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A Close Look into Research Studies on Capacity Utilization in India and Abroad

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ABSTRACT

Capacity utilization as measures of performance indicators of an industry has a long history of research. Every industry is endlessly in a course of self-appraisal and in search of tools for measuring its own current performance in comparison with the various targets, past achievements and operative capacity. Manufacturing capacity utilization is such a key indicator of economic performance which explains changes in investment, inflation, long-run output growth etc. This article tries to overview the studies undertaken on capacity utilization in India and abroad so far to find the gap existed for further empirical research. This research review gives closer and analytical insight into the capacity utilization and may provide an answer in future to the prospective researchers to the debate of whether liberalization has significantly contributed to the improvement in industrial growth and performance or not, amidst the shift in paradigm from "state-intervention-cum-import substitution" to that of "liberalization-cum-export led-growth".

Keywords: *Capacity, Utilization, industry, efficiency.*

1. INTRODUCTION

Capacity utilization as measures of performance indicators of an industry has a long history of research. Every industry is endlessly in a course of self-appraisal and in search of tools for measuring its own current performance in comparison with the various targets, past achievements and operative capacity. Business decision and policy formulation mostly depend on economic indicators. Manufacturing capacity utilization is such a key indicator of economic performance which explains changes in investment, inflation, long-run output growth etc. After economic reforms initiated in 1991, while most of the recent studies investigating the industrial performance in India have focused on the analysis of total factor productivity growth, very negligible attention was given to capacity utilization. It may be noted that even the analysis of total factor productivity would be more meaningful if adjustment is made for fluctuations in capacity utilization.

This article tries to overview the studies undertaken on capacity utilization in India and abroad so far to find the gap existed for further empirical research.

2. RESEARCH REVIEW ON CAPACITY UTILIZATION

2.1. Studies on Capacity Utilization in India

In view of the overriding importance of capacity utilization in the overall resource-use efficiency of the economy, however, a few researchers have tried to examine the trends and determinants of capacity utilization in Indian industry. In line with the earlier attempts, recent studies (Ajit, 1993,[1] Burange, 1992[2]) also show the existence of excess capacity in the industrial sector in India. Studies that examined the determinants of capacity utilization (CU) found that most of the industries are demand-constrained (Goldar and Renganathan, 1991[3], Srinivasan, 1992[4]). Also there are few studies that correlate utilization with public investment in infrastructure, capital and intermediary imports and the adoption of liberal policy (Seth, 1998[5]). An examination of the literature reveals that most of the studies have used conventional measures of capacity utilization (CU) and have paid inadequate attention to the possible theoretical problems. It has long been recognized in the literature that the engineering approach is deficient, in the sense that it is not based on any explicit theoretical foundation. The economic capacity of given stock of capital will vary with the relative price changes, resulting in a change in the optimum combination of capital and other variable inputs. Therefore, the role of non-capital input in deciding potential output is crucial. In India, the engineering CU figures are mainly based on the installed capacity data collected from firms and published by different agencies like DGTD (Directorate General of Technical Development). The data that many studies used for this purpose are quite unsatisfactory in that they compound inevitable conceptual difficulties with several statistical drawbacks (Bhagwati and Srinivasan, 1975 [6]). Additionally, these figures give highly exaggerated picture of actual capacity, mainly due to policy reasons and reporting errors. The definition of installed capacity differs from firm to firm, there is no uniform way to define it and it is not clear how firms respond to the question of their capacity. Many of the firms report capacity based on a single shift operation, which is not the case in practice. This creates ambiguity in explaining the results also. Moreover, as the economy moved from a system of licensing and strict control on production to a system of capacity increase endorsements and then further to Broad-banding and then finally to de-licensing, the importance of the installed capacity figure to the government agencies (such as DGTD) has declined substantially. However, a number of theories have been developed in the last 50 years to explain the concept of capacity and measurement of its utilization across industries. The conclusions drawn on these subjects so far are presented here.

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Budin and Paul (1961) [7] estimate capacity utilization for the period 1951-59. Their study is based on MSP which takes into consideration installed capacity and production. The study covers 75 industries for which installed capacity data are available. The study shows increased utilization of capacity in the industrial sector over the period from 1951 to 1959 (from 62 percent in 1951 to 91.53 percent in 1959). Inter-industry variations in CU are also analyzed in this study. Industries were classified into three categories – infrastructural, intermediate and consumer goods industries. The study indicated almost full utilization in infrastructure during second plan period. The study also shows that some intermediate goods industries and some consumer goods industries like paper products and enamel-ware have large excess capacities.

