Chapter II

CONCEPTS AND MEASUREMENTS OF INDUSTRIAL CAPACITY
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The preceding introductory chapter emphasised the importance of capacity and its utilisation in economic theories as well as in econometric model building. The practical definition of capacity presents a difficult task and even more difficult is the problem of its measurement. Though the concept of capacity is a relatively unambiguous concept, its measurement has been beset with serious difficulties. The literature discussing concepts and measurements of industrial capacity is prolific, but the controversy around an acceptable measure is never ending, and the most satisfactory approach may be that concept and measurement of industrial capacity should be defined according to its use in the study. The following issues are to be considered in the discussion on concepts and measurement:

(i) The economic and engineering concepts of capacity;
(ii) Measures based on these two concepts;
(iii) Measurement of capacity and optimal shift work;
(iv) Measurement of potential on peak production basis;
(v) Imbalanced structure - Capital structure at plant level and structural imbalance in the sense of input-output relationship at industrial sectoral level - or in the sense of bottlenecks in general equilibrium;

(vi) Aggregation of capacity from plant level to a national level index;

(vii) Capital stock and capacity.

CONCEPT OF CAPACITY

The concept of capacity defined in economic theory is that of full capacity output defined as the output level associated with stable equilibrium in a frictionless economy. For an individual firm with freedom of entry, this point would occur in the long run at the minimum of average cost curve. Under the condition of pure competition this is a definition of capacity for a theorist which is known as the economic concept. But it has been realised by empirical investigation that it is difficult to introduce long run cost considerations into measurement of capacity as it is difficult to get a

minimum average cost point for the firm in the long run, because long run cost curves may not be "U" shaped like short run cost curves. Klein states, "One problem is the proper introduction of cost consideration into capacity measurement. Suppose that it is decided to measure capacity as the minimal point on a firm's cost curve. The short run cost curve may very well be "U" shaped with a distinct minimal point but there is a serious doubt that the long run curve actually turns up." The discussions of excess capacity under monopolistic competition were based on the assumption that long run costs curves are U-shaped. However, it is well known that empirical cost studies have come to the usual conclusion that cost curves in the long run are linear and that average cost curves derived from them are not "U" shaped. Here enters the limitations of the pure economic concept (which takes into account costs) in measuring costs in practice. Of course, attempts have been made in some econometric exercises to estimate "profit cost function" which will be discussed later.


There are two major concepts of capacity defined according to the (i) Economic concept and (ii) Engineering concept. These two concepts themselves are clear as noted above, but the measures based on each of them pose the following problems:

(i) Which of the concepts of capacity does the measure consider?

(ii) Is it possible to measure capacity in practice purely on either of the concepts?

(iii) If the midway approach of measurement suggested by Bhagwati⁵ is taken, then in what way the concept is to be matched with these measures?

The entire empiricism of measuring capacity has failed to give any clearcut distinction between the measures employed and concept of capacity. Before we review the empirical studies, considering these problems, let us clarify the defined concepts.

(1) Economic Concept of Capacity

An economic concept of capacity takes into account the cost of production. It is a theoretical concept of

capacity, hence, could only be empirically measurable if and only if we have knowledge of cost curves confronting the firm. Since, this concept takes into account the costs of production it may change with a change in relative input prices. Involved in it are also certain minimisation assumptions which may not be valid in practice. The engineering concept of capacity differs from the economic concept since what is technically possible may not be economically necessary. The differences in definition among economists are also significant. These differences are attributable (a) to the differences in economic issues under consideration and (b) to the limitations of measurement procedures.

(2) **Engineering concept of Capacity**

The engineering concept of capacity is in terms of the capacity potential of the equipment which is generally built up from estimates of speeds of major machines and finally assessed in terms of limitations set up by the slowest equipment. If 'shut down' and 'down time' allowance for machine maintenance, repairs etc. are regular events then they are taken into account. Essentially this approach is similar to that of installed or rated capacity which defines capacity as potential output per unit of time that a plant can yield under given processes and conditions. This is a technical
definition of capacity. Klein puts it, "to an engineer capacity may be associated with the nameplate rating on a generator or some analogous technical concept.  

In a purely technical sense this concept of capacity is defined as the potential output of capital equipment if it is assumed that output is homogeneous and can be measured unambiguously. In that sense capacity is not a single number. It is often a function of a number of technological factors such as the character and quality of material inputs and power. It is a strictly technical relationship between the range of intensity with which equipment can be used, quality of inputs and output per unit. An instance may given of technical substitutes between the quality of materials. For instance, in the case of Thermal Power Station, it can be built so as to use both coal and oil but gives higher output with oil. Thus, if the technological variables that affect output can be identified and their relationship with output is defined, potential output can be expressed as a function of technological variables. The function can be used to define capacity.

6/ L.R. Klein, op.cit., p.274.
In this way, the technical concept of capacity may be defined as the output associated with the maximum feasible levels of variables; while, economic concepts of capacity may be defined as output associated with the optimum or cost minimising levels of the variables.

**Capacity Measurements**

While the concept of capacity, either economic or technical, is clear, the empirical measure of it, even at a plant level, is a tough task and the discussions on this aspect have so far not succeeded in producing even a widely accepted measure of capacity. Solomon Fabricant poses this difficulty in his comments on Schultz's paper in these words - "I would be surprised if the various capacity measurements were very good substitutes for one another since differences among them especially when they are expressed as percentage of capacity not utilised, vary considerably. This is not to say that it would be easy to choose among the several concepts on the basis of goodness of fit measured in the ordinary way".² He

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also expresses the near impossibility of arriving at a concrete figure of assessment of the full capital stock, in the way we have succeeded in arriving at a figure of full employment labour force. The answer to this question of estimating unemployment of capital stock would determine, according to him, the concept and measurement capacity, but since the question can be and has been answered differently, a variety of concepts and measurements appear even among economists having the same purpose in mind.

Let us examine these differences in different measures of capacity. Broadly, there are following six approaches to capacity measurement.

1. Survey approach, i.e., expert's judgment.
2. Maximum achieved output approach.
3. A multiple shift work approach.
4. Production function approach.
5. Linear programming approach.

Among these approaches, maximum achieved output approach claims to measure capacity on the basis of economic concept of capacity while multishift approach claims to measure engineering concept of capacity. The linear programming and input-output method take care
of balanced-imbalanced capital structure respectively at plant level and at sectoral level while survey approach is an independent estimate of capacity. Let us examine virtues and limitations of each of these measures.

Survey Approach:

This is the most common approach to get estimates of capacity from engineers or managers, running the plant, on the grounds that they would be the best judges. The producing units are surveyed through canvassing questionnaires. The firms are asked to state their installed capacity and their plan to utilise it. Information is also collected about the capacity expansion during last one or two years. The questionnaire is designed according to the purpose of the study. On the basis of response from firms, firmwise capacity output is ascertained. To arrive at the capacity output for an industry the firms are aggregated by considering weights of each either in the total industrial output or in the net value added by that industry. Though, this is a simple and sometimes only source of information of getting capacity estimates, the assumption that expert's judgement is the best of possible estimates may often be mistaken. Phillips has pointed out that since capacity is often regarded as an indicator of business performance, respondents may tempted to overstate
it and firms that are expanding fast may have overstated relatively more amongst the respondents. Ashok Desai points out another important limitation of possible bias in expert's judgement by stating that even engineers and managers have no precise idea of relationship between factors such as composition of output and inputs and about technological practices on which capacity depends. These experts may tend according to him, to define capacity in terms of the technological conditions they are familiar with in their work and their estimate may bear no relation to what a plant could produce either technically or economically if the production possibilities were known. Moore supports this limitation by his experience in working out capacity in mining and metal industries.


Prominently known in these types of surveys are MacGraw Hill capacity and utilisation surveys for U.S.A. manufacturing conducted by MacGraw Hill department of economics. These began in 1947 and since 1948 have included the questions relating to recent and planned addition to capacity. These surveys are the major source of information for Federal Reserve Board (FRB) index of manufacturing capacity to estimate yearly capacity growth by drift adjusted method. Perry and Phillips criticise this approach as also the FRB estimates which rely on MacGraw Hill utilisation rate survey.

For Indian manufacturing the National Council of Applied Economic Research (NCAER) had conducted a survey in 1965 to study the capacity utilisation in industrial units during that year. The sample was

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13/ A. Phillips, op.cit.

very large covering 4,728 units in 17 industries groups and 276 industries. Unfortunately the response was very poor, only 129 replies were received. Obviously, this can not provide a very firm basis for formulating any general hypothesis. The main feature of this survey was that trend of under-utilisation was studied for the period 1955 to 1964. The estimates of under-utilisation of capacity are based on the reported annual installed capacity and reported annual actual production. The following formula was used in the computation of the extent of underutilisation of capacity.

\[
U = (1 - \frac{P}{C}) \times 100
\]

where \( U \) = per cent. underutilisation
\( P \) = Actual annual production
\( C \) = Annual installed capacity

Also an overall index of underutilisation, covering all the 10 years, was constructed by this survey.

The second important survey for Indian industries is by R.K. Koti of Gokhale Institute of Politics and Economics for the year 1967-68.\(^{15}\) It was a big sample and about 618 factories responded to the mailed proforma.

