and second works, consisting of mainly construction work. In case of rolling stock the coefficients have been worked out separately for locomotives, wagons and passenger coaches. For this gross investment during the year is obtained by adding the value of different kinds of locomotives placed on line during the year, or new wagaons or new passenger coaches placed on line during the year. The dates and numbers are obtained from Annual Report on Railway Board and the 1960-61 prices worked out from the Budget Papers of the Ministry. This stock is net of replacement. For the second component, that is works, consisting mainly of construction work, the expenditure method is applied. The expenditure figures obtained from Budget Papers of the Ministry.

The ratios are obtained for two time periods namely 1951-52 to 1961-62 and 1962-63 to 1971-72 by method similar to that used for the manufacturing sector. [Results presented in Table 3.9(b).]

Saluja's results are presented without giving any interpretation. Even when the value of the coefficient turns out to be negative, which is meaningless in case of regression approach, no explanation is given.

(vi) Venkatramaiah, P., Argade, L., and Kulkarni, A.R. (in a project presently continuing) have obtained ICOR by the regression method for the time period 1973-74 to 1982-83 for the manufacturing sector consisting of twenty-seven sub-sectors. The study obtains both capital-output and capital-value added ratios. Both arrived at using no lag. The capital-output ratios are divided into components, namely, (1) Building and Construction, (2) Plant and Machinery, (3) Transport Equipment, and (4) Other Fixed Assets. The break-up is based on the usage for year 1978-79.

For obtaining gross fixed capital the following method is used:

$$GFC_t = GFC_{t-1} \frac{P_t}{P_{t-1}} + A_t + D_t$$

where GFC is Gross fixed capital, P_t is price level in t^{th} year, A_t is addition to net value of capital stock and D_t is depreciation in t^{th} year. For the first year of the time span i.e. 1973-74 the gress fixed capital is obtained as book value plus depreciation in 1973-74. As Saluja also pointed out the regression coefficient is unaffected by this.

The ratios are obtained at both current and constant prices. Constant price ratios are obtained using first 1973-74 as constant base and then 1982-83 as constant base.

The gross fixed capital is converted to base year price simply as $GFC_t \times P_c/P_t$, where P_c is base year price level. For converting output three criteria are used namely, (a) the implicit deflators of value added obtained directly from NAS, (b) the gross output deflators, and (c) double deflation approach of which the output deflator approach is found useful at sectoral ICOR level. The capital coefficient values for the two different base periods turn out to be different. This indicates the relative price movements of capital and output within the sector. (Results presented in Table 3.12.)

Venkatramaiah et al. also encountered negative values of regression coefficient. According to them these could be due to structural changes in the economy or other abnormalities in certain years. To study these structural changes a dummy variable was used for certain years, which appeared abnormal on cursory observation of data. The first dummy D_1 for year 1974-75, D_2 for 1976-77 and D_3 for year 1980. So that the regression equation took the specification -

$$Y_t = \alpha + \beta_1(D) + \beta_2 X_t + \beta_3 X_t(D),$$

where D = 1 for years 1974-75, 1976-77 and 1979-80 and 0 for rest of the years. Y_t is cumulative investment upto 't', α is regression constant, β_1 is a parameter of shift in equation, β_2 is initial ICOR and β_3 is additional ICOR. The sign of β_3 an indicator of increasing or decreasing trend in the ICOR.

Significant negative values are observed only for D_3

for total manufacturing sector as well as for majority of sub-sectors. In one sector 'Wood and Wood Products' where negative ICOR was observed, after introduction of D_3 the sectors showed positive ICOR. Thus the introduction of dummy gives the indication of the direction of structural change taking place in the sector.

(vii) Chitale (1986) examines the trends in the capital-output ratio for the industrial sector for the period 1971-72 to 1980-81. In contrast to earlier estimates Chitale uses the simplest possible technique to estimate the value of ACOR. He simply relates (a) Net fixed capital to net value added and (b) invested capital (Fixed capital plus physical capital) to Net value added. No adjustment either for prices or for replacement value is made. Data as obtained from ASI is directly used. But the importance of the study lies in the analysis done by Chitale on the behaviour of capital-output ratios for the period under study.

Firstly he points out that during the period under study capital invested in fixed assets increased by 40 per cent but nearly three-fourths was accounted for by only three industries, namely, electricity, chemicals and chemical products, and basic metals and alloys. Hence the relative effectiveness with which capital resources are utilized in these industries would strongly influence the industries capital-output ratio. This heavy concentration of capital is further emphasized when the largest enterprises, each

having above Rs. 20 lakhs worth of machinery and plant are just 6.6 per cent in number but account for 93.2 per cent of fixed assets. According to the author this has happened due to institutional factors like easy access of big business houses to money and capital markets, autonomous flow of funds from government to public sector enterprises and substantial fiscal incentives to capital intensive industries.

Secondly he points out that behavioural patterns of capital-output ratios in different industries are the resultant of relative growth rates in capital invested and net value added in each of these industries. In the first half of the decade under study there was an erosion of capital in real terms. The phase of slow down in capital formation according to Chitale was provoked by energy crisis and higher inflation. Only fertilizers, tyre and tubes and aluminium pushed up investment. Later part of seventies witnessed revival of investment with easing of pressure on the economy.

Thirdly Chitale contends that not all industries are active on investment front due to under-utilization of capacity. He makes a study of COR of only those industries which are at the forefront of investment by taking samples from ICICI, IDBI and BPE. Here industrywise analysis discloses relatively high ratios in fertilizers, cement, sugar, pulp and paper and non-ferrous metals. But relatively modest in chemicals/petrochemicals and low in tyres/tubes machinery

manufacturing, etc. For the first time inventory ratios show that stocks have locked up higher proportion of total capital especially in industries like cement, chemical, fertilizers and non-ferrous metals. However capital has been released from liquidation of excessive stocks in sugar, machinery manufacture.