The NCAER (National Council of Applied Economic Research, 1966) study depicts that capacity utilization is as high as 89 percent for all industries in India. The mail survey reflected a very poor response rate but revealed valuable insight into the causes of underutilization of capacity. Shortage of raw materials and foreign exchange, labour unrests etc. has been identified to be the causes lying behind such underutilization. The study is based on MSP data and mail survey data and covers 276 industrial products which are classified into two major groups- metal products and non-metal products for the period 1955-64.In this study, a detailed analysis is made for five groups of industries namely-metal products, machinery other than electrical, electrical machinery and appliances, transport equipments and chemical and chemical products.

Koti (1967) [8] estimates capacity utilization of Indian manufacturing for the period 1966-67. The study was based on survey data which also analyses the factors affecting capacity utilization. The study is based on 151 companies to whom questionnaires were sent and study covers 234 products. Out of these, 20 companies were found to have fully utilized capacity. Products with more than 60 percent unutilized capacity consist of chemical, fertilizers and drugs, steel, rubber, steel forgings and non-ferrous alloys etc. Shortage of raw materials and shrinkage of demand, labour problem followed by shortage of power might be the possible reasons for underutilization of capacity.

Paul (1974) [9] conducted a study on Indian manufacturing which shows that capacity utilization rate is around 80 percent and when it is adjusted for shift pattern, capacity utilization rate is 53 percent. The study also reveals that overall utilization index increased from 50.4 percent in 1961 to 55.3 percent in 1965, declined to 51.3 percent by 1967 and increased thereafter to 55.3 percent till 1970 and was 54.3 percent in 1971.The study also attempted to explain capacity utilization as a function of six explanatory variables using regression analysis. The six variables used are market concentration, pressure of demand, and size of the firm, import substitution, effective rate of protection and import content of production. The study is based on MSP data for the period 1961-71 for 42 industries. According to Paul, MSP classifies 18 product groups as working on three shift basis, 7 on a two shift basis and all the remaining 275 on a single shift basis while a large number of manufacturing units which are classified under a single shift in MSP actually operate on a two or three shift basis. Therefore, in the study, an adjustment is made for shift work and installed capacity is recomputed in the same way as Winston (1974) had done earlier for Pakistan.

Nayar and Kanbur (1976) [10] estimates capacity utilization using production function approach for 1945-65. Capacity utilization rates based on Cobb-Douglas and CES production function shows high utilization rate of over 97 to 99 percent taking data from CMIE and ASI and full employment, supply of labour forces is collected from Yearbook of Labour Statistics of ILO.

Most of the studies reviewed above are for earlier period and are limited in coverage of industries and time period. There are also some studies which cover only conceptual issues related to capacity. In recent years, there have been a few more studies on capacity utilization in India which are discussed below.

Vishwanathan and Mukhopadhyay (1991) [11] have presented economic measure of capacity utilization for Indian cement industry for a period of 1960-61 to 1984-85. Their study suggests that, for some years, CU is found to be more than one, on the basis of which the authors conclude that the firms could have reduced their production cost by moving to the minimum point of short-run average cost curve.

Padma Suresh (1991) [12] applies the econometric cost-minimization framework to obtain two economic measures of capacity utilization for four two digit industries corresponding to the ASI classification for the period 1960-61 to 1982-83.These two digit industries form part of the basic and capital goods industries. The translog variable cost function is specified and estimated. In this study, capacity output corresponds to minimum point of the short-run average total cost curve and the tangency between short and long-run average cost curves. Economic measures obtained in this study are closer to unity and spanned both sides of unity while the traditional measure of capacity utilization is less than unity always. The conclusion reached in this study is that since economic measures are closer to unity, this suggests that actual output levels are determined by cost considerations. The low correlation between economic measures and traditional measures suggests the importance of deriving economic measures. Accordingly, she concludes that the traditional measure understates the true economic capacity utilization.

