CHAPTER VIII

SUMMARY AND FINDINGS OF THE STUDY
(1) The study of process analysis of steel forgings industry with special reference to the problems of continuity and product multidimensionality for sector specification in the interindustry framework is oriented to a two fold problem.

(i) To study the economic features of steel forgings industry in India and the structural role of this jobbing type industry in the interindustry system, especially as a separate sector in the available input output table of Indian economy for 1963;

(ii) To resolve the problems of continuity and product multidimensionality of steel forgings with the help of data on engineering variables and of statistical methods, and to bring out discrete processes or product groups' dissimilar input structures, for analytical uses in the disaggregative commoditywise input output tables or in the linear programming models.

(2) The economic features of the industry are studied with reference to the structure, supply, demand pattern and development problems of the industry. The structure of firms according to plant capacity ranges is summarily presented by the modal type size of the plant capacities. The modal type size of the plant capacities rose from 334 tons in 1963-64, to 396 tons in 1964-65 and to 1531 tons by the end of December 1966. The production/capacity of the industry in private sector reached peak levels from 1960-61 to 1965-66, followed by a sudden trough during 1966-67 and a slight recovery during 1967-68. The demand pattern is dominated by
(i) railways, (ii) motor vehicles, (iii) earth moving equipment, (iv) diesel engines, and (v) all other non-electrical machinery. Imports are high and exports of steel forgings are negligible. The percentage of indigenous production to the total available supply, excluding those of captive and/or small scale units, for internal demand rose from 4.78% in 1960 to 36.84% in 1964.

(3) The development problems of this industry throw light on the necessity of requisite detailed data on the economic variables and on the nature of the products with respect to product dimensions of steel forgings. In this industry, price discriminations and other market imperfections are prevalent. As the nature of the industry demands complete specifications of the various product dimensions by every customer at each stage of any single order, it is necessary to have a rough knowledge of the distinct prices and dissimilar input structures of product groups with discrete ranges of the product dimensions for the interindustry analytical uses at the economy level as well as for financial planning at the firm level. The nature of the published statistics of the estimates of demand, capacity, production, imports and exports are too aggregative to be of any use either for the prospective entrepreneurs or for the analytical researchers. They demand a more detailed techno-economic data on the nature of the products with respect to product dimensions and to users of steel forgings in India. All other development problems also stress this lacuna.
(4) All these broad and general economic features of the industry are required to be studied in the light of a detailed investigation of the processes, products and materials of this industry. In the field investigation, it is observed that a wide range of products and materials are possible for production to meet the requirements of customers. The flexibility in the use of available equipments of the firms enables to meet the continuous change in the specifications of product-dimensions, which identify the numerous products. This is the problem of continuity for discrete sector specification in the inter industry framework. Secondly, the variations in the physical values of the multiple product-dimensions are likely to affect the input structures of the firms and of the industry. This is the problem of product multidimensionality for stable sector specification in the inter industry framework.

(5) To study these problems, initially, the firms in the industry are broadly classified as (i) Die forging firms, (ii) open forging firms and (iii) repairs and maintenance type forge units, which may be open or die forging units, but most of them are open forging units. This distinction of the firms is based on the nature of the products, processes and materials, which are likely to provide distinct product dimensions ranges.

(6) Next, the refined input and capital structures of the open and die forging firms are evaluated as technological parameters of the economic production functions of the units.
In this connection, a discussion is attempted on

(i) the different analytical approaches (traditional and modern) to explain the production theories of the units,

(ii) the nature, uses and limitations of Leontief input output analysis, as an instantaneous production function approach, to a firm or an industry,

(iii) conceptual and empirical problems in the evaluation of the input and capital structures of firms and processes in this industry in particular and in the preparation of input output tables of an economy in general,

(iv) Analysis of the input and capital structures of the firms. The adjustments carried out, for sub-contracting jobs, on the input structures of the firms and the role of sub-contracting jobs for sector specification, signify the importance of the industry studies in refining the structural coefficients of the economy.