Lastly the overall tendency for capital-output ratios has been to rise during the decade. Some of the reasons as listed by Chitale are (1) Major public sector projects get delayed in implementation causing higher capital-output ratios, (2) Cost of servicing capital, on account of higher capital intensive is more, leading to an increase in capital-output ratio, (3) Government's policy of sustenance of sick industries, (4) sharp escalations and over-runs in project costs like power plants, irrigation, etc., (5) Infrastructure bottlenecks and lastly, (6) Overall industrial environment being marred by slow down in total factor productivity.

III

3.3 Capital Coefficient Matrix

A capital coefficient matrix, applicable to Leontief's specification of dynamic input-output model provides in a highly disaggregated, yet systematic form information on the capital requirements of the economy. It is very useful in planning. As P.N. Mathur *et al.* point out: "The input-output table will give the commodity balances for a year but whether the structure of production of different commodities is

appropriate for the type of planned growth envisaged can only be ascertained with the help of inter-industry capital matrix" (P.N. Mathur et al., 1967, p. 342). But creation of such a matrix requires data at a highly disaggregative level. Due to lack of appropriate data very few attempts have been made to create a capital coefficient matrix for the Indian Economy. Even in these few, most efforts have been restricted to the industrial sector alone, as data is relatively easily available for this sector.

(i) P.N. Mathur, A.R. Kulkarni, S.N. Baldota and P.D. Parkhi (1967) created a capital coefficient matrix for the year 1960, to be utilized in conjunction with 29x29 input-output table constructed by Economic Division of Planning Commission. Though the input-output table is for year 1951 the capital coefficient matrix was created for year 1960 as ASI publication started in that year. (Presented in Table 3.10.)

Some adjustments had to be made to bring about compatibility in the capital coefficient matrix and the input-output table. Firstly the construction column had been shifted in that table to the capital formation column of final demand. Secondly two industries 'Electric Equipment' and "Non-electrical Equipment' were aggregated into one industry, 'Machinery and Manufacture' as the data source for capital coefficient matrix does not have this disaggregation. Finally Trade, insurance, etc., had been omitted from the capital table mainly due to non-availability of data. The omission

is justified on the ground that physical capital used under this category is small. Hence ultimately the matrix consists of 28 sectors.

Since the data is obtained from the ASI, the capital within each industry had been classified under the sub-heads: (1) Building and Improvements, (2) Transport Equipment, (3) Machinery and other assets, (4) Stocks of Materials and Stores, (5) Stock of semi-finished goods, and (6) Stock of finished goods. After reducing the physical capital under the above six heads to per unit level by dividing them by the gross output of the industry, the stocks have been distributed in proportion to input coefficients of the corresponding industries. The underlying assumption is that the industry stocks all materials to suffice for the same period. Stocks of finished goods have been apportioned diagonally. No attempt made to bring the net depreciated book value as reported in ASI to the replacement value: coal, other mineral industry and construction industry are not covered in ASI hence have been obtained from RBI Bulletin. Railway figures have been improvised from data available in Perspective Planning Division paper on 'Nature of Perspective Planning'. For agriculture, forestry, animal husbandry and fisheries, a capital matrix was prepared from report of Working Group for Agricultural Planning and then aggregated together according to their output in 1960.

The authors themselves were aware of the limitations

of the estimates due to data limitations and hence they conclude: "The limitations and tentative character of this inter-industry capital table are obvious from the above description. While using it, these should be kept in view. However, it must be emphasized that its use even in the present imperfect form may give more reliable guidelines for sectoral allocations of planned investment compared to those based on just hunches of laborious trial and error methods" (Mathur et al., 1967, p. 346).

(ii) R.K. Koti obtains a capital coefficient matrix for the industrial sector based on company data for the year 1960. After which again for year 1963 he obtains a capital coefficient matrix for large scale manufacturing. It is the latter which is reviewed here. The method of obtaining capital stock estimates for year 1963 is exactly the same as that of Hashim and Dadi. In fact it is the latter who use Koti's study as guideline.

After obtaining the capital stock for the three categories of fixed assets Koti tried to obtain the further industrywise classification of plant, machinery and tool. Not sufficient data was available for the same. The Report of Planning Group for Machinery Industries, Planning Commission, classifies them according to ASI classification. But not all industries are covered by this. Hence at times the author had to use his discretion. To remove the cost of installation from the value of capital all gross values of fixed assets were reduced by 10 per cent in value.

Figures of output were estimated as $B_i = A_i V_i/(V_i-W_i)$ where V_i and W_i are value added and net work done for others in the i^{th} industry. Output A_i is total value of sales minus the sales of products in the same condition as purchased, by the i^{th} industry and B_i is the output of i^{th} industry relevant for Koti's estimates.

The gross value of fixed capital estimates distributed among different industries are divided by the respective B_is to arrive at the fixed capital coefficients.

The value of inventory coefficients were derived by first obtaining values of stocks of raw materials, semi-finished and finished goods from ASI and distributing them according to their industry of origin. Using the same values of B_is the inventory coefficients were obtained with this the capital coefficient matrix for the manufacturing sector for the year 1963 was ready. (Presented in Table 3.10.)

The Working Committee (1985) while estimating ICORs for the Seventh Plan also present a capital coefficient matrix. But instead of making use of total output of the industry, it uses only value added figures, to obtain the capital coefficients, which makes it inappropriate for Leontief framework. Further the table presents only proportions of various components of capital used in various industries.

(iii) Hashim and Dadi (1972) making use of their estimates for registered manufacturing obtain a vector of

coefficients portraying the direct as well as indirect capital requirements of the industry. (Presented in Table 3.10.) For this they adjusted their industrywise capital stock estimates to total output rather than value added. In addition they included estimates of agricultural sector and obtained a vector of capital coefficient. By multiplying this vector to the input-output table created by Gokhale Institute for year 1963 they obtained the capital coefficients indicating both direct and indirect capital requirements. The comparison of this new vector with estimates of simple capital-output ratio show that the inter-sectoral variation diminishes with Leontief type estimates.