Goldar and Ranganathan (1991) analyze econometrically the effect of market structures and government policies on capacity utilization of Indian industries, the methodology of which is very similar to those of Paul (1974). But, unlike Paul (1974), this study

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makes an attempt to incorporate explicitly the effect of industrial policy into econometric analysis. The study uses production and capacity data from DGTD sources. For measuring market concentration, the share of the top three firms in the total industry sales published by the CMIE is used. As a measure of demand pressure, the growth rate of production between 1978 and 1983 has been used. To capture the effect of trade and tariff policies on capacity utilization, the study uses the level of effective protection enjoyed by industries as explanatory variable. Four dummy variables were used to reflect the nature of licensing and other controls the industry faced. The study reveals a significant positive relationship between demand pressure and capacity utilization and also between market concentration and capacity utilization .The significant positive relationship between market concentration and capacity utilization reflects, to some extent, the problem of demand deficiency arising out of excessive entry of new firms in the industry. The study finds inverse relationship between levels of effective protection enjoyed by the industries and the rate of capacity utilization attained by them. The study also depicts that the relationship between capacity utilization and dummy variables representing industrial policies is not very clear pointing to the limitation of data and inadequacies of methodology adopted to incorporate the influence of industrial policy into the analysis.

The first study of Srinivasan (1992a) examines the determinants of capacity utilization in Indian industries. Data on full capacity and utilization levels for different industrial sectors is taken from CMIE (1987).Time series data on capacity utilization from 1970 to 1984 has been collected from World Bank (1989) for selected industries from four broad sectors: basic, capital, intermediate and consumer goods. A correlation analysis between actual and capacity output, between capacity expansion and lagged output and capacity utilization rates was carried out which shows that a high correlation was observed in former case but no systematic relationship was found in latter case. Using industry-wise data, a cross-section regression analysis was carried out to determine the factors affecting capacity utilization. Only industry characteristics like capital intensity, scale of operations and variability of demands due to seasonal and other factors were included while other explanatory variables like import substitution, effective rate of protection were not included due lack of comparable data. The study shows that high variability of demand leads to lower level of capacity utilization. A positive relationship is obtained between capacity utilization and the explanatory variables like capital intensity, scale of operation and market concentration.

The second study of Srinivasan (1992b) [13] uses methods in disequilibrium and shortage modeling to estimate the extent of slack or shortage in each year for different industries. The supply factors that affect capacity utilization includes availability of raw materials and inputs, infrastructural bottlenecks such as power shortage and transport bottlenecks etc. The demand factors include changes in domestic and foreign demand caused by changes in tastes or by general macro-economic situations. Industry groups like diesel engines, railway wagons and vanaspati etc which operate with more than excess capacity face mainly demand constraints. Agricultural tractors and cotton cloth (mills) with excess capacity of more than 25 percent face mainly supply constraints.

In his study, Burange (1992) computed CU indices for the period 1951 to 1986-87 for the organized manufacturing sector of Indian economy. The index constructed is a weighted arithmetic mean of capacity utilization calculated by the formula:

$$U=\sum u_i w_i / \sum w_i$$

Where U is the index of capacity utilization, u_i is the capacity utilization, (ratio of actual to capacity output) of the i th product, w_i is the capacity output value added weight of i th product. This study uses data from MSP on installed capacity and output. The study reveals that at the one digit level of industrial classification, the aggregate manufacturing sector showed an increase in capacity utilization from 65.97 percent to 68.51 percent during 1951 to 1955. It fluctuated between 72.23 percent and 73.38 percent during 1956 to 1959, between 68.6 percent and 77.41 percent during 1960 to 1969, and between 62.13 percent and 73.66 percent during 1970 to 1986-87. At the two digit industrial classification, manufacture of machinery other than electrical showed wide variations in capacity utilization over the period of study. Capacity utilization (CU) in manufacture of electrical machinery increased from 58 percent in 1951 to 94.65 percent in 1961 and it declined to 53.78 percent in 1983-84. Capacity utilization in manufacture of rubber products, paper and paper products, tobacco manufactures were higher on an average among all industries over the entire period though in paper and paper products, it declined throughout. Capacity utilization in manufacture of chemical and chemical products, manufacture of leather and fur products was lower over the entire period.