(7) While the similarity of some inputs coefficients between firms and over years is partly due to the levels of aggregation and evaluation methods adopted, the discrepancies in the nature of inputs distinctly different from others are mainly due to the nature of products of the individual firms. This feature is very much observed regarding steel inputs, because hundreds of steel grade specifications are being used in the industry and some firms specialize in some products requiring particular sets of specifications of steel. Thus, the availability of materials and processes gets reflected in the nature of products of the firms. Because of the dis-
tinct nature of the products and their influence on the
input structures, sleepers are distinguished from wheel sets,
these two are distinguished from all remaining die forgings
and the latter are distinguished from open forgings. Within
each of the latter two, the problems of product multidimen-
sionality still persist. These are the analytical results
of the derived input and capital structures of the production
units in this industry.

(8) Given the input structures of the firms in steel forg-
ings industry and the aggregative nature of the available
input output tables in India, it is intended to examine the
direct and indirect repercussions of incorporating this
jobbing type steel forgings industry, as an approximate dis-
crete sector, distinguished from combined sectors, in the
available disaggregative input output table of Indian economy
at purchasers prices of 1963. Steel forgings as intermediate
products place mainly intermediate demand within the inter-
industry structure and the growth of this intermediate demand
rests with the growth of using industries' products and the
latter's unit output requirements of steel forgings. Thus,
(1) Railways, (ii) Motor vehicles, (iii) Diesel engines and
(iv) all other non-electrical machinery industries take the
major shares of the intermediate demand of steel forgings.
The raw input coefficients of 'Steel forgings' sector and
of 'Iron and steel castings and forgings' sector are dis-
similar in respect of their major users for the years 1963
and 1964. This stresses the need for distinguishing the
'Steel forgings' as a separate sector, when the users requirements and their growth rates are dissimilar from those and of a combined sector 'Iron and Steel castings/forgings'.

(9) The column vectors of (i) '66 - Steel forgings' sector in A (66 x 66), (ii) '45 - residual of Iron and steel exclusive of basic Iron and Steel and Steel forgings' sector in A (66 x 66), and (iii) '11 - Iron and Steel castings and forgings' sector in A (241 x 241) are constructed and presented for comparison of their input coefficients. The column vectors of the latter two combined sectors are dissimilar from those of steel forgings sector, in respect of major inputs like the (i) forging quality steel, (ii) fuel oils, coke oven gas and other fuels, (iii) electric light and power inputs of steel forgings sector. The need for separate 'Steel forgings' sector in the input output tables of Indian economy is thus stressed because of its distinct column and row vectors from those of combined sectors.

(10) Incorporating the '66 - Steel forgings' as a separate sector in the (66 x 66) sectors input output table of Indian economy at purchasers prices of 1963, the following results are obtained: The estimated captive and/or small scale units' production of steel forgings in India are significantly high (65.46% of the total intermediate demand of steel forgings) compared to large scale units production and/or to imports (exports are negligible) of steel forgings in India at 1963 producers prices. The estimate of captive and/or small scale units' production is of the order of Rs. 8,73,99,458.
which is not accounted for in any of the official and un-
official reports.

(11) The first stage indirect requirements of steel forgings,
given in 66th row of $A$ matrix, out of the total indirect
requirements, given in the 66th row of $\sum_A^2 + A^3 + \ldots$ are
of very high proportion (86.97%), mostly because they are
intermediate products with a very high intermediate demand.
The relative advantages of disaggregation of a combined
'15 - Iron and steel other than basic' into (i) '66 - Steel
forgings' and (ii) '15 - residual of iron and steel exclusive
of basic iron and steel and steel forgings' are also examined
in respect of their total direct and indirect requirements.

(12) The second problem posed in paras (1) and (4) of this
Chapter VIII, of product multidimensionality and of conti-
nuous change in product dimensions, especially in respect
of a jobbing type industry like steel forgings, is taken up,
here, to specify the discrete and distinct product groups in
the industry. Such a discrete product groups specification is
essential for many economic studies, especially in respect
of interindustry analysis, as the illimitable products violate
the discrete nature of a process. In the above study of the
first problem, described in paras 5 to 11 of this Chapter
VIII, the implicit assumption is that the technological
forging process, described as a sector in the input output
table, is an approximate discrete sector for the purpose of
analysis. This implicit assumption is not required, if the
product groups specified in the following study, have discrete
processes with dissimilar input structures. Incidentally,
they may serve as the activities of linear programming models and as sectors in the disaggregated commoditywise input output tables. Their relevance to the project cost estimates of the forge units are also examined.