Among them 475 factories furnished less than systematic information, so totally 475 factories were analysed. Since this is a well recognised survey, its main features should be noted. (i) The weighted average of per cent unutilised capacity for a product or group of products was worked out by using value of production as weights either from ASI (1963) or from the reported figures in the survey. (ii) The method of estimating the value of capacity of the $i^{th}$ product in 1967-68 at 1963 or 1967-68 price as the case may be was as follows:

If $P_i$ be the value of production of the $i^{th}$ product in 1963 according to ASI 1963, and $r_i$ be the index ratio i.e. ratio of the average monthly index for 1967-68 to that for 1963,

then $P_i = P_i r_i$

is the estimated value of production of the $i^{th}$ product in 1967-68 at 1963 prices or the value of the product at 1967-68 prices as reported in the survey in cases when $P_i$ is not available.

If $U_i$ be the per cent unutilised capacity of the $i^{th}$ product (considering the overutilisation as zero per cent unutilised capacity).
then \( C_i = \frac{100 \ P_i}{100 \ U_i} \) is the estimated value of capacity of the \( i \)th product in 1967-68 at 1963 or 1967-68 prices as the case may be.

In case of aggregation, if \( n \) products belong to a given industry the percent unutilised capacity of that industry was given by \( U \), where

\[
U = \frac{\sum_{i=1}^{n} C_i U_i}{\sum_{i=1}^{n} C_i}
\]

Both these surveys were criticised as being based on limited response from industrial units and also subject to the general weaknesses of this method. Koti admits that “the details so far given reveal many shortcomings but unavoidable in these estimates as this is the best that could be done with available data.”

The fear which is inherent in survey method is that the firms may misreport. In some cases, on one hand tendency may be to understate capacity in an attempt to conceal the capacity installed that has no official sanction, and on the other hand there may be a tendency to overstate capacity in order to claim more foreign exchange (for the imported raw materials

16/ Ibid., p. 23.
and spare parts) than the firms entitled to get on the basis of their existing capacity. These opposing tendencies may not cancel each other in the case of any single product. \footnote{17} In India it has been observed that the temptation to overstate capacity may be reinforced by its use in the allocation of industrial and import licenses.

**Maximum Achieved Output Approach**

This approach claims to consider economic concept of capacity which takes into account costs and defines capacity as the output at which the average cost would be minimum. As already noted that though the measures in terms of costs are of considerable theoretical interest, they have not as yet found an empirical use. A few empirical studies of cost functions have found a point at which average costs reach a minimum, e.g., in case of "L" shaped cost curves which Johnston found in his studies. \footnote{18} However, 'L' shaped cost curve has utility only in case of a single product cost curve and is not useful in measuring minimum average cost point in case of multi-product cost curves of a firm. It has

\footnote{17}{Ashok Desai, *op. cit.*}

\footnote{18}{J. Johnston, *op. cit.*}
statistical limitations also. In studies on demand behaviour it has been attempted to locate the least average cost point of competitive equilibrium by using non-linear total cost curves which contain the phases of decreasing and increasing marginal cost and known as a "profit cost function" in statistical annals which can be depicted as in the figure below: 12/

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12/ L.R. Klein, Econometrics, op. cit.
With some changes in this demand function, it can be used as a statistical cost function. De Leeuw and Walters have suggested an alternative to measure costs in terms of output beyond which the proportional differences between the average and the marginal costs exceed a specified minimum.20/

This is one of the most controversial approach of measuring capacity. The Western literature on capacity measurement has discussed this in great detail, particularly the Wharton Index of capacity pioneered by Klein for U.S.A. manufacturing.21/ The main feature of this approach is that it relates output achieved to time. It is very simple in calculation as it is based on factual observation of maximum output achieved at a point of time.

We now discuss the following two related major measures of capacity:

(1) Wharton Index of Capacity Utilisation for U.S.A. manufacturing.22/


22/ Ibid.
(2) Index of potential production and level of utilisation ratio worked out by Reserve Bank of India for Indian manufacturing.\textsuperscript{23}\\

The Wharton Index of capacity utilisation is pioneered by the Wharton School of Economic and Forecasting Unit of the University of Pennsylvania. Seasonally adjusted monthly values of output, for each industry is averaged into quarterly figures. These figures are plotted and peaks of output in each of the series are selected. Then each peak is defined as capacity and a straight line from peak to peak which describes the capacity is drawn. For the period after the peak, when another peak is reached the last straight line is extrapolated with the same slope unless production intersects the line. After such an intersection, capacity is taken to be connecting the last peak and the most recent production figure until a new peak is reached. The index of capacity utilisation in period $t$ is simply defined as

$$W_t = \frac{Y_t}{Y^c_t} \times 100$$

where \( Y_t \) is the output in period \( t \) measured in real terms and subscript "C" indicates full capacity output. \( W_t \) stands for Wharton Index of Capacity Utilisation. This index has been worked out for 30 industrial sectors using Federal Reserve Board's (FRB) Index of Industrial Production. The individual industries have been combined to the total with FRB value added weights. Conceptually, the combined index can reach 100 per cent as an upper limit but this requires that each of the thirty groupings should peak in an identical quarter. The following computational rules are suggested by this method to determine peaks. In order to recognise peak output series in period \( t \), the following conditions are summarised:

\[
Y_{t-1} < Y_t \max (Y_{t+1}, Y_{t+2})
\]

i.e., a peak period is one where output exceeds the level of the immediately preceding quarter and the two succeeding quarters. But peaks do not occur identically all the time, hence, extrapolation is required. In special cases the rules are as follows:

2\ymathbf{See G. Briscoe, P.O. Brisen and D.I. Smith, The Measurement of Capacity in United Kingdom, Manchester School of Economic and Social Studies, Number 1, March 1970, pp. 91-107.}
for \( i = 1 \) (1)s, the first of the capacity peaks is chosen. Where output declines from a peak one period and thereafter turns to that level then

\[
Y_t - 1 < Y_t \leq \max (Y_t + 1, Y_t + 2) \geq Y_t + 3
\]

The first peak \( Y_t \) is selected as the appropriate single capacity peak under the assumption that capacity is rising overtime.

When fitting linear segments between successive peaks the output index in any period may well exceed the interpolated trend line, i.e., \( Y_t \geq Y^C_t \). In this case a new slope is derived by fitting a linear trend from last peak to the present value of index \( Y_t \) which thus becomes an effective peak. The same procedure is used for extrapolating the linear trend line with the projections. Continuous revisions must be made until a cyclical downturn in the index can be recognised.

The following are the rules for interpolation between peaks. Let \( Y^C_t \) and \( Y^C_{t-j} \) be peaks, where \( j \geq 3 \) and the slope of the line segment connecting them be:

\[
\frac{Y^C_t - Y^C_{t-j}}{j}
\]
Now suppose that \( Y_t - k \) \((k < j)\) is the output in some interpeak period then the method computes:

\[
Y_{t-k}^C + Y_{t-j}^C + \left( \frac{Y_{t-k}^C - Y_{t-j}^C - c}{J} \right) \times (j-k)
\]

which yields an index of capacity utilisation in period \( t-k \) as

\[
W_{t-k} = \frac{Y_{t-k}^C}{Y_{t-k}^C} = \frac{Y_{t-k}}{Y_{t-k}^C - j}
\]

Thus, the Wharton index assumes that capacity grows at a constant absolute amount for several periods and then switches to growth by a different constant amount for another set of periods and so on.

There is a long list of critics of the Wharton method. Important among them are Perry,\(^{25/}\) Phillips,\(^{26/}\) Alan Greenspan,\(^{27/}\) Nathan Edmonsen,\(^{28/}\) Briscoe and associates,\(^{29/}\) Winston,\(^{30/}\) Samuel Paul,\(^{31/}\) and

\begin{itemize}
  \item \(^{25/}\) George L. Perry, op.cit.
  \item \(^{26/}\) A. Phillips, op.cit.
  \item \(^{27/}\) Alan Greenspan, Comments and Discussion in George L. Perry, op.cit.
  \item \(^{28/}\) Nathan Edmonsen, Comments and Discussion in George L. Perry, op.cit.
  \item \(^{29/}\) G. Briscoe, P.O. Brisen, D.I. Smith, op.cit.
\end{itemize}
Since it is difficult to discuss all their comments, the following are the three major issues which emerge from the discussion of the Wharton procedure:

(i) The Wharton approach treats capacity output as a single function of time and does not relate output to inputs. Consequently, as Briscoe puts it, if one peak occurs at a lower level of output than a preceding peak then an output below capacity at one point of time may be treated as full capacity output later and this seems unlikely as no available manpower and equipment can be so depleted between periods even if we assume no technical change between periods. Perry supports this comment, by emphasizing "the obvious drawback of every peak in output as a point of full utilisation," and concludes that "the Wharton index can tell different stories to the researchers using it historically and to the decision makers using it currently." Phillips agrees by stating... there is more danger and less logic in accepting every output peak for every industry as capacity.


33/ G. Briscoe, Brisen and Smith, op.cit.

34/ G. L. Perry, op.cit., p. 709.