This study also classifies the products of organized manufacturing sector into (i) consumer goods, (ii) intermediate goods (iii) capital goods. The consumer goods category is further sub-divided into (a) consumer durable goods and (b) consumer non-durable goods. Capacity utilization in consumer goods is more or less steady at around seventy percent. But, it fluctuated widely in capital goods industries; increasing from 34.04 percent in 1951 to 92.18 percent in 1967 and declining to 47.59 percent in 1973. From 1974 onward, it increased again to 79.17 percent in 1982-83 and again declined thereafter. The intermediate goods showed an increasing trend in capacity utilization (CU) from 73.32 percent in 1951 to 81.09 percent in 1964 and then declined continuously to 55.98 percent in 1983-84.

Out of various types of the consumer goods, capacity utilization in consumer durables fluctuated widely from 32.41 percent to 89.22 percent over the

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period. The fluctuation in the utilization of consumer durables are relatively smaller (between 59.23 to 79.83 percent) with no-long term trend. Therefore, the study by Burange (1992) provides a continuous series of CU over the entire period from 1951 to 1986-87.But, the indices constructed are the traditional indices based on data on installed capacity and production from MSP. The limitation of the study is that CU is not based on economic notion of capacity utilization.

In a later study, Burange (1993)[14] estimates the implication of full capacity utilization of the manufacturing sector in the Indian economy using input-output framework. The study is carried out using the open Leontief model and semi-closed model using endogenous household demand. The working of the model is presented using 1973-'74 data and CU indices constructed in the earlier study, by Burange (1992). The study shows that by fully utilizing the capacity of the manufacturing sector, the output, income and employment increases by 22.86, 16.31 and 14.11 percent respectively in the open model and will increase by 38.68, 37.08, 38.59 percent in the semi-closed model respectively.

The study of Ajit(1993) depicts a declining trend in the industrial sector in India over twenty years period ,1970-90.The trend in capacity utilization (based on data on installed capacity and actual production from CSO) for 86 industries accounting for one fourth of weight in index number of industrial production have been examined using a used based classification. On an average during 1970-90, nearly one fourth installed capacity remained underutilized. Capacity utilization in all industrial groups have shown a declining trends, although during the eighties' there have been some modest enhancement in capacity utilization. Average CU of 76.1 percent during 1980s' was higher than average CU of 73.3 percent during 1970s.Among the used based groups, the extent of underutilization of capacity was highest in basic good industries (37 percent) followed by capital goods (34 percent), consumer goods (25 percent), and intermediate goods(10 percent).A significant improvement in capacity utilization was noticed in basic goods and capital goods industries in 1980s', This conclusion was supported by Goldar and Renganathan(1991). Capacity utilization in industrial sector was postulated as a function of income (as a proxy for demand), imports of capital goods and dummy variables to capture the effect of changes in government policy. The predominant factor influencing capacity utilization is demand. Evidence suggests that easing of government controls lead to increase in CU.

Seth (1998) explores the pattern of relationship that has been existing between the economic& industrial policies and capacity utilization in Indian industries. He establishes that the period 1960-65 witnessed apparently high capacity utilization rates as a result of huge public investments in infrastructure, capital and intermediate goods industries as well as conducive policies (import substitution strategy). The author arrived at a decision that the decline in capacity utilization rates during the late sixties and early seventies can be ascribed to fall in public investment, severe drought and wars with neighboring countries. Poor management of public infrastructure was also a major reason. The distinct policy orientation in the late seventies and during eighties with focus on industrial development, and in particular, consumer, and consumer goods industry led to recovery of the industrial sector. The study points out that capacity utilization has improved after the path breaking economic reforms got under way in 1991 and the study concludes that while there does not exist a unique relationship between the prevalent policy regime and industrial performance, an optimal combination of policies capable of correcting some of the structural imbalances can create a favorable environment for better industrial performance.

Uchikawa (2001) [15] has discussed the reasons for investment boom in Indian industries in the first half of the 1990s and has drawn attention to the adverse effect it had on productivity. The study covers the period from 1979-80 to 1997-98 taking into account 5 main investing industries NIC 30,31,33,35-36 and 37. He notes that as a result of reforms, the Indian manufacturing sector had an investment boom in the first half of 1990s and shows that although lumpy investment raised output sharply, demand did not expand as much as capacity and this led to under utilization of capacity which has an adverse effect on productivity.