(13) Specification of the distinct product groups in this industry is made with respect to the homogeneity of the two very important engineering variables or characteristics or product dimensions. To arrive at the discrete and distinct product groups, the principal components analysis and scatter diagrams are adopted in this study. Six product groups (I to VI) of die forgings and four product groups (I to IV) of open forgings are formed with distinct and discrete ranges and means of the product dimensions. Statistical tests of significance for the homogeneity of means and of variances of the product groups are carried out.

(14) Average prices of a set of 4 (A to D) aggregated product groups (I to VI) of die forgings and of a set of 3 (K, J, N) aggregated product groups (I to IV) of open forgings are derived by the method of linear transformations, $P = VT^{-1}$, where $P$ is price vector of product groups, $V$ is value of production vector of firms and $T$ is tonnage distribution matrix of firms over product groups. The prices of wheel sets and sleepers are given in 'Statistics for Iron and Steel' published by the Hindustan Steel Limited, Ranchi. Thus, the average prices per ton of the products during 1966-67, presented in the Table I, are distinctly different from each other. Similarly, average prices of (i) all small die forgings
and (ii) all big die forgings as one set and of (i) small die forgings of inferior and medium quality, (ii) small die forgings of superior and very superior quality and (iii) Big and very big die forgings of medium quality as another set are also distinct (Not presented here).

Table I. **Average prices of the product groups in steel forgings industry**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Product groups</th>
<th>Description</th>
<th>Average price in Rs, per M.Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Die forgings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>A (I and II)</td>
<td>Small die forgings of inferior and medium quality</td>
<td>3537.13</td>
</tr>
<tr>
<td>2</td>
<td>B (III)</td>
<td>Small die forgings of superior quality</td>
<td>5048.94</td>
</tr>
<tr>
<td>3</td>
<td>C (IV)</td>
<td>Small die forgings of very superior quality</td>
<td>9304.22</td>
</tr>
<tr>
<td>4</td>
<td>D (V and VI)</td>
<td>Big and very big die forgings of medium quality</td>
<td>20331.35</td>
</tr>
<tr>
<td>5</td>
<td>Wheel sets</td>
<td></td>
<td>1792.50</td>
</tr>
<tr>
<td>6</td>
<td>Sleepers</td>
<td></td>
<td>830.00</td>
</tr>
<tr>
<td></td>
<td><strong>Open forgings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>K (I and III)</td>
<td>Small and big open forgings of medium quality</td>
<td>5932.23</td>
</tr>
<tr>
<td>8</td>
<td>J (II)</td>
<td>Small open forgings of superior quality</td>
<td>6382.72</td>
</tr>
<tr>
<td>9</td>
<td>N (IV)</td>
<td>Very big open forgings of medium quality</td>
<td>1147.94</td>
</tr>
<tr>
<td></td>
<td>(Mostly repairs and maintenance type parts)</td>
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</tbody>
</table>

The distinct prices of the products/product groups throw light on the standardization and specialization of the pro-
ducts/product groups by the firms, when the demands of the users are also specific to particular products/product groups. Mostly because of this specialization and the demand of only Railways for wheel sets and sleepers, the cost structures of the products are distinctly low. Similar is the case with product group N. The qualitative and quantitative features of the steel forgings are represented in the distinct prices of the product groups specified in Table I.