(ii) When the behaviour of other inputs is ignored the pattern of output growth does not seem very plausible, especially, since it implies utilisation rates for different periods which are not likely to be considered. Perry again explains this weakness of Wharton index by pointing out its limitation in distinguishing differences in the intensity of utilisation from one peak to another, because the individual industry's operating rates at peaks are defined by this method to be 100 per cent uniformly. This is simple because the peak operating rates for different manufacturing can differ from cycle to cycle and they do not peak in the same quarter. Gardner Ackely emphasises the inherent inability of the Wharton measure to determine differences in capacity pressures at different cyclical peaks, except to the extent that it takes into account the norm of capacity pressure, wherein the aggregate measure would vary due to a different time dispersion of individual industry peaks. In particular he noted its failure to distinguish between inflationary and non-inflationary peaks and pointed out that would hinder the Wharton measure's performance in price equations.  

(iii) In an economy, which is characterised by supply constraints and other rigidities, the peaks which are

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36/ Gardner Ackely, Discussions and Comments in George Perry's paper, op.cit.
identified may be lower than the true peaks and hence the utilisation may be overestimated. This point has been emphasised by Samuel Paul and Shrinivasamurthy while studying the relevance of this method in the case of Indian industries.

Apart from these main comments the method for extrapolation and interpolation have also been criticised by A. Phillips and Ashok Desai.

It is not that only the limitations of Wharton method have been brought forward. Its merits have also been recognised considerably. The first and foremost is that this method due to its simplicity provides quick

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37/ Samuel Paul, op.cit.


40/ Ashok Desai, op.cit.
and frequent estimates of capacity and utilisation. Perry appreciates its technique which is easily applied and yields prompt estimates of capacity utilisation over a wide range of industries. Murray Foss reports the success of Wharton measure (compared to FRB measure), which he used in his regression explaining investment between 1964 to 1973. Phillips admits that "the primary advantage of Wharton School capacity index is that its computation is quick and easy, and capacity and utilisation figures emerge as soon as the FRB Index of Industrial production for the quarter is available."

Also those limitations which are discussed above should be considered in the light of the notion adopted in this method. Klein himself clearly shows that "our empirical efforts are directed at measuring the following concept: The capacity of an industry at a particular time is the maximum sustainable level of output the industry can attain within a very short time if demand for its product were not a constraining factor when industry is operating its existing stock of capital at its

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41/ George L. Perry, op.cit.
42/ Murray Foss, Discussions and Comments in George L. Perry, Ibid.
customary level of intensity. Also, he is aware of the limitation of this method, and in particular about the risk of calling a local maximum point as full capacity output and admits the existence of the problem of weakpeak (which is adjusted by estimating capacity from production function about which we shall discuss below). The Wharton unit also has indicated that it may attempt to assess the intensity of the cyclical peaks, perhaps, by applying a diffusion index and such modifications have been appreciated by a critic like Phillips.

The major focus of the critics of the lack of supply or cost characteristics (inputs) associated with the measure, has also been discussed earlier.

Because of its merits narrated above, Wharton method, in recent years has been applied to data on industrial production in many countries other than U.S.A. to produce historic and current estimates of utilisation. Briscoe, Brien and Smith estimate capacity and utilisation in U.K. manufacturing by this method. V.V. Divetia and

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45/ A. Phillips, op. cit.
46/ G. Briscoe, Brien and Smith, op. cit.
Ravi Verma attempt to estimate potential output and utilisation in the Indian industries by a similar method, \(^{17}\), which we discuss now.

**The Potential Production and Level of Potential Utilisation Ratio:**

For Indian industries V.V. Divetia and Ravi Verma of the Department of Statistics of Reserve Bank of India have worked out Index of Potential Production and Level of Potential Utilisation Ratios for 72 Indian industries which are similar to the Wharton index method with the following minor changes:

(i) The RBI index of Potential Production uses monthly output indices, instead of quarterly (because data is available on monthly basis) to locate peak production;

(ii) Monthly peaks are treated as potential output so successive peaks are not connected in interpolation as is done in case of Wharton index.

(iii) In case of Sugar, Tea and Salt seasonality has been taken care of by treating annual peak rather than monthly as potential output.

\(^{17}\) V.V. Divetia and Ravi Verma, *op. cit.*
Apart from these differences the RBI follows almost the Wharton School procedure. The Index of Potential Production for an industry in a year has been defined as the peak monthly level of production index during the year.\(^{48}\) The level of potential utilisation ratio for an industry is defined as the percentage ratio of the average monthly production of the industry for the year under consideration, to the potential output.\(^{49}\)

For highly seasonal industries like Tea, Salt and Sugar, potential production is defined in terms of yearly peaks rather than monthly peaks. Potential utilisation in these industries is the percentage ratio of annual production to the potential production for the year.

The data base for these indices is the official series of the Index Number of Industrial Production (INIP) which has 1960 as the base year. At present these indices are available for 72 manufacturing industries which are grouped as Basic Goods, Capital Goods, Intermediate Goods and Consumer Goods according to use-

\(^{48}\) Ibid., page 575.

\(^{49}\) Ibid., page 580.
based classification and as Agro-based, Metal based and Chemical based industries according to input-based classification with total weight for former group being 82% and of latter being 78.94% of the official Index Number of Industrial Production. These indices are available for the years 1960 to 1973. The index of potential production and level of utilisation ratios for a group of industries is obtained as a weighted average indices and ratios for the constituent industries with IIIP weights.

This method has been criticised on the following two major grounds.

(i) The definition of potential production assumes that once the potential is built up it does not decline in a subsequent period. This seems unrealistic in case of industries whose net investment is negative.

(ii) The measure of potential production is only a lower limit to the measure of capacity based on the synthetic concept. Because of this the potential utilisation is likely to have an upward bias.

Apart from these limitations a distinctive feature of this approach is that it uses only official production data and does not use dubious capacity data. The first critique would apply only to years where net investment is negative.

**Capacity and Multishift Operation Approach**

This is the second major approach of capacity measurement which claims to measure capacity on the basis of the Engineering concept of capacity. This method defines capacity output on the basis of number of shifts on which the firms are operating. Conceptually this is a variant of engineering approach of capacity where it is defined as the maximum production which the firm can attain under given conditions and procedures. Smithies defines it thus: "By full capacity output I mean the output that the existing stock of equipment is intended to produce under normal working conditions with respect to hours of work, number of shifts and so forth." 51/

A number of empirical studies are there employing this measure of capacity either at a plant level or at an industry level. Important among them are studies by

Winston for Pakistan industries,\(^52\) Gul Afroz and Dilip Roy\(^53\) and Qazi Ahmed\(^54\) for Bangladesh and Budin Morris and Samuel Paul for Indian industries\(^55\) also J.C. Sandesara's study for Food manufacturing industries of India.\(^56\)

At plant level important studies are by Solomon Morris,\(^57\) Prabhat Patnaik\(^58\) for engineering industry and

\(^52\) G.C. Winston, op. cit.


Dastur's for heavy engineering units using this measure of capacity. All these studies are for Indian industries.

Two major problems are there in measuring the capacity on the basis of operating shifts;

(i) The estimation of capacity based on current operating rate which always underestimates capacity.

(ii) The estimation based on assumed number of shifts or desirable number of shifts. Now in this case the problem is of defining desirable number of shifts as it may involve a subjective judgement on given operating conditions.

The first problem is of a purely engineering approach while the second may be considered as a modified engineering approach. The pure engineering approach is in terms of capacity potential of the equipment of the speed of major machines and finally assessed in terms of the limitation set by the slowest

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60/ Budin Morris and Samuel Paul, op. cit.
equipment. If the machine maintenance and shut downs are the regular events then they are to be considered in assessing capacity.

The modified engineering approach takes into considerations the other factors of production, e.g., the quality and quantity of available labour and management, quality of raw materials and regularity of delivery, schedules of inputs etc. Budin and Paul adopt this approach. They explain how the estimates by modified engineering approach differ from pure engineering approach as the former takes into account the influence of management capabilities and the established pattern of operation which include the effectiveness of plant layout, supervision costs over labour and the methods of time dimensions of work in terms of actual plant utilisation. Paul estimates capacity for 39 Indian industries for the period 1960 to 1970 by giving un-adjusted and adjusted capacities in which the former is estimated on the basis of current level of operations while latter is estimated by assuming 2.5 shifts for the firms which were found working on two shifts and 2 shifts for the firms which were working on one shift.\(^\text{61}\) in

\(^{61}\) Paul Samuel, *op.cit.*
reports of Monthly Statistics of Production of Selected Industries of India (MSP) of Central Statistical Organisation (CSO) which give product wise information of operation levels. Similarly, for Pakistan industries Winston has assumed 2.5 shifts for all industries which he found working on less than it and has estimated capacity on the basis of this assumed operation level.

An entirely different theory of capacity utilisation through multi shift approach, which takes into account the psycho-economic factor in managing multi-shift, is by Robin Harris who tested his theory empirically for U.K. manufacturing. Marris' analysis is based on planned rate of utilisation which has mainly two elements: (i) cost-technological relationship and

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62/ Government of India, Industrial Statistical Wing, Central Statistical Organisation, Monthly Statistics of the Production of Selected Industries of India (Delhi, Manager of Publications, Bimonthly).

63/ G.C. Winston, op.cit.

preferences that largely define the cost of production. Briefly, in his analysis, under utilisation has been described as a deliberate action or a rational decision by firms because people generally prefer to work during day time. Night is a non-preferred time to work because of some psychological and sociological reasons, therefore, the increase in number of shifts will increase the cost of production by the shift differential payment for night shifts. In this case it would be profitable for firms to keep some capacity idle to allow the capital-labour ratios to be high.