Azeez .E. Abdul (2001) [16] estimates a consistent series for the economic capacity utilization of the Indian non-electrical machinery manufacturing sector. The optimal or economic capacity is defined as the output where short-run average total cost is minimized. Using an iterative version of Zellner's Seemingly Unrelated Estimation technique, a translog short-run cost function is estimated imposing the condition of economic optimizing behaviour of firms to calculate optimal output. Such a measure assumes that variations in capacity utilization, defined as the result of actual output to capacity output, are the systematic results of rational optimization procedures, depending on price and cost conditions of firms. A comparison with the new series with conventional engineering measures of CU shows that the widely used installed capacity figures clearly underestimates the true economic utilizations levels, mainly due to definitional problems.

Danish.A.Hashim (2003) [17] makes an attempt to measure the extent of capacity utilization in Indian airlines industry and its impact on unit cost of production. Using data from 1964-65 to 1999-2000 and applying a translog variable cost function, the capacity utilization has been estimated with respect to two alternative measures of potential output: (i) where short run average cost is minimum and (ii) where short run and long run average cost curves are tangent. The results reveal that the capacity utilization in Indian airlines has been poor in general and also declining over the last decades. The study suggests a need to improve the capacity utilization which in turn would improve the financial performance of

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Indian airlines by reducing its cost per unit of output. The study finds that the financial performance of the state-owned Indian airlines has deteriorated since 1989-90. Rising fuel prices, excess staff, serving uneconomic route and increasing expenses on insurance have been indicated to be the several reasons for poor financial performance of Indian airlines. Low capacity utilization has rarely been cited as one of the main reasons for the poor performance. Inspite of poor financial performances since 1989-90, the study proposes to expand its capacity in a large way.

Abdul Azeez Erumban (2005) [18] examines the trends in and determinants of economic capacity utilization (CU) in Indian manufacturing over the period 1974-2000. An attempt is also made to understand the impact of policy changes, inter alia, on the observed movements of CU. The economic CU, defined as the realization of output at which the short run average total cost is minimized, is estimated using a translog cost function, which is estimated along with the share equations, using an iterative version of the Zellner's Seemingly Unrelated Regression Estimation (SURE) technique. The analysis reveals that the conventional installed capacity utilization measures underestimate the true economic utilization levels, while the arbitrary measures like Wharton indices tend to overestimate it. Further, the Indian manufacturing sector has experienced a cyclical pattern in economic capacity utilization over the period of study. Three distinct phases have been identified with regard to the movements in CU. While phase one (1974-1984) is characterized by relatively wide fluctuations, phase two (1985-1990) witnessed a roughly stable level of utilization. In the third phase (1991-2000), a variant of the fluctuations witnessed in the first phase is seen to have resurfaced. Another major point emerging from the study is the significant role of supply side as well as demand side factors in affecting the level of economic capacity utilization. The impact of economic reforms per se is not significant though the policy changes may influence supply and demand side factors determining the level of economic capacity utilization.

Kaustuva Barik (2007) [19] estimates the rate of capacity utilization for Indian paper industry for the period 1973-74 to 1997-98 on the basis of the theoretical framework of translog cost function. It is based on the basic premise that the deviation from full utilization of capacity takes place as the level of certain input, particularly capital are fixed in the short run and thus can be changed only in the long run. In order to meet the increase (decrease) in demand in the long run, the industry puts the existing capital to more(less) intensive use. The study undertakes the empirical estimation of a translog variable cost function by considering three variable inputs, viz labour, energy and raw material and one quasi-fixed input- capital, on the basis of aggregate industry level data taken from Annual Survey of Industries (ASI). It is found that underutilization of capacity prevails in the Indian paper industry and there has been a decline in the rate of capacity utilization over time.