To derive the dissimilar input structures of the product groups A, B, C, D, K, J and N (input structures of wheel sets and sleepers are given by the respective production units), the United Nation's (U.N.) general methods of linear transformations are adopted in the analysis. Two distinct assumptions and mixed assumptions of the two, specified below, are made and correspondingly linear transformations describing the technology matrices are derived by them. The assumptions are:

(i) commodity technology assumption is that each commodity will have its own input structure irrespective of the industry in which it is produced;

(ii) industry technology assumption is that every industry will have its own input structure irrespective of its product mix. These assumptions are correspondingly redefined as to (i) product group technology assumption and (ii) firm technology assumption and their respective linear transformations, for the purpose of the problem setting, in this industry study. The need for commoditywise input output tables is often
stressed with respect to the stability of inter industry structures, of final demands of the commodities and of the price structures of the commodities in comparison to those of industries or industry groups as sectors.

(16) While the United Nations have evolved general methods of preparing commodity by commodity and industry by industry input output tables from the available commodity by industries data tables, with the help of the linear transformations under either of the two or mixed technologies assumptions, for aggregative sectors of the economy, this industry study, while bringing out the product groupwise input structures, stresses the implications and limitations of such general methods. It is not always true that we can derive the feasible (commodity by commodity and industry by industry) input structures of each sector, with either of the technology assumptions, without any distinction between the different inputs of each sector. This difficulty arises because of the restrictive condition of square matrix and the inverse matrix elements of the linear transformation under commodity technology assumption and because of the conformability conditions of the product matrices of the linear transformations. As such it implies the precautions: (i) the number of commodities is equal to the number of industries, (ii) the derived input coefficients are non-negative and are not spurious. Findings of this industry study, especially the different technologies assumptions for different inputs of the sectors, are not spelt out by U.N., while suggesting the very general methods.
(17) The product group D (big and very big die forgings) is particularly more specific to the firm technology assumption in respect of all inputs. In the case of other product groups of die forgings, some direct inputs like steel, fuels and electricity are more specific commodity technology, while all other overhead items of inputs are more specific to firm technology for the product groups A (small die forgings of inferior and medium quality), B (small die forgings of superior quality) and C (small die forgings of very superior quality). In the case of open forgings, both the technologies assumptions are being followed by 3 product groups corresponding to all positive coefficients of the firms. The proper choice of the suitable technologies assumptions depends on the prior knowledge of the requisite inputs of the product groups and/or of firms, especially with regard to zero and/or negative input coefficients and gross value added coefficients of the firms and/or of product groups.

(18) It is also seen that all small die forgings are more specific to commodity technology and all big die forgings are more specific to the firm technology assumption. Similar results are obtained on the 3 product groups (see para 14) of die forgings analysis. Very different findings may be thrown up in the other individual industry studies. Such findings of the individual industry studies are to be taken into consideration, before one makes use of generalized methods even for aggregative sectors of the economy. Such of these industry studies help in the refinement of the input structures of the commodities and/or of the industries, taking into
account their concerned technologies. They serve as part of the disaggregative studies, so far as all other technological processes are also disaggregated to arrive at the independent input structures of their multidimensional product groups. Any analytical use of such of the most disaggregative tables requires that the final bill of goods demand also need to be distinguished by the same ranges of the product groups of the multidimensional products. But in practice, even the problems of product mix and process mix emanating from the aggregated input output tables could not be resolved for all practical reasons of nonavailability of detailed data on outputs and corresponding inputs.

(19) The utility of this study of arriving at the average prices and the input structures of the product groups of multidimensional products is quite obvious in financial projections every year or project cost estimates of the prospective entrepreneurs. The traditional practice of providing the project cost details for a given tonnage capacity of the plant is too aggregative to be of any use, as the demand pattern is guided by many product dimensions specified by customers at each stage of production. Even the capital structures of the firms under a given technology are likely to be different for different ranges of product dimensions. The proper choice of the current and capital expenditures of the entrepreneurs ultimately depends upon the proper identification of the ranges of the product dimensions or of their product groups.
The two-fold problem of this study is thus oriented to provide a methodology for similar jobbing type industries studies, with their problems of continuity and multidimensionality for sector specification in the interindustry framework. The available Annual Survey of Industries' reported data which are the main source to bring out the most disaggregative input output tables may at best take into account the problems of productmix and processmix to some extent at least on some sectors for the stability of the interindustry structures. For any further refinement of the multidimensional products' problems on stability of interindustry structures, resort to the individual industry studies is the only alternative.