Table 3.1 : Uma Dutta Roy Choudhary's Estimates of ACOR and ICOR

1	ACOR (Current Prices)				ACOR (Constant 1960-61 Prices)				ICOR (Constant 1960-61 Prices)			
	2	3	4	5	6	7	8	9	10	11	12	13
Sector	1950	1961	1966	1971	1950	1961	1966	1971	1950-61	1961-71	1961-66	1966-71
Agriculture	1.16	1.13	1.18	1.15	1.27	1.13	1.37	1.28	0.71	2.01	-	0.66
Mining and Quarrying	1.57	1.35	2.31	1.91	1.35	1.35	2.20	2.03	0.69	3.27	4.69	0.68
Manufacture	1.54	2.99	3.50	3.81	1.80	2.99	3.28	3.67	3.21	5.00	4.32	5.86
(i) Registered	2.75	3.43	4.18	4.74	2.85	3.44	2.40	4.63	3.38	6.62	4.90	9.13
(ii) Unregistered	0.84	2.36	2.46	2.28	1.02	2.36	18.09	2.09	2.93	1.37	19.58	0.26
Electricity	14.12	16.83	20.72	16.97	16.10	16.83	12.69	16.37	16.46	16.13	14.49	13.31
Railways	8.33	12.19	13.58	14.15	9.16	12.19	6.96	11.89	11.09	11.35	8.65	8.04
Transport by Other Means	5.47	6.51	7.00	5.57	7.53	6.51	3.89	6.26	5.98	5.93	2.36	4.22
Communications	3.10	3.68	4.03	3.69	2.76	3.68	1.28	4.22	3.94	4.80	0.68	5.28
Trade, Hotels and Restaurants	1.36	1.42	1.20	1.11	1.64	1.42	1.26	1.18	-	0.68	2.02	0.67
Banking and Finance	1.13	1.08	1.01	1.15	1.04	1.08	29.62	1.32	1.10	1.59	54.58	1.44
House Property	15.42	26.62	27.62	38.03	18.53	26.62	4.80	33.89	17.86	77.14	-	133.56
Public Administration	1.46	4.77	5.99	5.15	1.43	4.77	0.27	4.31	8.08	3.95	-	3.29
Other Services	-	0.36	0.28	1.24	-	0.36	3.08	1.27	2.52	4.34	4.86	3.18
Total	2.08	2.60	2.38	2.90	2.35	2.60	2.34	3.10	2.13	3.57	5.96	2.60
Total Excluding House Property	1.46	1.93	2.33	2.23								

Source : Uma Dutta Roy Choudhary (1977).

Table 3.2 : Pratap Narain and Katyal's Estimates

Sector	1950	1951	1956	1961	1966	1969	1974	1977
				Capital Stock to Value Added (1970-71 Prices)				
Agriculture	0.73	0.75	0.77	0.84	1.04	1.04	1.22	1.17
Forestry and Logging	0.11	0.11	0.11	0.27	0.39	0.54	0.68	0.62
Fishing	0.43	0.42	0.64	1.03	0.99	0.94	1.15	1.73
Mining and Quarrying	1.33	1.21	1.39	1.25	1.72	2.08	2.69	3.70
Manufacture - Registered	3.41	3.45	3.44	3.79	3.83	3.82	3.70	4.16
Unregistered	1.72	1.72	1.43	1.34	1.46	1.81	2.73	2.99
Construction	1.51	1.76	1.39	1.36	1.16	1.11	1.32	0.98
Electricity, Gas, Water Supply	15.53	14.65	14.89	13.23	14.81	13.89	15.59	14.66
Railways	13.43	13.54	12.64	13.02	14.02	13.73	14.53	12.18
Transport by Other Means	7.25	7.14	6.23	5.19	5.31	4.95	4.86	4.50
Communications	3.23	3.33	3.37	3.31	3.40	3.78	3.99	4.05
Trade, Hotels and Restaurants	3.43	3.36	2.90	2.41	1.95	1.85	2.00	2.10
Banking and Insurance	1.76	1.75	1.29	0.95	0.90	0.83	0.82	0.57
Real Estate	19.75	19.74	18.25	16.88	19.51	16.98	16.74	16.19
Public Administration & Defence	4.87	5.08	5.60	6.50	6.11	5.84	5.62	5.50
Others	1.55	1.53	1.42	1.38	1.48	1.59	1.72	1.78
Total	2.52	2.55	2.40	2.47	2.81	2.81	3.10	3.02
				Fixed Capital to Value Added (1970-71 Prices)				
Agriculture	0.58	0.60	0.64	0.71	0.83	0.69	0.87	0.84
Forestry and Logging	0.11	0.11	0.18	0.27	0.39	0.54	0.68	0.62
Fishing	0.43	0.46	0.64	1.03	0.99	0.94	1.15	1.73
Mining and Quarrying	1.16	1.05	1.21	1.06	1.60	2.05	2.43	3.00
Manufacture - Registered	2.24	2.41	2.51	2.84	2.89	2.86	2.82	3.09
Unregistered	0.78	0.76	0.63	0.65	0.76	1.14	1.90	2.05
Construction	1.20	1.35	1.06	1.02	0.84	0.80	0.94	0.69
Electricity, Gas, Water Supply	15.04	14.13	14.27	12.34	13.37	12.72	14.43	13.60
Railways	13.35	13.42	12.60	12.90	13.69	13.39	14.09	11.88
Transport by Other Means	7.18	7.07	6.15	5.11	5.08	4.74	4.60	4.22
Communications	3.12	3.20	3.22	3.19	3.19	3.63	3.77	3.83
Trade, Hotels and Restaurants	1.17	1.09	0.88	0.67	0.57	0.52	0.64	0.60
Banking and Insurance	1.76	1.75	1.29	0.95	0.90	0.83	0.82	0.57
Real Estate	19.75	19.74	18.25	16.88	15.51	16.98	16.74	16.19
Public Administration & Defence	4.00	4.14	5.02	5.56	5.61	5.63	5.55	5.23
Others	1.55	1.53	1.42	1.38	1.48	1.59	1.72	1.78
Total	2.10	2.12	2.01	2.07	2.37	2.33	2.60	2.49

Source : Pratap Narain and Katyal, R.P. (1980).