Gajanan and Malhotra (2007) [20] estimate capacity utilization (CU) rates for selected industries in Indian manufacturing for the 20-year period 1976-1996. They estimate a generalized Leontief variable cost function, with capital as a quasi fixed input, to derive capacity utilization measures, using error-component techniques. They observed substantial variations in capacity utilization both across industries and over time. In general, they found that capacity utilization rates were higher in the earlier time-period, dropped in the mid-80s and started rising again in the early 90s. Capacity utilization rates in their analysis are sensitive to input prices with the sole exception of the price of labour. They also confirmed the standard result that variations in demand were a significant driving force for variations in capacity utilization and noticed that capacity utilization is positively related to the magnitude of labor intensity in production. This holds for both between-industries and within-industries. Empirical results also indicate that traditional measures of capacity utilization such as minimum capital-output ratio and peak-to-peak measures are not appropriate proxies for the short-run decision making of the firm regarding capacity utilization. As compared to the estimates derived from the choice-theoretic framework, it was found that the traditional measures exhibit substantial bias.

Goldar and Renganathan (2008) [21] analyze trend in import penetration and capacity utilization in Indian industries in the post-reform period. An attempt has been made to assess econometrically the impact of import penetration on capacity utilization in Indian industrial firms using a data set covering 62 industrial firms for eight years, 1996-97 to 2003-04.The selected firms belong to industries that encountered significant import penetration during 1996-2003.The analysis of trends reveals that a liberalization of imports of manufactures led to a significant increase in import penetration between 1991and 1998, which was followed by a slight decrease in import penetration between 1998 and 2003.Estimates of capacity utilization presented in the paper show that capacity utilization in organized manufacturing fell between 1995 and 2001, but rose between 2001 and 2004.Firm-level analysis of the determinants of capacity utilization , based on cross sectional regression and estimates of dynamic model, brings out that capacity utilization is positively related to size of the firm, market share and market concentration. There are indications from the econometric results that while import penetration have a short-term adverse effect on capacity utilization in industries over time, firms are able to make adjustment and thus, analysis suggests that the adverse effect on capacity utilization may get neutralized in the medium to long term as firms may make adjustments so that the benefits of trade liberalization are more fully realized.

Kumar and Arora (2009) [22] provides the trends of capacity utilization (CU) levels in Indian sugar industry from regional perspectives using time series data spanning

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over the period 1974-75 to 2004-05. The results reveal that: i) on an average, the sugar industry in India is operating with the excess capacity in tune to 13 percent in each sample year; ii) substantial variations in CU levels appear in the sugar industry of 12 major sugar producing states under consideration; iii) a steep decline in CU levels is noted in the post-reforms years relative to what has been observed in the pre-reforms period; iv) except the state of Rajasthan, the sugar industry in the remaining 11 states observed a significant decline in CU levels during the post-reforms period relative to the pre-reforms period; and v) availability of raw material is most significant variable explaining the CU in Indian sugar industry.

2.2 Studies on Capacity Utilization Abroad

There are generally two measures of capacity utilization – one group of studies measure capacity utilization from an estimated cost function and another group follows Federal Resource Board (FRB) or Wharton measure and investigates into the macro-economic implications of high or low capacity utilization.

Rasche and Tatom (1977) [23] assumed a Cobb-Douglas function which implies the assumption of capital-energy substitutability and concluded that increase in energy price since 1973 have reduced the US capacity output by 10% and that therefore any expansionary monetary or fiscal policy would be ill-advised.

Berndt and Morrison (1981) [24] incorporate economic measure of capacity utilization based on dynamic cost function model with capital as a single quasi-fixed factor in one case and capital and non-production labour as the two quasi-fixed inputs in other case and concluded that economic measure of capacity utilization for each year between 1958 and 1977 is greater than one for US manufacturing in both cases whereas Wharton and FRB figures are always less than unity and increase in energy price will have a modestly positive effect on capacity output.

C. J. Morrison (1985) [25] formalizes the definition and representations of primal output and dual cost capacity utilization measures within a dynamic model of a monopolistic firm. A model is estimated using data from the US automobiles 1960-1980 and then primal and dual CU indexes are constructed. Application of these indices to adjustment of productivity measures for disequilibrium is carried out using dual-cost measure. The result indicates that MFP growth based on traditional accounting procedures declined about 20 percent from 1960-65 to 1973-79 from an average annual growth rate of 2.99 percent to 2.38 percent and once one adjusts these traditional calculation for variations in CU by dividing cost CU(CU_C), this variation between sub-periods is reduced.