The implications of the uniqueness, in Harris' approach of capacity, are of a major significance in that the economic rational variables may appear highly correlated to capacity use in underdeveloped countries.

Winston's work on capacity utilisation contains significant influence of Harris' theory. In one of his studies he states 'Robin Harris' work heavily influenced his analysis by showing that regular day/night wage rhythm due to work time preferences, is a major reason why capital rarely will be installed with the intention that it will be utilised as much as technically it could be.'

Morris J. Solomon, on the other hand, discusses another issue of profitability of multishift operation by studying Indian conditions. He sought a "break-even" point which is shown in a figure below beyond which the intensive use of plant through multi-shift operation would be profitable, because beyond that point the increase in output will be cost profitable as the variable cost would increase less than proportionately and revenue more than proportionately.
B, is the "break-even" point. P can be expected to be specially profitable when a firm can sell all it can produce at the existing prices and variable costs are strictly proportionate to an increase in output and profit increases disproportionately. He concludes that under Indian conditions the efficiency of the third shift can be fully as good as the first shift, provided shift supervision cost is included in components heads. But, even if productivity per man or machine is low, the gain can be substantial.

Another interesting measure of capacity which also modifies the engineering concept but in a way different from what Paul67/ and Winston68/ have done (respectively for Indian and Pakistan manufacturing) is sought by Gul Afroz and Dilip Roy for Bangladesh in the case of Sugar and Jute industries.69/

This measure defines capacity as the maximum outflow which could be achieved from the installed capital stock in a given period. Capacity utilisation is defined as:

67/ Paul Samuel, op.cit.
69/ Gul Afroz and Dilip Roy, op.cit.
where

\[ Cu = \frac{A}{T \cdot X_k} \]

\[ Cu: \text{degree of capacity utilisation} \]
\[ A: \text{Actual annual production} \]
\[ X_k: \text{hourly output at 100 per cent efficiency} \]
\[ T: \text{period of observation (8760 hours = 365 x 24)} \]

The modification here in this measurement is in terms of feasible number of working hours and the level of efficiency as \(T \cdot X_k\) is a theoretical maximum output, but practically it is possible neither to work a machine for 24 hours of 365 days nor to obtain 100 per cent efficiency level. So, instead of \(T\) and \(X_k\), the following modified definition takes \(t\) and \(aX_k\), where \(t\) is the maximum feasible hours which can be worked which is determined as 75 per cent of engineering efficiency level of Bangladesh, which incidently, may be true for many underdeveloped countries and "a" is the proportion of \(X_k\) considered attainable under prevailing conditions. Hence, the feasible capacity utilisation is defined as follows:

\[ C_F = \frac{A}{t \cdot aX_k} \]
where
\[
C_p : \text{ Feasible capacity utilisation rate} \\
A : \text{ Actual Annual Output} \\
t : \text{ Feasible maximum number of hours that can be worked during } t, \\
a : \text{ Proportion of } X_k \text{ considered attainable under prevailing conditions.} \\
X_k : \text{ Hourly output at 100 per cent efficiency level.}
\]

Now scope for more utilisation is estimated by measuring capacity utilisation on the basis of actual number of hours worked which is defined as:
\[
C_A = \frac{A}{t'aX_k}
\]

where \( t' \) = actual number of hours worked. Where there is an underutilisation of capacity there is a scope for utilising capital more intensively by increasing shifts of work, i.e., shift co-efficient, which is expressed as:
\[
S = \frac{E_1 + E_2 + E_3}{E_1} = \frac{E}{E_1}
\]

where \( S \) = Shift co-efficient.

While \( E_1 \), \( E_2 \) and \( E_3 \) are respectively number of man hours worked in 1st, 2nd and in 3rd shift.
Capacity Measurement From Production Function

The method of estimating capacity by production function which is a recent development in the measures of capacity can provide, with certain conditions, the engineering estimates of capacity for a firm, industry or region. This method has been developed by Klein and Preston. 70/

Klein and Preston estimated capacity through production function for thirty U.S.A. manufacturing industries to correct the weak-peak obtained by trend through peak method (discussed earlier) for the period 1957-60. 21/

In this method briefly the conventional production relationship has been postulated by Klein and Preston as:

\[ X_t = \alpha L_t^\beta_K t u_t \ldots \ldots v_t \ldots \ldots (1) \]

where \( X_t \) is actual output in period \( t \). "\( L_t \)" is man-


21/ Ibid.
hours employed at time $t$. $K_{ut}$ is real capital utilised at time $t$. $e^r t$ is a proxy for technical change and $v_t$ is disturbance at time $t$.

Full capacity output is defined as

$$\hat{X}_{ct} = \hat{A}_{ct} L_t K_t \ldots (2)$$

where $\hat{X}_{ct}$ denotes full capacity real output at time $t$. $L_t$ is available man hour at time $t$ (in practice frictional unemployment is allowed for) $K_t$ is fully utilised real capital at time $t$ and $e^r t$ is a proxy for technical change. The main problem they sought was how to measure full capacity, i.e., $K_{ut}$ in equation 1 and full employment labour force, i.e., $L_t$ in equation 2, because both these inputs are in some degree interrelated. Secondly, it is difficult to estimate a relationship between capital stock (for which data is available) and the flow of capital service (which is difficult to measure) in order to estimate $K_{ut}$ in equation 1.

These problems have been solved by Klein and Preston by introducing a link between aggregate labour supply and labour utilisation, as it is assumed that:

$$\frac{K_{ut}}{K_t} = \frac{L_{at}}{L_t}$$
Solow on the other hand has postulated a definite relationship between capital and labour by specifying the function as Cobb-Douglas in form and made the ratio of actual output to the potential output a function of unemployment.\(^{22}\)

In this method, if the estimating procedure produces unbiased estimates of the parameters, the estimate of full capacity output \((X_{ct})\) is assumed to be error-free. The estimate of full capacity utilisation is defined as \(R_t = \frac{X_t}{X_{ct}}\) where \(R_t\) is the rate of capacity utilisation.

Ashok Desai points out the main limitation of this measure by Klein and Preston, that is, the limitation of substituting labour utilisation estimates for those of capital utilisation which they could not get. In view of this limitation their estimate of potential output becomes a function, solely of labour inputs.\(^{23}\)


\(^{23}\) Ashok Desai, op.cit.
Contrary to this, Ashok Desai studies the functional approach of estimation of technological capacity to quantify the relationship between output and the commonly mentioned technical variables, by means of regressions, to use them for estimating potential output of Indian Steel plants of HSL and TISCO.\(^2\)

**Linear Programming Approach**

In uniproduct firms like Sugar, Cement etc., the capacity may be well defined, while the industry which produces many products and where such products have to pass through several processes the concept of total capacity is difficult to define. Engineering industries like machine manufacturing fall into this category.

The linear programming approach to capacity output defines the capacity technologically. It is also helpful in defining the balanced capital structure and also measures the degree of imbalances in it. A study by P.N. Mathur, Valvade and Kirloskar for Machine tools and Electric motor manufacturing industries of India estimates capacity output by applying linear programming.

\(^2\) Ibid.
method. In their study, the total available hours for each machinery is the constraint and the total profit earned is the objective function to be maximised. The solution of LP gives the optimum production pattern. The data used in this study is the time in machine hours. Each machine is occupied for sometime in production of each type of products. Thus with \( m \) machines and \( n \) products \( nxm \) time coefficients will be available. Then the number of hours each machine can work, on the basis of number of shifts on which the firms work, is to be worked out. From these data the utilisation of individual item for each machinery for the optimum production pattern will be calculated. Thus, to estimate capacity utilisation at unit-level, linear programming will be of great help. A. Phillips main criticism on this approach is on the ground that it fails to distinguish the nature of unused capacity which may be either due to insufficient demand or due to capacity bottlenecks in a given product mix.

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76/ A. Phillips, *op. cit.*
**Input-output Approach**

While linear programming determines the balanced/imbalance capital structure for a given product mix, the input-output approach traces capacity bottlenecks in a general equilibrium sense. Klein and Long emphasise the importance of this approach as, "capacity is a general equilibrium concept which should be altered in the light of bottlenecks, whose effects can be traced through an input-output analysis. That is, the whole point in using capacity utilisation measures as signals of inflationary pressures and accounts, for my view, that other measures strongly overstate the amount of spare capacity available, by not taking account of interrelationships among industries."\(^77\) Nathan Edmonson also agrees on this and finds the need for using industry capacities and input-output coefficients to build a matrix of constraint relations.\(^78\)

The major criticism on this approach is that it ignores the possibilities of substitutes for the materials, which pose bottlenecks in an entire industrial

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\(^78\) Nathan Edmonson, *op. cit.*
structure. Hence, it has been suggested that this approach should be used by considering the available substitutes.

Empirically, this approach has been used by P.N. Mathur, in one of his studies in which he has estimated balanced investment vector necessary to utilise unutilised capacity in all industries in such a way that there may not be excess capacity due to structural bottlenecks.\textsuperscript{72} He has used 32 x 32 Input-output matrix by Gokhale Institute and excess capacity estimates have been used from Koti's study and from MSP.\textsuperscript{81} Another study using this approach is by Alagh, Rohit Desai and J. Shah where the structural bottlenecks have been examined in the light of interdependent loss of output due to excess capacity in the key sectors.\textsuperscript{82} They have used Saluja's 77 x 77 Input-output


\textsuperscript{80}/ R.K. Koti, \textit{op. cit.}

\textsuperscript{81}/ Government of India, Central Statistical Organisation, \textit{op. cit.}

model and excess capacity estimates have been derived from RBI's study on Index of Potential Production and Level of Utilisation ratios.