Table 3.3 : Dholakia's Estimates of Capital-Output Ratios

Sectors	Mean Values of ACOR at 1970-71 Prices						Trends in ICOR at 1970-71 Prices					
	Without time lag			With two year lag			Without time lag			With two year lag		
	1948-49 to 1960-61	1961-62 to 1970-71	1971-72 to 1980-81	1950-51 to 1960-61	1961-62 to 1970-71	1971-72 to 1980-81	1950-51 to 1960-61	1960-61 to 1970-71	1970-71 to 1980-81	1950-51 to 1960-61	1960-61 to 1970-71	1970-71 to 1980-81
Agriculture	0.99	1.24	1.50	0.92	1.15	1.37	1.51	1.91	4.66	1.47	1.67	4.06
Mining	1.95	2.75	5.33	1.77	2.25	4.28	1.90	7.17	17.02	1.43	6.39	13.57
Registered Manufacture	3.74	5.23	6.08	3.20	4.50	5.43	6.85	7.13	7.81	5.25	7.08	6.65
Unregistered Manufacture	1.61	1.76	3.15	1.52	1.51	2.64	0.99	4.61	5.70	0.80	3.25	5.29
Construction	1.15	1.24	1.27	1.05	1.11	1.21	1.77	1.16	2.64	1.22	1.36	2.42
Electricity	15.82	18.17	19.89	12.69	14.37	16.88	17.92	20.23	23.17	15.03	16.83	19.54
Railways	15.95	15.36	14.36	14.45	14.06	13.77	14.95	16.16	10.02	13.14	16.92	9.27
Other Transport	7.12	5.86	5.35	6.62	5.28	4.83	3.71	5.53	3.69	2.82	4.93	3.60
Communications	3.63	3.69	4.45	3.27	3.15	3.86	3.31	5.02	4.85	3.33	4.42	4.06
Trade	1.36	1.10	1.44	1.24	1.04	1.21	1.17	0.68	2.78	1.30	0.59	2.58
Banking	0.81	0.61	0.53	0.73	0.55	0.48	0.38	0.49	0.43	0.32	0.46	0.36
House Property	45.17	31.06	26.25	43.53	29.94	25.25	12.92	11.76	16.67	14.33	9.46	17.81
Public Administration	4.17	5.80	5.20	3.53	5.00	4.69	10.14	5.33	3.29	8.14	5.30	2.99
Other Services	0.98	1.50	1.85	0.90	1.33	1.73	1.68	6.02	2.29	1.39	5.88	2.12
Total	2.79	3.12	3.55	2.60	2.85	3.23	3.04	4.02	5.28	2.69	3.67	4.76

Source : Dholakia, B.H. (1983).

Table 3.4(a) : Variability of ACOR Across Sectors Using Net Capital Output Ratio at 1970-71 Prices

Year	Mean	Standard Deviation	Coefficient of Variation	Range of Variability	
				Lowest Value	Highest Value
1948-49	7.481	12.925	1.728	0.87	40.53
1950-51	7.614	13.184	1.732	0.92	50.20
1955-56	7.292	11.660	1.600	0.70	43.92
1960-61	7.103	10.674	1.486	0.66	39.71
1965-66	6.735	8.668	1.287	0.60	30.31
1970-71	6.824	8.160	1.196	0.57	27.82
1975-76	6.850	7.733	1.129	0.58	26.92
1980-81	7.038	7.627	1.084	0.50	24.89

Source : Dholakia, B.H. (1983).

Table 3.4(b) : Variability of ACOR Over Time in Broad Sectors of Indian Economy

Source of Variation	Primary Sector			Secondary Sector			Tertiary Sector			All Sectors		
	1948-49 to 1964-65	1964-65 to 1980-81	1948-49 to 1980-81	1948-49 to 1964-65	1964-65 to 1980-81	1948-49 to 1980-81	1948-49 to 1964-65	1964-65 to 1980-81	1948-49 to 1980-81	1948-49 to 1964-65	1964-65 to 1980-81	1948-49 to 1980-81
Two year lag	0.07	0.10	0.17	0.52	0.19	0.71	0.11	-0.89	0.02	0.20	0.08	0.28
Changing weights	0.01	0.01	0.02	0.49	0.52	1.01	-0.16	-0.15	-0.31	0.32	0.42	0.74
Changing sectoral ratio	0.19	0.57	0.76	0.58	1.50	2.08	1.64	-0.58	-2.22	-0.29	0.41	0.12
Interaction effect	-0.01	0.01	0.00	-0.23	0.06	-0.17	-0.13	-0.01	-0.14	0.01	-0.03	-0.02
Overall variation	0.26	0.69	0.95	1.36	2.27	3.63	-1.82	-0.83	-2.65	0.24	0.88	1.12

Source : Dholakia, B.H. (1983).

Table 3.5 : Estimates of ICOR by Regression Approach and Their Comparison with Conventional Approach

Sectors	Sixth Plan				Seventh Plan						Chitale Conventional		
					Public Sector		Private Sector		Combined				
	Lag	t-Stat.	Regression Coefficient	ICOR used in Plan	1960-70	1971-81	1960-70	1971-81	1960-70	1971-81	1950-51 to 1960-61	1960-61 to 1970-71	1970-71 to 1980-81
Agriculture	1	1.72	0.21	3.61	20.57	15.71	1.35	2.02	1.88	2.88	1.00	2.00	5.00
Forest and Logging	4	2.25	0.29	0.96									
Fishing	2	5.14	0.66	8.83							-	-	-
Mining and Quarrying	4	1.70	3.49	4.82	6.84	16.68	-	-	6.84	16.68	1.36	5.18	16.33
Manufacture	3	3.14	3.35	4.29	11.31	18.28	6.29	6.36	7.47	8.33	5.72	5.20	9.24
Construction	3	1.41	0.12	0.20	3.03	0.99	1.66	0.85	1.78	2.00	1.27	0.83	2.61
Electricity, Gas and Water	6	8.83	14.50	25.00	17.25	25.51	9.45	3.71	17.00	22.46	19.76	20.00	21.74
Railways	3	0.56	1.02	6.16	18.97	8.71	-	-	18.97	8.71	16.53	29.06	10.42
Other Transport	2	5.73	6.47	8.27	7.19	7.92	6.89	4.01	7.26	5.19	-	-	-
Communications	3	8.66	4.45	6.41	5.13	5.64	-	-	5.13	5.64	3.85	4.78	4.31
Trade, Hotels and Restaurants	2	3.63	2.14	1.20	-	-	1.31	3.34	1.31	3.34	1.08	0.97	3.77
Banking and Insurance	2	3.49	0.14	0.05	0.36	0.46	(-)0.05	0.62	0.82	0.56	-	-	-
Real Estate	2	3.21	12.31	5.46	-	-	-	-	-	-	-	-	-
Public Administration and Defence	1	4.68	2.76	1.30	5.58	3.33	-	-	5.58	3.33	-	-	-
Other Services					0.96	1.31	28.08	5.85	14.65	12.78	-	-	-
All Sectors					8.32	7.00	4.06	4.75	5.32	5.85	2.79	4.45	6.22