Shapiro (1989) [26] enquires into the dynamic relations between lagged capacity utilization rates (as measured by FRB) and production, between lagged utilization rates and change in relative prices and also between utilization and other macro-economic variables. Covering a study period of 1967-88 and applying over aggregate manufacturing as well as several disaggregated industries, he finds that relative prices do not rise significantly during the states of high capacity utilization and his findings do not support the hypothesis that high capacity utilization acts as a barrier to further output expansion.

Kim (1999) [27] develops a model of economic capacity utilization and its determinants treating output as endogenous which is applied to US manufacturing for the period 1948-81 and finds that measured capacity utilization is greater than one in almost every year. This study also shows that higher material and capital prices lead to low capacity utilization whereas higher energy price increases capacity utilization.

Garofalo and Malhotra (1997) [28] conclude that faster growing states and states with lower input prices have higher utilization rates whereas states with high capital-output ratio and low proportion of high technology industries in their manufacturing sector generally have low utilization rates. The data base of the study is the pooled cross sections of time series for the period of 1983 through 1990.For the US as a whole, the average of the measured capacity utilization over their study period was 79.0 percent.

Corrado and Mattey (1997) [29] observe noticeably positive correlation between the capacity utilization rates and acceleration of consumer prices excluding food and energy. The correlation between manufacturing capacity utilization and acceleration of manufacturing goods prices is higher and concludes that inflation begins to accelerate when capacity utilization exceeds a threshold near 82 percent.

Omer Goksecus (1998) [30] empirically tests the hypothesis that trade liberalization increases capacity utilization .It calculates capacity utilization for the Turkish Rubber industry by using a Generalized Leontief cost function system. Capacity utilization levels were low but improved when the trade regime shifted from a restrictive to a more liberalized one. The location and size of plants were two significant factors which created capacity utilization differences among plants within the industry. Larger plants and plants located closer to international markets, ceteris paribus, had higher capacity utilization levels. However, capacity utilization levels appeared to improve primarily because of trade liberalization. These occurrences suggest that rubber industry producers were forced to use their installed capacity more fully following trade liberalization.

Subhas.C. Ray and Kankana Mukherjee (2005) [31] compute indirect capacity utilization measure for the total manufacturing sector in USA as well as for number of disaggregated industries for the period 1970-2001 and find considerable variations in capacity utilization rates both across industries and over years within industries and

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their result suggests that expenditure constraint was more binding specially in periods of high interest rate.

The review of studies on capacity utilization discloses the importance of obtaining capacity utilization for a long period of time and for a wide range of industries which are based on an economic notion of capacity. While in developed countries, a number of studies have used both the parametric cost minimization and non-parametric production framework to obtain economically meaningful measures of capacity utilization, there is a lack of such measures in India.

3. CONCLUSION

From the above discussion, it has been found that study of capacity utilization in India as a measure of performance of industrial sector in India has received very little attention. Moreover, most of the studies on capacity utilization have used conventional methods, and have paid insufficient attention to the possible theoretical problems. Most of the studies conducted in India followed the conventional engineering (installed capacity) approaches which are basically statistical constructs based on officially published data.

The principal problem underlying the interpretation of most of the existing studies is the weak link between the underlying economic theory and the used measures of capacity utilization; therefore a theoretical investigation into the problem is difficult to find.

Above all, the studies for India are for specific years or a short time period. The coverage also extends to a limited number of years or only the aggregate manufacturing sector. No comprehensive studies on capacity utilization exist for India which are based on an economic notion of capacity and whose coverage is comprehensive in terms of time period of the study as well as coverage of the industrial sectors.

It is, thus, observed that the earlier studies on capacity utilization has left unaddressed several theoretical and data problems in measuring capacity utilization. Moreover, the computational procedures underlying traditional measures demonstrates that their application and interpretation is ambiguous , since their economic foundations are not well-defined and therefore, analyses concerning their sensitivity to exogenous shocks are not possible. Moreover, very little research work has been undertaken so far on economic measurement of capacity utilization in India. This motivates me to have an inquiry into the previous studies on capacity utilization that can be applied in any industry either in India or aboard to find the operational efficiency of industry.

This research review gives closer and analytical insight into the capacity utilization and may provide an answer in future to the prospective researchers to the debate of whether liberalization has significantly contributed to the improvement in industrial growth and performance or not, amidst the shift in paradigm from "state-intervention-cum-import substitution" to that of "liberalization-cum-export led-growth".

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