**Capital-Output Ratio Approach**

The important advance towards a better understanding of capacity will come through the capital-output approach. This is another version of stock-flow problem. A few studies have attempted to measure capacity by this approach. Important among them are the estimates by National Industrial Conference Board and also by Fortune magazine for U.S.A. industries, by Krengel for German industries and by Hickman for

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84/ See V.V. Divetia and Ravi Venna, op.cit.


U.S.A. manufacturing. Among these, the estimation method by National Industrial Conference Board is similar to Wharton trend through peak method, in which the former uses deflated capital-output ratios and examines changes in capital-output ratios for cyclical peak period and selects benchmark year for which capital-output ratio indicates full capacity utilisation. This benchmark capital/output ratio is then used as the capital/capacity output ratio and is examined to the extent to which subsequent output rates depart from an imputed capacity-output ratio. For an industry the computations are:

\[
\begin{align*}
(1) \quad & \frac{F_{01}}{C_{01}} = \frac{F_{00}}{C_{00}} = C_{01} \\
(2) \quad & \frac{C_{01}}{C_{00}} = \% \text{ of capacity utilised at time } 1.
\end{align*}
\]


88/ Daniel Creamer, op. cit.

89/ L.R. Klein and R. Summers, op. cit.

90/ A. Phillips, op. cit.
$F_{c1}$ is fixed capital at time 1, $F_0$ is fixed capital in benchmark period, $Q_{00}$ is the capacity output in benchmark period, $Q_{01}$ is the estimated capacity output at time 1 and $Q_1$ is actual output at time 1.

Krengel uses the simple method to estimate capacity by multiplying the currently estimated output capital ratio (using historical data) with capital stock. He also uses capital expenditure data to estimate capacity along with current output-capital ratios.\(^{21}\)

Hickman does not give a direct estimate of capacity by using capital-output method but he provides a variable which might behave like capacity\(^{22}\) using statistical estimation of accelerator equations.

Phillips criticises this approach by emphasising the difficulties of estimating capital stock in practice, and also the difficulties of deflating capital series.\(^{23}\) He also shows the problem of using output in estimating capital-output ratios. He suggests to use the current incremental capital to value added ratios for balanced

\(^{21}\) Rolf Krengel, \textit{op.cit.}\n
\(^{22}\) Gart G. Hickman, \textit{op.cit.}\n
\(^{23}\) A. Phillips, \textit{op.cit.}\n
expansion and to multiply it by total current value added to get an economic valuation of capital. Ashok Desai, on the other hand, points out the double-counting of capacity in any empirical estimation of output-capital ratio. Ashok Desai, op. cit.

Aggregation and Disaggregation of Capacity Estimates

Since the different measures of capacity discussed above measure up the capacity either at plant level or at industry level only, it is necessary and useful to estimate the national index of capacity by appropriate method. Manne suggests the following practical method of combining a group of capacity measures for interrelated industries into an overall index by equi-proportional expansion of capacity output through input-output model.

First, Array separates industries by the size of their per cent utilisation, determined by whichever method. Now, the industry, which has capacity utilisation nearest to full capacity could be raised to 100 per cent utilisation without any new net investment and all the other industries' output could be raised by the same proportion.

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94/ Ashok Desai, op. cit.

95/ See A. Manne, referred by L.R. Klein, op. cit., p. 281.
This can be called an effortless increase since it requires no net investment. It simply requires a movement by all industries towards fuller use of existing capacity. The original input-output scheme, i.e., $Ax = f$ would change in $AP_1x = P_1f$, where $A$ is an input-output matrix, $x$ is a vector of industry's output, $f$ is a vector of final demand and $P_1$ is the reciprocal of the operating rate (per cent utilisation of capacity) of the industry nearest to full utilisation. On the second round, the industry second nearest to full utilisation is to be raised up to its capacity output and all the other industries' output should be raised by same proportion. Here, in this second round, industry which is nearest to full capacity utilisation and industries below it can raise their output without any net addition to investment i.e. an effortless increase should be multiplied by $P_2$ (the reciprocal of the operating rate in the second industry), but the first industry which has already increased its output to 100 per cent capacity utilisation level cannot increase its output without some new investment and this calls for the introduction of an accelerator coefficient.

$$I_1 = a_1 A(x)$$
where \( \text{II} \) is net investment in the \( i \)th industry, \( \Delta(X_c) \) is the increment in capacity output of the \( i \)th industry and \( a_i \) is the accelerator coefficient of the \( i \)th industry. This is a capacity version of the accelerator.

On the third round of application, the third industry's utilisation, up to full utilisation, is to be raised and all other outputs are to be raised in the same proportion. Here two accelerator coefficients are to be used as this calls forth necessary investment in the first two industries of the original array. Successive rounds thus are to be continued until the investment potential is exhausted. In a practical application as Manne suggests the maximum recent total investment may be taken as the limiting factor.

This is the method of arriving at a national index of capacity, however the disaggregation of measures of capacity has also been emphasised, e.g., Perry states that the aggregate measures of capacity utilisation conceal a great deal of irregularity in the position of individual industries.\(^{96/}\) The significance of measures of capacity and utilisation will vary from industry to industry.

\(^{96/}\) George L. Perry, op. cit.
Similarly, the significance of utilisation rates of explaining investment and price sensitivity will differ among industries. Perry gives examples of Petroleum Refining and Automobile industries and asserts that in both these industries, significance of utilisation rates for new investment and for price pressures differ widely. So the disaggregation of capacity and utilisation at any possible micro-level is always desirable.

Review of Capacity Approaches under Indian Conditions

The preceding section discussed the various concepts and measurements of capacity and, as emerges from that discussion, none of the measures is full proof or non-controversial. Each of them has some or the other limitations. But important among them are measures based on desirable shifts and peak output approaches. The remaining measures are either an independent estimate of capacity e.g. survey approach.

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97/ Ibid., p. 722.
98/ Paul Samuel, op.cit.
99/ V.V. Divetia and Ravi Verma, op.cit.
100/ R.K. Koti, op.cit., also NCAER, op.cit.
or capacity estimate limited at plant level, e.g., linear programming approach.\textsuperscript{101} Since we have discussed the limitations of each measure in detail in preceding section, the present section will examine the suitability of these approaches particularly desirable shifts and peak output approaches to estimate capacity and utilisation for Indian industries in the light of data availability and other economic considerations.

The official data sources which give data on capacity and utilisation in Indian industries are, in the main, as follows:

\begin{enumerate}
\item[(A)] \textit{Monthly Statistics of Production of Selected Industries of India (MSP)}
\end{enumerate}

This is a monthly publication by Central Statistical Organisation (CSO) which gives monthly and annual figures of installed capacity and production in physical units for a wide range of products in the mining and manufacturing sectors except in cases like coal, iron, tea, salt and gold.\textsuperscript{102} It measures the capacity in current practice

\begin{itemize}
\item[101] P.N. Mathur, Valvade and Kirloskar, \textit{op. cit.}
\item[102] Government of India, MSP Central Statistical Organisation, \textit{op. cit.}
\end{itemize}
of operation which can be defined as maximum output that can be produced per unit of time under given normal working conditions which is being specified in terms of shifts per day and number of working days in a year. It claims to use the technical or engineering concept of capacity. Though most of the studies on Indian industrial capacity utilisation have used this source of data it has the following main limitations.

(i) In certain industries the actual production has been reported to have exceeded the installed capacity which is practically impossible. The obvious reasons for this is that the firms are working on more shifts than the reported shifts in MSP on the basis of which the capacity is assessed. The modified engineering approach

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103/ Paul Samuel, op.cit.
D.U. Sastry, Capacity Utilisation in Cotton Mill Industry in India, Monograph, Indian Institute of Economic Growth, University of Delhi.
A.P. Srinivasamurthy, op.cit.
J.C. Sandesara, op.cit.

104/ Budin Morris and Paul Samuel, op.cit.
on the basis of desirable shifts is therefore the resultant of this limitation.

(ii) In case of some industries like Cotton and Jute textiles the units of products and installed capacity are different due to which it is difficult to work out capacity utilisation ratio, though it has been estimated by using per loom or per spindle production ratio to arrive at the estimates of capacity utilisation in those industries. 105/

(iii) The information on capacity is reported by the firms on the basis of number of shifts per day and number of working days per year which are not in accordance with actual working conditions of the factory level or of the technical feasibility consideration. Due to these reasons MSP underestimates capacity which has been evidenced for some industries by a comparison between MSP and survey by R.K. Koti. 106/

(iv) The product coverage of MSP appears highly incomplete.

105/ D.U. Sastry, op.cit.
106/ See P.N. Mathur, Explorations of Making Full Capacity Utilisation, op.cit., also R.K. Koti, op.cit.
(B) Reserve Bank of India Bulletins

This is the second major source which furnishes data on capacity and utilisation in Indian industries. The first of the studies by Reserve Bank of India relates to the period 1963 to 1967 assesses capacity utilisation on the existing shift basis. The indices of potential production for the year 1967 are based on the assumption that all industries work to full capacity on the existing pattern, and the other on the assumption that industries work to full capacity on desirable multi-shift pattern, are also given. The second study by the same source, develops an alternative measure of capacity (or potential production) on the basis of peak (maximum) production realised from time to time which is similar to Wharton index approach to capacity measurement and provides such estimates of potential production and utilisation for 72 Indian industries for the years 1960 to 1973. The second measure, viz., the Index of Potential Production and the Level of Potential Utilisation Ratios is more prominent and its merits and limitations have been already discussed earlier.