Source : 1) Gupta, S., et al. (1981).
2) Working Committee Report
3) Chitale, V.P. (1986).

Table 3.6 : Estimates of ACOR for Registered Manufacture

Industry Group with Code	Hashim and Dadi's estimates for Registered Manufacture					Dholakia's estimates for Registered Manufacture					
	Value of Net Capital-Output Ratio at Current Prices					Mean Value of Net Capital-Output Ratio at 1970-71 Prices					
						Without lag			With lag		
	1960	1961	1962	1963	1964	1959-60 to 1964-65	1965-66 to 1970-71	1971-72 to 1977-78	1961-62 to 1964-65	1965-66 to 1970-71	1971-72 to 1977-78
20 Food Products	4.70	5.08	5.07	5.09	4.92	5.35	5.73	6.07	5.02	5.03	5.68
21 Beverages	3.89	3.52	3.89	3.70	2.80	2.33	2.42	3.40	2.19	2.06	3.12
22 Tobacco Products	1.83	1.84	1.93	1.66	1.87	1.57	1.35	1.72	1.47	1.26	1.64
23 Textiles	3.17	3.18	3.20	3.32	3.29	2.81	3.45	3.28	2.59	3.29	3.06
24 Footwear and Wearing Apparel	2.77	2.47	2.83	2.31	2.19	1.24	1.79	2.71	1.45	1.77	3.24
25 Wood and Cork Products	3.17	2.91	3.26	3.26	3.60	3.53	3.19	2.65	3.15	2.82	2.47
26 Furnitures and Fixtures	2.08	2.53	2.42	2.57	2.40	1.93	2.33	2.53	1.60	2.24	2.53
27 Paper and Paper Products	5.96	5.96	6.15	5.74	6.08	4.93	6.52	4.68	4.11	5.92	4.24
28 Printing and Publishing	2.51	2.45	2.68	2.56	2.56	2.42	2.29	2.78	2.07	2.09	2.59
29 Leather and Fur Products	3.75	3.73	3.92	3.59	4.03	2.28	2.77	4.82	2.04	2.93	4.35
30 Rubber Products	1.45	1.50	1.94	1.93	2.52	1.83	1.99	2.96	1.41	1.72	2.53
31 Chemicals	4.56	4.62	4.43	4.52	4.54	3.22	4.91	4.60	2.57	3.70	4.11
32 Products of Petrol and Coal	3.91	3.72	5.22	4.89	6.73	10.53	13.00	7.20	8.88	10.09	6.74
33 Non-Metallic Mineral Products	4.79	4.91	4.56	4.65	4.91	4.47	4.92	4.59	3.79	4.18	4.28
34 Iron and Steel Basic Metal	11.59	10.71	11.03	9.85	8.74	9.38	12.76	10.10	6.66	11.69	9.27
35 Metal Products	2.92	2.99	3.04	2.72	2.92	1.92	2.78	2.94	1.57	2.47	2.84
36 Non-electric Machine	2.82	2.81	3.47	3.12	3.26	3.21	4.41	4.14	2.08	3.32	3.62
37 Electric Machine	2.86	2.89	3.00	3.37	3.56	3.24	4.58	3.52	2.29	3.43	3.12
38 Transport Equipment	2.93	3.31	2.88	3.09	3.17	2.59	3.17	3.45	2.04	3.03	3.37
39 Miscellaneous	2.76	2.95	2.87	2.72	2.70	2.25	3.06	3.63	1.82	2.43	3.73
All Industries	4.35	4.33	4.62	4.54	4.50	3.57	4.67	4.43	2.95	4.07	4.03

Source : 1) Hashim, S.R., and Dadi, M.M. (1973).
2) Dholakia, B.H. (1983).

Table 3.7(a) : Temporal Variation in Net COR (1970-71 Prices) With Lag

Industry Code	Constant	Regression Estimate			R^2
		X_1	X_2	X_3	($\bar{R}^2$)
20	4.799	33.839*	-157.886*	-0.868	0.989*
		(28.657)	(20.500)	(0.989)	(0.987)
21	1.898	6.402*	-6.696	-1.287	0.815*
		(5.461)	(2.040)	(0.641)	(0.772)
22	1.232	38.159*	-56.310*	0.739	0.893*
		(6.571)	(6.689)	(1.581)	(0.868)
23	2.830	24.175*	-65.957*	-0.760	0.987*
		(31.214)	(13.534)	(2.016)	(0.985)
24	0.785	20.308	20.104	-6.560*	0.619*
		(1.429)	(1.936)	(3.243)	(0.531)
25	2.882	36.869*	-109.891*	0.840*	0.816*
		(17.103)	(22.575)	(3.243)	(0.970)
26	2.422	15.722*	-36.706*	-0.192	0.993*
		(36.865)	(37.079)	(1.748)	(0.992)
27	4.267	14.584*	-62.675*	1.068	0.988
		(30.138)	(9.281)	(0.893)	(0.986)
28	2.353	26.788*	-60.914*	-0.351*	0.997*
		(56.957)	(41.666)	(3.275)	(0.997)
29	4.175	15.797	-44.505	-5.099	0.920*
		(2.708)	(7.463)	(1.862)	(0.902)
30	1.793	12.673*	-23.416*	0.312	0.996*
		(38.022)	(25.075)	(1.948)	(0.995)

(continued)

Table 3.7(a) :(Continued)

Industry Code	Constant	Regression Estimate			R^2
		X_1	X_2	X_3	($\bar{R}^2$)
31	3.825	9.007*	-31.607*	-2.210	0.981*
		(20.635)	(9.727)	(2.102)	(0.977)
32	7.849	3.003*	-13.406*	-10.113*	0.906
		(4.532)	(4.713)	(2.75)	(0.884)
33	3.786	26.019*	-96.047	-0.449	0.983*
		(22.482)	(14.232)	(1.213)	(0.979)
34	8.732	22.943*	-191.265*	4.210	0.913*
		(8.521)	(3.947)	(0.290)	(0.893)
35	2.237	15.567*	-33.998*	0.029	0.986*
		(13.184)	(7.562)	(0.069)	(0.983)
36	2.988	17.247*	-48.573*	-2.766*	0.988*
		(22.325)	(11.147)	(3.835)	(0.985)
37	2.774	13.247*	-35.075*	-1.444*	0.992*
		(24.699)	(13.359)	(3.605)	(0.990)
38	3.126	15.496*	-46.375*	-0.663	0.980*
		(12.174)	(8.998)	(0.866)	(0.975)
39	2.579	19.524*	-49.316*	-0.593	0.997*
		(59.054)	(16.059)	(1.888)	(0.996)
All Industries	3.662	10.274	-36.971	-0.851	0.998*
		(53.153)	(21.281)	(2.281)	(0.997)

* Statistically significant at 5% level of significance.

Source : Dholakia, B.H. (1983)

Table 3.7(b) : Cross Sectional Inter-Industry Variation for Each Year Net COR, 1970-71 Prices

Years	X_1	X_2	X_3
1959-60	63.5*	11.1	22.8*
1960-61	72.5*	14.7	14.1
1961-62	53.2*	1.7	18.7
1962-63	41.1*	0.03	39.8*
1963-64	61.2*	4.3	30.0*
1964-65	60.1*	8.7	33.7*
1965-66	79.1*	1.1	27.9*
1966-67	69.5*	5.6	27.5*
1967-68	56.8*	8.6	35.6*
1968-69	47.4*	5.5	29.2*
1969-70	50.9*	9.0	23.2*
1970-71	68.1*	16.4	27.6*
1971-72	24.4*	1.0	21.8*
1972-73	42.7*	15.7	36.7*
1973-74	47.2*	21.6*	38.3*
1974-75	25.5*	0.05	27.4*
1975-76	38.4*	24.1*	7.7
1976-77	21.2*	10.0	42.7*
1977-78	16.0	6.5	62.6*

* Statistically significant at 5% level of significance.

Source : Dholakia, B.H. (1983).

Table 3.8 : Saluja's Estimates of Capital Value Added and Capital-Capacity Ratios

Industry	Componentwise Net Fixed Capital to Value of Output Ratios				Componentwise Net Fixed Capital to Value of Output at Capacity Ratio			
	Buildings	Plant and Machinery	Tools and Equipments	Total	Buildings	Plant and Machinery	Tools and Equipments	Total
Flour Milling	-0.0857	-0.0492	-0.0923	-0.2132	-0.0857	-0.0452	-0.0923	-0.2232
Sugar	0.1292	0.3282	0.0618	0.5192	0.1448	0.3705	0.0565	0.4718
Vanaspati	0.0260	0.0726	0.0206	0.1192	0.0360	0.1611	0.0239	0.2210
Cigarettes	0.0261	0.0762	0.0063	0.1086	0.0602	0.1610	0.0155	0.2367
Paper and Paper Product	2.0521	3.7951	0.1638	6.0110	1.5691	3.5199	0.1604	5.2494
Fertilizers	0.3514	1.4282	0.1484	1.9280	0.3066	1.0808	0.1109	1.4983
Heavy Chemicals	0.2298	0.9852	0.3132	1.5282	0.1826	0.7827	0.2883	1.2536
Synthetics	0.2435	1.1152	0.0370	1.3957	0.9954	4.9925	0.1638	6.1517
Manmade Fibre	0.2656	1.6287	0.0233	1.9176	0.2745	1.6513	0.0249	1.9507
Paints and Varnishes	0.1812	0.1143	0.6683	0.9638	0.0948	0.0654	0.2604	0.4206
Soaps and Glycerine	0.0391	0.1056	0.1041	0.2488	-0.8818	-0.2008	0.0134	-1.0692
Matches	0.1471	0.0844	0.0589	0.2904	0.0956	0.0607	0.0389	0.1952
Cement	0.5182	0.4953	0.0882	1.1017	0.4911	0.4603	0.0822	1.0336
Boilers, etc.	0.3756	0.6538	0.0759	1.1053	0.0564	0.8111	0.0949	0.9624
Textile Machinery	0.2520	0.7088	0.0894	1.0502	0.1072	0.2638	0.0429	0.4139
Power-driven Pumps	0.1207	0.2159	0.0520	0.3886	0.1638	0.2950	0.0700	0.5288
Ball bearings	0.1903	0.7610	0.0436	0.9949	0.2258	0.9385	0.0488	1.2631
Machine Tools	0.6211	0.8363	0.1071	1.5645	0.3945	0.5285	0.0698	0.9928
Earth-moving Equipment	0.1578	0.4756	0.1196	0.7530	0.1832	1.2167	0.0725	1.4724
Office Equipment	0.0776	0.2799	0.1370	0.4945	0.0472	0.2019	0.0965	0.3456
Refrigeration	0.2243	0.3283	0.0552	0.6078	0.1121	0.1461	0.0332	0.2914
Sewing Machines	0.0951	0.3622	0.1193	0.5766	0.0605	0.1492	0.0373	0.2470
Electricity Equipment	0.6188	0.7110	0.0698	1.3996	0.6125	0.7051	0.0690	1.3866
Electric Motors	0.1132	0.2854	0.0422	0.4408	0.1509	0.3813	0.0536	0.5858
Electric Fans	0.5774	0.0954	0.0349	0.7077	0.0431	0.0706	0.0218	0.1355
Electric Lamps	0.1891	0.7467	0.0371	0.9729	0.1944	0.7898	0.0390	1.0232
Cables and Wires	0.1361	0.3267	0.0278	0.4906	0.0623	0.1470	0.0150	0.2243
Storage Batteries	0.1132	0.2208	0.0453	0.3793	0.1027	0.2022	0.0422	0.3471
Dry Cells	0.0437	0.1330	0.0126	0.1893	0.0432	0.1398	0.0132	0.1962
Radio Receivers	0.1422	0.1008	-	0.2430	0.2634	0.1894	-	0.4528
Locomotives	0.3115	0.4008	0.4568	1.0691	0.2607	0.3388	0.3011	0.9006
Motor Vehicles	0.1610	0.5744	0.0624	0.7978	0.1665	0.5927	0.0646	0.8238
Motorcycles and Bicycles	0.0704	0.1439	0.0536	0.2679	0.0597	0.1250	0.0450	0.2297