107/ Raghavachari, op. cit.

(C) Hand Book of Industrial Data

This is published by Directorate General of Technical Development (DGTD).109/ Though this is not a major source of information as it adopts the same approach of shifts work like MSP, it gives unitwise ready assessment of capacities and production. Since it uses the same definition of capacity like MSP it is also subject to the limitations of MSP definitions. The latest available handbook for the year 1975 gives such information for about 246 industries. The capacity figures are in physical units.110/

The main limitation of this source is that it covers only those units which are under the jurisdiction of DGTD.

It is apparent from above discussion that as far as Indian industries are concerned the official sources of data are limited and are also subject to controversy about the reliability which makes the scope for studies limited. This has been pointed out by many


110/ Ibid., 1975.
Though the engineering or technical assessment of capacity is always preferable, the official data in MSP is not reliable for such type of assessment. Therefore a reassessment has always been required by assuming desirable or feasible shifts by the studies which have used these data. The assumption of desirable shifts always introduces a subjective judgement rather than reflect the true situation of capacity and utilisation. That is why people who opt for this source of data are not sure about the criteria to be adopted for assuming desirable shifts, e.g., Winston assumes 2.5 shifts as desirable shifts for Pakistan industries \(^{112}\) while Samuel Paul uses 2 shifts and 2.5 shifts as desirable shifts. \(^{113}\) The result is that there is a considerable difference between capacity estimates at current operating rates, i.e., unadjusted to shifts basis and on the

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111/ Jagdish Bhagawati, op. cit.


113/ Paul Samuel, op. cit.
basis of assumed operation level, i.e., adjusted to assumed shifts (See Table 1 below).

Also the reported number of shifts in MSP does not reveal the reasons for not operating on full number of shifts, which may be either because of demand or supply constraints or the third shift may not be profitable or the Government policies may prevent them to operate on the more number of shifts than their customary operation level. So it is not possible to assess correctly the technical capacity on the basis of this approach.\[11b/\]

Contrary to this, peak output approach by RBI is more relevant to the Indian industrial situation because of the following reasons.

(i) Peak production indicates the potential (possible maximum) production which has attained with the functioning of the economy.

(ii) Peak production is also a production level achieved by the current operating shifts level, hence, it involves no subjective judgement in reassessing the operation level.

(iii) Since the factors which affect the underutilisation of capacity are mainly from supply side, i.e., raw material available, etc., hence, for Indian industries it is

\[11b/\] K.L. Krishna, \textit{op. cit.}
### Table 1

Capacity Utilisation Rates Estimates by Unadjusted/Adjusted Shifts base by Peak Output Method

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Sectors of Paul's study</th>
<th>Unadjusted Rates of Utilisation (%)</th>
<th>Adjusted Rates of Utilisation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vanaspati</td>
<td>63.3</td>
<td>31.6</td>
</tr>
<tr>
<td>2</td>
<td>Cigarettes</td>
<td>113.9</td>
<td>91.1</td>
</tr>
<tr>
<td>3</td>
<td>Cotton Textiles</td>
<td>87.5</td>
<td>50.1</td>
</tr>
<tr>
<td>4</td>
<td>Wood &amp; Cork</td>
<td>153.8</td>
<td>76.9</td>
</tr>
<tr>
<td>5</td>
<td>Leather &amp; Leather Products</td>
<td>71.3</td>
<td>35.6</td>
</tr>
<tr>
<td>6</td>
<td>Drugs &amp; Pharmaceuticals</td>
<td>53.9</td>
<td>25.9</td>
</tr>
<tr>
<td>7</td>
<td>Soaps and Glycerine</td>
<td>72.3</td>
<td>36.1</td>
</tr>
<tr>
<td>8</td>
<td>Matches</td>
<td>68.8</td>
<td>34.4</td>
</tr>
<tr>
<td>9</td>
<td>Office and household Machines</td>
<td>79.6</td>
<td>39.8</td>
</tr>
<tr>
<td>10</td>
<td>Radio Receivers</td>
<td>149.0</td>
<td>74.5</td>
</tr>
<tr>
<td>11</td>
<td>Paper and Paper Products</td>
<td>83.6</td>
<td>80.3</td>
</tr>
<tr>
<td>12</td>
<td>Other Transport equipment</td>
<td>87.6</td>
<td>43.8</td>
</tr>
<tr>
<td>13</td>
<td>Synthetic fibres</td>
<td>118.0</td>
<td>59.0</td>
</tr>
<tr>
<td>14</td>
<td>Tyres and Tubes</td>
<td>96.9</td>
<td>96.9</td>
</tr>
<tr>
<td>15</td>
<td>Rubber Products</td>
<td>96.8</td>
<td>48.9</td>
</tr>
<tr>
<td>16</td>
<td>Heavy Organic Chemicals</td>
<td>55.7</td>
<td>36.4</td>
</tr>
</tbody>
</table>

contd.
<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Heavy inorganic Chemicals</td>
<td>76.5</td>
<td>74.9</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Dyes and Dyestuff</td>
<td>130.3</td>
<td>65.1</td>
<td></td>
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<td>19</td>
<td>Fertilisers</td>
<td>64.9</td>
<td>45.7</td>
<td></td>
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<td>20</td>
<td>Paints and Varnishes</td>
<td>61.5</td>
<td>45.5</td>
<td></td>
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<tr>
<td>21</td>
<td>Petroleum Refinery Products</td>
<td>92.1</td>
<td>92.1</td>
<td></td>
</tr>
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<td>22</td>
<td>Cement</td>
<td>90.5</td>
<td>90.5</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Non-metallic mineral products</td>
<td>66.0</td>
<td>33.00</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Aluminium</td>
<td>61.7</td>
<td>61.7</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Machinery, Components and Accessories</td>
<td>87.6</td>
<td>43.8</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Electrical Machinery</td>
<td>169.5</td>
<td>84.7</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Other Ele. Goods</td>
<td>83.1</td>
<td>42.1</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Railway Wagons</td>
<td>84.0</td>
<td>84.0</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Motor Vehicles</td>
<td>97.7</td>
<td>48.8</td>
<td></td>
</tr>
</tbody>
</table>

better to use this approach:

The following table 2 gives the estimated capacity utilisations by these two approaches which leads us to conclude that the desirable shifts approach gives lower estimates of capacity use than the peak production approach.

Jagdish Bhagawati attempts to give a mid-way solution to estimate capacity where he suggests to assess capacity first on the basis of current practices (as done by MSP) and to add to it the capacity portion which is the difference between technological assessment (assuming full level of operation) of capacity and assessment on the basis of current practices in which case the portion of capacity which remains unutilised due to demand and supply constraints is to be included in the latter. This mid-way assessment is on a realistic calculation basis that the difference between current practices and the technological estimates can be viewed as the sum of two components. (i) the portion which represents lack of utilisation due to supply/demand difficulties, e.g., the firm works the plant on single shift due to lack of raw material although the firm would like to work on three shifts

115/ J. Bhagawati, op.cit.
Table 2

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of the comparable sectors in both Paul's and Veitaa and Divetia's study</th>
<th>Paul's Rates of Level of Potential utilisation (%)</th>
<th>V.V. Divetia and Adjusted Ravi Verma's Rates of Level of Potential utilisation (%)</th>
<th>1965</th>
<th>1965</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vanaspati</td>
<td>31.6</td>
<td>75.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Tobacco products</td>
<td>91.1</td>
<td>92.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cotton Textiles</td>
<td>50.1</td>
<td>92.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Wood and Cork</td>
<td>76.9</td>
<td>93.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Leather and Leather Products</td>
<td>35.6</td>
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<td></td>
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<tr>
<td>7</td>
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<td>36.1</td>
<td>88.5</td>
<td></td>
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<td>75.9</td>
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<td>Paper and Paper Products</td>
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<td>84.6</td>
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<td>92.4</td>
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<td>89.5</td>
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<td><strong>contd..</strong></td>
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<td>Machinery, Components and Accessories</td>
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<td>84.1</td>
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<td>84.6</td>
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<td>89.1</td>
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<td>25</td>
<td>Motor vehicles</td>
<td>48.8</td>
<td>79.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Office and household machines</td>
<td>39.8</td>
<td>77.7</td>
<td></td>
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</tr>
</tbody>
</table>


(ii) the portion which represents conscious choice by the firms not to work full technological capacity, e.g., the firm could work on three shifts but prefers not to because the third shift may involve additional organisational problem. This is similar to the reasons of Marris’ thesis for under utilisation of capacity.116/

Though Bhagawati talks in reference to capacity of an equipment assessed on current level of operation and its technical capacity, the similar mid-way can also be applied to estimate capacity for an industry by using both the estimates of capacities, viz., on the desirable shift basis and on peak production basis.

In fact it is necessary to estimate capacity by all possible measures and compare the variation of capacity and utilisation by different methods and find out the variations in results, using the different measures. This is attempted in the next section for one industry, namely, cotton textiles. The upshot is that while the different measures give different levels of capacity use, trends in this variable are caught by all the measures. We therefore use the potential output method in this study.