Source : Saluja, M.R. (1980).

Table 3.9(a) : Average Componentwise Capital-Output Ratio for Agriculture

	1960-61	1965-66	1971-72
Agricultural implements	0.0604	0.1038	0.0888
Livestock	0.3175	0.3779	0.3234
Rural non-residential house property	0.1661	0.1728	0.1479
Land improvement and irrigation works	0.5037	0.7552	0.6462
Plantations	0.0367	0.0366	0.0313
Agriculture Total	1.0844	1.4463	1.2376
Fisheries	0.7820	1.0629	0.9993

Source : Saluja, M.R. (1980).

Table 3.9(b) : Componentwise Capital-Output Ratios for Railways

		1952-62		1962-72	
			s.e. of		s.e. of
Locomotives on line	Gross	0.8780	0.0296	0.9702	0.0682
	Net	0.6310	0.0256	0.3827	0.0450
Wagons + Coaches on line	Gross	2.5824	0.0860	2.6819	0.2534
	Net	1.7407	0.0632	1.3431	0.1843
Capital on works	Gross	5.2900	0.5078	4.9620	0.6230
	Net	4.1758	0.7358	3.3506	0.4395
Total	Gross	8.3015	0.6521	7.5848	0.7008
	Net	5.9850	0.5321	5.1646	0.5509

Source : Saluja, M.R. (1980).

Table 3.10 : Estimates of Capital Coefficients (Total for Each Sector)

Sector	Mathur et al.	Koti 1963	Hashim & Dadi's comparison for year 1963)		
			Capital coefficient	Leontief	Capital/ Value added
Food Industry	0.6567	0.8132	0.63	1.2	1.73
Tobacco Manufacture		0.3830	0.28	0.6	0.48
Beverages	-	0.9351	0.78	1.4	1.22
Textiles	0.8371	0.5459	0.64	1.0	0.86
Apparel	-	0.5355	0.42	1.1	0.91
Wood Products	1.2509	0.6015	0.55	1.0	0.96
Furniture	-	0.7841	1.51	2.3	2.13
Paper	1.6325	1.0398	1.32	1.9	2.00
Printing	-	0.8058	0.54	1.1	0.79
Leather Products	0.5187	0.7437	0.45	0.8	0.64
Rubber Products		0.5456	0.48	1.0	0.90
Chemicals	1.4529	0.7008	1.23	1.9	1.99
Petroleum Products	-	1.3519	0.37	1.0	0.51
Non-Metal Minerals	0.8836	1.3480	1.15	2.0	1.77
Iron and Steel	1.5641	1.6288	2.29	3.5	3.83
Metal Products	0.7847	0.6282	0.46	1.5	0.70
Non-Electrical Machine	0.8924	1.0780	0.80	1.7	1.32
Electrical Machine		0.9329	0.72	1.4	1.01
Transport Equipment	1.0217	1.0558	0.65	1.4	1.00
Miscellaneous Manufacture	0.8691	1.1880	0.53	1.0	0.70
Electricity	3.5994	2.4937	2.18	3.6	3.95
Coal	1.0360	0.0782	2.57	3.6	3.87
Iron Ore	0.8836	0.1639	0.16	1.3	0.24
Crude Oil	-	1.2863	1.29	1.2	1.29
Agriculture	0.9567	0.3735	0.37	0.5	0.44
Construction	1.0251	0.0000	0.54	2.3	1.99
Fertilizer	2.4180	2.5901	-	-	-
Cement	1.6122	1.4506	-	-	-
Non-Ferrous Metal	-	0.7506	-	-	-
Railway	3.6058	5.2101	3.32	3.9	4.41
Road Transport	1.9286	0.0160	1.38	2.2	4.73
Cotton	0.8851	-	-	-	-
Plantations	1.2140	-	-	-	-

Source : 1) Mathur et. al. (1967).
2) Koti, R.K. (1969).
3) Hashim, S.R. and Dadi, M.M. (1973).

Table 3.11 : ICORs in Various Plans

First Plan	3.2
Second Plan	4.1
Third Plan	5.4
Annual Plans	4.9
Fourth Plan	5.7
Fifth Plan	3.9
Sixth Plan	5.4
Seventh Plan	4.65
Eighth Plan Perspective	4.35

Source : 1) First to Sixth Plans: Plan Document on Sixth Plan.

2) Seventh and Eighth Plans: Adiseshia (1989).