116/ Robin Marris, op. cit.
A NOTE ON CAPACITY UTILISATION IN INDIAN COTTON TEXTILE INDUSTRY

This note examines different estimates of installed capacity or potential output in Cotton Textile Industry of India as employed in different studies and examines variation, if any, in rates of utilisation of the estimated potential over a period of time.

The studies on capacity utilisation in Indian industries have estimated installed capacity or potential output in Cotton Textile Industry as per the following five methods.

(1) A Desirable or Assumed Shifts Approach 117/

Samuel Paul in his recent study on "Industrial Performance and Government Control" has advocated this method by stating that government policies and several other factors prevent industries to work on three shifts in a day. 118/ The reported capacities of different industries in Monthly Statistics of Selected Industries

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117/ This approach claims to measure engineering capacity. In this method the officially estimated capacity is to be reassigned by assuming potential working condition in an industry under the case. See G.C. Winston, op.cit., and Paul Samuel, op.cit.

118/ Ibid.
in India (MSP - a CSO publication), on the basis of actual number of shifts and working days in a year, have been found underestimated. And therefore, in many cases, the production achieved during the year was higher than the reported capacity.

Keeping this limitation in mind, a time series on capacity and utilisation rates have been developed by modifying the definition of CSO. The installed capacity given in MSP has been recomputed by assuming 2.5 shifts for those industries which have been reported to be working on two shifts and 2 shifts for those which have been reported to be working on one shift respectively in MSP. This is worked out for 39 industry groups for the years 1961 to 1971. The total weight of these industry sectors, in this study, is 62.23 per cent. Among other groups, the consumer goods industry group accounts for 33.99 per cent of weight. Cotton Textile sector has been allocated in consumer goods group. This Industry has 21.13 per cent of weight which is the highest not only in consumer goods industry group but also in all industry groups under the study. The weights are based on the value added details. For the aggregate level

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112/ Government of India, MSP (CSO), op.cit.
industrial groups, weighted rates of utilisation are worked out using the production data given in MSP.

The main feature of this method is that the unadjusted rates of utilisation which are based on number of shifts reported in MSP and adjusted rates of utilisation based on the assumed shifts of operation for cotton textiles industry for the year 1965 have been estimated as 87.50 per cent and 50.10 per cent respectively which show wide variation. 120/

(2) Index of Potential Production and Level of Potential Utilisation Ratio

These have been worked out for Cotton Spinning and Weaving of Cotton Textiles separately by Divetia and Verma in the Department of Statistics, Reserve Bank of India. 121/ In this method, installed capacity of Cotton Spinning and Weaving of Cotton Textiles have been defined as Index of Potential Production which is nothing but the peak monthly level of production index reached by the industry during the year. Since Index of Industrial Production is available on Monthly basis the potential

120/ Paul Samuel, op.cit., Appendix C, p. 642.
121/ V.V. Divetia and Ravi Verma, op.cit.
has been estimated by this method on the basis of monthly peak production. This method of estimating potential has been found similar to the well-known method of Wharton Index of Capacity Output pioneered by Klein and Summers for U.S. manufacturing industries.\textsuperscript{122}

The level of potential utilisation has also been worked out both for Cotton Spinning and Weaving of Cotton Textiles. It is defined as the percentage ratio of the average monthly production index to the potential production of the industry during the year.

The index of Potential Production has 1960, as its base. The weight of Cotton Spinning is 11.79 per cent out of the weight of 25.42 per cent of Intermediate goods group under which this industry has been classified and out of 82 per cent weight of total manufacturing under the study. The Weaving of Cotton Textiles has been included in consumer goods industry group with 9.39 per cent weight out of 36.05 per cent of weight of the group under which it is placed and 82 per cent of all the industry sectors under the study.

\textsuperscript{122} L.R. Klein and R. Summers, \textit{op.cit.}
D.U. Sastry has estimated the capacity in Cotton Textile by following six methods:

(i) The Wharton Index of capacity utilisation,
(ii) Maximum output per spindle/loom,
(iii) The minimum capital/output ratio,
(iv) The R.B.I. Index of potential utilisation,
(v) National Productivity Council’s (NPC) measure based on Machine hours, and
(vi) Measure based on two shifts.

Though the present note does not intend to discuss the different concepts of capacity. It is just to be mentioned that among these six measures of capacity number (i), (iii) and (iv) are conceptually based on economic definition of capacity while number (ii), (v) and (vi) belong to technical or engineering concept of capacity.

The present note has discussed, on preceding pages the measure by Wharton Index of capacity that is the R.B.I. Index of potential production, and the level of potential utilisation and the measure based on desirable shifts, the estimates of capacity and utilisation based on the remaining three methods by D.U. Sastry are

\[123/\text{D.U. Sastry, Capacity Utilisation in Cotton Mill Industry of India (Mimeograph) Institute of Economic Growth, University of Delhi.}\]
discussed below.

(3) **Maximum Output per Spindle/loom:**

The output per spindle/loom has been worked out using the data on installed number of spindles and looms and production of cloth in metres and tonnes of yarn respectively from MSP.\(^{124/}\) A number of local maximum output per spindle and per loom has been identified which has been treated as full capacity output. This has been multiplied by the number of installed looms and spindles during the year to arrive at the potential output at a point of time. Actual production as a proportion of estimated capacity output has been treated as a rate of utilisation. These estimates have been given for the years 1951 to 1972.\(^{125/}\) A single global maximum has not been considered because as it is clarified that it would have inflated capacity estimates. The years 1957, 1961 and 1968 have been found observing local maximum output per loom, whereas maximum output per spindle has been observed in 1956, 1961 and 1964. The year 1961 has been selected as common year having maximum output per loom as well as per spindle. To estimate

\(^{124/}\) Government of India, MSP (CSO), *op. cit.*

\(^{125/}\) D.U. Sastry, *op. cit.*
capacity output between the years of peak production and below peak production in spinning, the 1956 peak production has been used to estimate capacity production for the period 1950-56, 1961 peak production has been selected for the period 1957 to 1961 and 1964 peak production has been chosen for the period 1962 to 1972.

Similarly, in the weaving sector, the 1957 peak production has been used for the period 1950 to 1957, 1961 peak production used for the period 1958 to 1961 and 1968 peak production used for 1962 to 1972. The value added weights have been used for combining the estimated capacity in spinning and weaving to arrive at an estimate of capacity production for Cotton Textiles Industry as a whole.

(4) Estimates by minimum capital-output Ratio:

In this method of estimation, gross fixed capital-output ratios for cotton textile industry have been worked out for all the years under the study. On the basis of the lowest capital-output ratio a benchmark year has been selected considering other independent evidences too.

This lowest capital-output ratio has been considered as the corresponding capacity output. The estimate of capacity has been obtained from the real fixed capital stock deflated by minimum capital-output ratio. The utilisation rate has been obtained by the actual as a proportion of the estimated capacity output.
The data have been obtained from a study by Reserve Bank of India on "Finances of Public Limited Companies for Cotton Textiles." The gross fixed capital-output ratio has been taken to work out capacity because the data on depreciation do not reflect the wear and tear of capital equipments and also because companies do not follow uniform accounting procedure.

The real capital series has been derived by deflating the gross fixed investment figures by a combined index of prices of machinery and construction. The construction index is not officially available; hence it has been taken from a study by R.N. Lal on "Capital Formation and its Financing in India". These two indices have been combined according to their relative proportions in the total gross fixed assets. The deflated investment series are cumulatively added to the base year capital stock. The gross value added has been derived by deducting the necessary expenses. It has been deflated by using the combined wholesale price index of yarn and cloth. For combining the two price indices of yarn and cloth their weights have been used as their relative shares in the total output.

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The minimum capital-output ratio has been observed for the year 1950-51 which is used to divide real gross fixed capital for each year in order to arrive at the estimates of capacity for that year. The real gross value added as a proportion of estimated capacity has been considered as the capacity utilisation ratio according to this method. The average rate of utilisation of capacity in Cotton Textiles Industry has been estimated as 67 per cent by this method during the period under study.

(5) NPC Estimates of Machine Hours:

Capacity of Cotton Textile has been estimated by National Productivity Council on the basis of machine hours. The total number of machine hours have been obtained by the total number of looms and spindles existing in the year multiplied by a constant 24, which refers to three shifts, each of eight hours in a day. This represents capacity of the industry. The capacity utilisation has been estimated by working out actual number of machine hours worked defined as the number of


looms and spindles actually worked during the year in each shift multiplied by eight which is the standard work hours of the shift. By adding the figures for all the three shifts, the total number of hours actually worked has been arrived. The rate of capacity utilisation has been derived by the ratio of actual machine hours worked to the total machine hours available. The study has given estimates of capacity and utilisation based on this method for looms and spindles separately for the period 1950 to 1973. The average capacity utilisation during this period has been found by this method as 67 per cent in the weaving sector and 74 per cent in the spinning sector.

II

Analysis of Estimated Capacity and Utilisation by Different Methods

Table 1 below presents the estimates installed capacity (IC) and the rate of utilisation (Uti) for the period 1960 to 1973 on the basis of the methods discussed above. The following are the main findings:

(i) The utilisation rates given by Reserve Bank of India (RBI) method and by Maximum output per spindle/

130/ D.U. Sastry, op.cit.
131/ V.V. Divetia and Ravi Venma, op.cit.
### Table 1

**Installed Capacity and Utilisation in Cotton Textile Industry of India by Different Methods**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Source</th>
<th>Description of Method of Estimation</th>
<th>1960</th>
<th>1961</th>
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<td></td>
<td></td>
<td>Unit</td>
<td>I.C.</td>
<td>Util.</td>
</tr>
<tr>
<td>1</td>
<td>S. Paul's Study</td>
<td>Desirable Shift Base</td>
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<td>N.A.</td>
</tr>
<tr>
<td>2</td>
<td>R.B.I. Study</td>
<td>Index of Potential Base Production and Level of Potential Utilisation Ratio (On the basis of Peak Production):</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(i) Cotton Spinning (11.79% weight)</td>
<td>100.0</td>
<td>91.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ii) Weaving of Cotton Textile (9.39%)</td>
<td>100.0</td>
<td>94.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(iii) Cotton Textile (21.18 weight)</td>
<td>100.0</td>
<td>92.4</td>
</tr>
<tr>
<td>3</td>
<td>D.U. Sastry</td>
<td>Maximum Output per Spindle/Loom</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(i) Spindles</td>
<td>845.46</td>
<td>93.23</td>
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**contd..**
### Table 1 contd.

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<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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<td>(i) Spinning</td>
<td>I.C. is in Rs. lakh</td>
<td>34171.0</td>
<td>59.18</td>
<td>40387.0</td>
<td>59.30</td>
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<tr>
<td>(ii) Weaving</td>
<td>I.C. is in Rs. lakh</td>
<td>N.A.</td>
<td>72.62</td>
<td>N.A.</td>
<td>76.52</td>
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<td>(iii) Cotton Textiles</td>
<td>I.C. is in Rs. lakh</td>
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<td>N.A.</td>
<td>68.13</td>
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<td>(iv) D.U. Sastry</td>
<td>NPC Method of Machine hours</td>
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<td>68.98</td>
<td>N.A.</td>
<td>72.80</td>
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<td>(v) D.U. Sastry</td>
<td>Minimum capital/output ratio method</td>
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<td>95.21</td>
<td>N.A.</td>
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<td>I.C.</td>
<td>Utl. %</td>
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<td>106.0</td>
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<td></td>
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<td>90.2</td>
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<td>(iii)</td>
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<td>4701.4</td>
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<td>(ii)</td>
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<td>(i)</td>
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<td>N.A.</td>
<td>73.68</td>
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<td>3 (i)</td>
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<td>N.A.</td>
<td>85.42</td>
<td>N.A.</td>
<td>81.41</td>
<td>N.A.</td>
<td>88.14</td>
<td>N.A.</td>
<td>N.A.</td>
</tr>
<tr>
<td>4 (i)</td>
<td>64721</td>
<td>59.35</td>
<td>67181</td>
<td>51.09</td>
<td>70734</td>
<td>58.31</td>
<td>74737</td>
<td>60.94</td>
</tr>
<tr>
<td>5 (i)</td>
<td>N.A.</td>
<td>75.24</td>
<td>N.A.</td>
<td>71.56</td>
<td>N.A.</td>
<td>74.02</td>
<td>N.A.</td>
<td>73.30</td>
</tr>
<tr>
<td>(ii)</td>
<td>N.A.</td>
<td>67.60</td>
<td>N.A.</td>
<td>65.34</td>
<td>N.A.</td>
<td>69.14</td>
<td>N.A.</td>
<td>72.98</td>
</tr>
<tr>
<td>(iii)</td>
<td>N.A.</td>
<td>70.91</td>
<td>N.A.</td>
<td>68.80</td>
<td>N.A.</td>
<td>71.86</td>
<td>N.A.</td>
<td>73.16</td>
</tr>
</tbody>
</table>

* I.C. - Installed Capacity.
** Uti. - Utilisation.
N.A. - Not Available.
loom show higher rates of utilisation in cotton spinning, weaving and textile industry as a whole compared to the rates given by other three methods.

(ii) The lowest rates of utilisation among all the five estimates, is found in Samuel Paul’s study, which is based on desirable shift approach. This method provides rates of utilisation in Cotton Textile Textile Industry as a whole.

(iii) The utilisation rates as estimated by the above referred five methods vary between 45 and 100 per cent during different years under study. These differences are in the expected direction. Measures which use actual peaks achieved (e.g. the RBI or the Maximum Output per Spindle/Loom) give low estimates of 'Potential' or installed capacity. Other measures which use technological norms give high estimates. There are no clearcut a priori reasons for choosing between the two. As shown elsewhere, for purpose of short run policy analysis, probably the former set of estimates are preferable. On the other hand for long term analysis or purely technolo-


133/ Paul Samuel, op.cit.
gical approaches, the latter may be useful. It is indeed likely that if the economy functions for considerable periods close to 'peak' outputs, entrepreneurs would search for decision to approach 3 shifts operations. If this is not so the latter concept remains an interesting theoretical abstraction without much immediate relevance.

A graph below shows the rates of capacity utilisation in Cotton Textile Industry in India estimated as per the above referred five methods for the years 1960 to 1973. It shows that the rates of utilisation estimated by assumed shift method and by minimum capital-output ratio method show similar trends. The rates of utilisation estimated on the basis of peak production approach and by maximum output per spindle/loom method lead to higher rates of utilisation (more than 90 per cent) compared to those given by other estimates. Estimates by maximum available machine hours give a moderate rate of utilisation lying between 60 and 80 per cent during the years under the study. An interesting feature of this graph is that while levels of capacity use differ, variations do not to the same extent as between the different measures. This has been examined more carefully.

The compound rates of growth of estimated capacity and utilisation rates as per the five methods have been
Note: Graph 1: Estimated by Desirable Shift-method.

2: Estimated by using RBI Indices of Potential Production and Utilisation Ratio.

3: Estimated on the basis of Output-Spindle/Locom Ratio.

4: Estimated by Minimum Capital-output Ratio method.

5: Estimated on the basis of Maximum Machine-hours method.
worked out fitting a semi log equation. Table 2 gives the growth rates.

This shows that there is a wide variation between the growth of estimates of installed capacity and utilisation in the Cotton Textile Industry. However, two important features emerge. First, except in the case of looms installed, estimated by maximum output per loom method by D.U. Sastry, none of other estimates showed negative trend in installed capacity over a given period of time. Thus, capacity in the industry has been increasing. The second feature, however, is that as regards utilisation of capacity, almost all estimates showed a negative trend over the period under study.

The present study accepts the peak-output approach and assesses potential production, potential utilisation and Excess Potential for selected Indian industries in the following chapters by using RBI's Index of Potential Production and Level of Potential Utilisation Ratios by Divetia and Verma. The performance for this approach is basically for following three reasons. First, our study analyses the implications of and reasons for idle capacity

134/ D.U. Sastry, op.cit.

135/ V.V. Divetia and Ravi Verma, op.cit.
### Table 2

Growth Rates (Compound Per Annum Per Cent) of Installed Capacity and Rates of Utilisation

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Method of Estimation</th>
<th>Coverage</th>
<th>No. of Observation</th>
<th>Growth Rates (% Compound per annum) Installed Capacity</th>
<th>Rates of Utilisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Desirable Shifts</td>
<td>All Textiles</td>
<td>10</td>
<td>2.17</td>
<td>17.13</td>
</tr>
<tr>
<td>2</td>
<td>R.B.I. Indices</td>
<td>Cotton Spg.</td>
<td>14</td>
<td>2.28</td>
<td>-0.71</td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td>Weaving of Cotton Textile</td>
<td>14</td>
<td>0.15</td>
<td>-0.86</td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td>Textiles as a whole</td>
<td>14</td>
<td>1.42</td>
<td>-0.78</td>
</tr>
<tr>
<td>3</td>
<td>Maximum Output</td>
<td>Spindles</td>
<td>13</td>
<td>3.22</td>
<td>-2.09</td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td>Looms</td>
<td>13</td>
<td>-0.86</td>
<td>-0.43</td>
</tr>
<tr>
<td></td>
<td>&quot;</td>
<td>Textile as a whole</td>
<td>13</td>
<td>N.A.</td>
<td>-1.32</td>
</tr>
<tr>
<td>4</td>
<td>Minimum Capital/Output Ratio</td>
<td>All Textiles</td>
<td>14</td>
<td>5.24</td>
<td>0.65</td>
</tr>
</tbody>
</table>

*contd.*
Table 2 contd.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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</thead>
<tbody>
<tr>
<td>5</td>
<td>NPC method of Machine hours</td>
<td>Spinning</td>
<td>14</td>
<td>N.A.</td>
<td>-0.49</td>
</tr>
<tr>
<td></td>
<td>&quot; Weaving</td>
<td></td>
<td>14</td>
<td>N.A.</td>
<td>-0.31</td>
</tr>
<tr>
<td></td>
<td>&quot; Textiles as a whole</td>
<td></td>
<td>14</td>
<td>N.A.</td>
<td>-0.46</td>
</tr>
</tbody>
</table>
(potential) for a short term policy programme for which this approach seems more suitable and, second, for study of Indian capacity under utilisation, examination of supply constraints is important, which is more easily captured by the peak output approach. Third, as the textile industry note shows, the method captures trends as well as other measures.