Table 3.12 : Confidence Interval for the Estimates of Incremental Capital-Output Ratio (ICOR) (Regression Coefficients) for the Manufacturing Branch of the Indian Economy (1973-82)

Manufacturing Division	Regression Coefficient	Standard Error	Confidence Interval	
			Lower Limit	Upper Limit
(a) Capital-Output Ratio at 1982-83 Prices				
Division 2 : Agro-based Industries	0.9212	0.1033	0.6830	1.1594
Division 3 : Non-Agro-based Industries	1.1614	0.0531	1.0389	1.2838
Division 2+3 : Manufacturing	1.1000	0.0666	0.9464	1.2536
Division 4 : Electricity	5.5752	0.3899	4.6761	6.4743
Division 2+3+4	1.5686	0.0832	1.3767	1.7605
(b) Capital-Value Added Ratio at 1982-83 Prices				
Division 2 : Agro-based Industries	6.8893 (3.0603)	1.4620	3.5179	10.2607
Division 3 : Non-Agro-based Industries	7.5363 (5.7560)	0.7289	5.8555	9.2171
Division 2+3 : Manufacturing	7.6710 (5.9040)	0.8080	5.8078	9.5343
Division 4 : Electricity	13.5536 (11.2121)	1.8689	9.2439	17.8633
Division 2 + 3 + 4	9.4278 (7.3018)	0.8531	7.4606	11.3950
(c) Capital-Output Ratio at 1973-74 Prices				
Division 2 : Agro-based Industries	0.6369	0.0807	0.4508	0.8230
Division 3 : Non-Agro-based Industries	1.1843	0.0339	1.1061	1.2625
Division 2+3 : Manufacturing	0.9956	0.0589	0.8598	1.1314
Division 4 : Electricity	6.3941	0.4471	5.3631	7.4251
Division 2 + 3 + 4	1.4426	0.0763	1.2667	1.6185
(d) Capital-Value Added Ratio at 1973-74 Prices				
Division 2 : Agro-based Industries	4.5769	0.9257	2.4422	6.7116
Division 3 : Non-Agro-based Industries	7.1122	0.6747	5.5563	8.6681
Division 2+3 : Manufacturing	6.5083	0.7148	4.8600	8.1566
Division 4 : Electricity	13.5626	1.8701	9.2501	17.8751
Division 2 + 3 + 4	8.2990	0.7659	6.5328	10.0652

Source : Venkatramaiah et al., (ongoing project).

CHAPTER IV

CONCLUSIONS

Capital-output ratio indicates the capital requirement per unit of output produced. It is the major factor determining the feasible rate of growth for an economy. The two types of growth models in which it is used are the Harrod-Domar Model and the Leontief's Dynamic Input-Output Model. While in the former capital is treated as an aggregate homogeneous unit, in the latter it is treated assetwise, which is more realistic. Further while in Harrod-Domar framework only direct capital requirements are taken in consideration, in Leontief's model both direct and indirect capital requirements are taken into consideration, rendering capital coefficient of Leontief framework a more relevant concept. But given the conceptual problems in defining capital in both frameworks, the data problems are greater in case of Leontief framework, as data is required at a highly disaggregated level. The paucity of data thwarts the empirical feasibility. Hence majority of estimates available for the Indian economy are relevant to Harrod-Domar framework, and very few to Leontief framework.

Estimates of capital-output ratio are obtained in two ways. First by the simple method of dividing total capital stock to total value added to arrive at ACOR or change in

capital stock to change in value added to arrive at ICOR. Second by regressing capital stock on output, so that the regression coefficient provides the estimates to ICOR. While the first method estimates capital-output ratio at a point of time the second estimates it over a period of time. In the latter approach a single average value of ICOR is obtained for the entire period under consideration. To study any change in the value of ICOR the time period has to be divided into sub-periods and estimates obtained for these sub-periods have to be compared. ICORs obtained by the simple method for each year of the time period under consideration show large variations which smoothen out if averages are taken. A study comparing the ICOR values obtained by the two methods concluded that for the economy as a whole ICOR obtained by regression approach show much less fluctuations than the ICORs obtained by the simple method. But it does not hold at sectoral level.

The capital-output ratios by various methods can be obtained with or without taking time lag into consideration. Results show that in every instance capital-output ratios obtained with a time lag turn out to be lower and more stable than the ratios obtained without a time lag.

Majority of capital-output estimates available are for the economy as a whole. Where the economy is divided into certain sectors and each sector is treated as a homogeneous unit. The ratio for the economy as a whole is

derived as a weighted average of the sectoral ratios. From these economy level estimates two conclusions can be safely drawn. Firstly, the capital-output ratio for the Indian Economy as a whole is showing an increasing trend. The trend is not uniform for each sector in the economy. Also there are large inter-sectoral variations in the values of capital-output ratios, irrespective of the method used. But as most of the studies cover the period upto year 1981 the increasing trend can be confirmed only till that year, from the economy level estimates available. A later date study in fact concludes that economy level ICOR has shown a decline in the decade of eighties and the value of ICORs estimated for the five year plans conform with this conclusion.

Secondly, most studies show a consistency in results, at least as far as the direction of the change is concerned. This is likely because the data source for all studies is the same which automatically implies same coverage of capital goods.

The likely factors influencing the trends shown by the ratio, as outlined by various studies are under-utilization of capacity, relative supply of capital and labour, technological peculiarities, government policy, organizational structure, productivity of labour, etc. But very little is done to measure the exact influence of each factor on capital-output ratio. Non-availability of adequate time-series data is the likely reason for the absence of such studies.

Non-availability of adequate data is also the reason why when economy level estimates are considered too aggregative in nature, very few detailed sectoral estimates are available. The few that are available are restricted to industrial sector as data is relatively easier to obtain for this sector.

The overall ratio for the industrial sector alone as obtained by the simple method shows an increasing trend with some exceptions. Sometimes these exceptional years have inserted very strong influence, making the estimate obtained by regression method negative. In such instances care has to be taken to determine the strong factor influencing the capital-output ratio.

From the study of Hashim and Dadi (1974) a comparison of Harrod-Domar framework estimates and Leontief framework estimates indicate that when both direct and indirect capital coefficients are taken in consideration the inter-sectoral variability of estimates diminishes.

Finally, no one method of estimation can be regarded as the best possible method. Each have their advantages and disadvantages. The method to be used can be determined by the use to which the ratio has to be put. But the study would not be complete without a comment on the overall ratio for the Indian economy. Amongst the various estimates available, pragmatically the most relevant are the estimates used in the various five year plans. As they determine the

actual plan outlays. The ICOR for the economy as a whole has shown an increasing trend till the Fourth Plan, in which the value received a maximum of 5.7 after which there was a decline. The Sixth Plan estimate showed an increase which was attributed to the second oil shock. After which again it has shown a decline. Currently the ICOR, which was obtained for making projections for the Eighth Plan, is estimated to be approximately 4.35.

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