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Economic Efficiency in Indian Rubber Industry

Sarba Priya Ray[1]

ABSTRACT The article tries to assess the utilization efficiency of capacity of Indian rubber industry in terms of econometric framework for the period,1979-80 to 2008-09.Capacity output has been obtained at the minimum point of short run average cost curve. The result suggests that there has been declining growth rate of capacity utilization in rubber industry of India during the post reforms period accompanied by declining output growth as well as capacity growth. There exists some excess capacity in the rubber industry which remains unutilized during our study period. The result exhibits that high correlation coefficient between actual output and capacity output for Indian rubber sector implies that major part of under utilization of capacity is intended and low correlation between capacity expansion (CE) and past utilization(CUL) seems to suggest that under utilization, if any, is mainly of the unintended nature, capacity expansions do not move in line with past utilization rates and it also indicates that abolition of restrictions on licensing due to trade liberalization do not help industry to expand capacity. On the other hand, low correlation between capacity expansion (CE) and lagged output (QL) indicates that unintended excess capacity is varying from year to year in an unsystematic matter.

KEY WORDS: capacity, utilization, growth, rubber, industry, India.

JEL Classification: D23, L65

[1]university of Calcutta, India

Introduction

A much overestimated claim without much empirical validation is that trade liberalization opens up new opportunities for enhancing investment as well as productivity, capacity utilization and promoting quality improvement vis-a-vis competitiveness in export markets arising from value added exports. However, the launching of trade reforms and liberalisation policies under the WTO mandated trade policy regime has seriously affected the Indian plantation sector in general and the rubber production sectors in particular. One of the most explicit impacts of the trade liberalisation policies had been the emergence of market uncertainties leading to a fall in the international and domestic prices of commodities caused by the removal or dilution in tariff and non-tariff protective barriers. The magnitude of decline in prices from the peak levels reported during the decade 1990-2001 has been the highest for rubber (42%). The instability in prices (expressed as coefficient of variation (CV) from the peak level prices) has also been the highest for rubber (26%) [Viswanathan, 2005].

The decline in commodity prices triggered its adverse effects on the rubber production and trade sectors leading to an unprecedented crisis in plantation agriculture in India. In the case of rubber, the liberal trade policy reforms have resulted in removal of quantitative restrictions (QRs) which in turn enabled the

Corespondence concerning to this article should be addressed to:
sarbapriyaray@yahoo.com

rubber products manufacturers to directly import rubber through the duty free channels as an incentive for export of rubber products. The policy changes in the post-QRs regime thus paved the way for increased imports of rubber and rubber products into India. Reportedly, almost 96 per cent of the total quantity of rubber imported in the 1990s was routed through the duty-free channels; especially through the advance licensing scheme (ALS).

It is well recognized that capacity utilization plays an important role in evaluating economic activities by means of explaining the behaviour of investment, inflation, productivity profit and output. Therefore the estimation of capacity output and its utilization will be very useful to evaluate the variations in the performance of an industry over a period of time. In this backdrop, the article tries to evaluate the performance of Indian rubber industry in terms of capacity utilization measured econometrically over a period of 30 years from 1979-80 to 2008-09.The paper is analyzed within econometric framework derived from an econometrically tractable short-run variable-cost function which assumes capital as a quasi-fixed input .

The paper is divided into the following sections: Section 2 depicts, in brief, concept of capacity. Section 3 provides data base and methodological issues. Section 4 estimates capacity and its utilization and analyses the results. Section 5 presents summary & conclusions.

Overview of the literature on economic definition of capacity

Capacity utilization measures as a procyclical indicator have been widely used to explain economic fluctuations. Unlike many well defined concepts, capacity has been subjected to alternative definition and misconceptions. Acutally, capacity utilization is an economic perception which refers to the extent to which an enterprise or a nation actually uses its installed productive capacity. Thus, it refers to the relationship between actual output produced and potential output that could be produced with installed equipment, if capacity was fully used.

Engineer's idea of capacity may differ from economist's idea because if certain volume of production is technically possible, it may not be economically desirable. One of the most used definitions of CU rate is as the ratio of actual output to potential output. Concerning the potential output, there are several ways to define it. One is the engineering or technical approach according to which potential output represents the maximum amount of output that can be produced in the short run with existing stock of capital (see Nelson, 1989, p273). A similar discussion can be found in Johansen (1968, see Fare, Grosskopf &Kokkelenberg,1989,p655) where the author defines the capacity as being "…. the maximum amount that can be produced per unit of time with existing plant and equipment ,provided that the availability of variable factors of production is not restricted".Following the last definition, in one of his paper, Fare(1994) describes the necessary and sufficient conditions for the existence of plant capacity as defined by Johansen . In a similar fashion, Fare, Grosskopf and Kokkelenberg(1989) developed measures of plant capacity, plant capacity utilization and technical change in the short run for multi product firms, based on frontier models using non parametric linear programming methods(DEA).

But, operating manager's notion of installed capacity may differ which assumes a variety of considerations such as number of shifts in work, quality of managerial staff, and availability of repair and replacement parts all of which suppose to modify the engineering estimation of plant capacity. Concept of installed capacity particularly is linked to the shift work decision problem which associates the problem of selecting an optimal number of shifts of work - single, double or triple shift. If a firm desires to operate on a single shift basis, the capacity output can be based on this assumption and it would be possible to have 100% capacity utilization rate if time utilization rate of capital is nearly 33% (as because firms operates on a single shift basis of eight hours for each shift assuming that there exists maximum three shifts).Whether decision of capital expansion or multi-shift operation will be undertaken depend ,by and large ,on the matter of weighing the alternative costs and gains both in short –run and long-run. Between two alternatives- expansion of new plant facilities or moving towards multi-shift operation, it is inevitable that most of the developing countries like India would favour the use of multi-shift operation in comparison with the further expansion of investment project because if customers' demand is rising gradually and new equipment is not available or is costly to replace, multi-shift operation would save additional capital outlay and at the same time generates employment opportunities without involving additional capital expenditure. It is also true that where there is underutilization of capacity, there is ample scope of utilizing capital more extensively by increasing working shifts in the industry. Nevertheless, a major lacuna in this engineering approach is that it does not explain the variations in capacity utilization mainly due to lack of any economic foundation.

The economic approach, on the other hand, defines the potential output as being the optimum level of output from the economic point of view. This alternative considers capital as a quasi fixed input and allows for distinction between short and long run cost curves. In the long run , capital can be adjusted in order to achieve optimal (cost minimizing/ profit maximizing) level. In the short run, capital is fixed and only the variable inputs can be varied. The short run equilibrium output , for a competitive firm , is then given by the equality between exogenous output price and the short run marginal cost curve (SRMC), Y*. The potential output would then correspond to that level of output at which short run average total cost (SRATC) is minimized-Y**(and equal to long run average total cost,LRATC).

The definition of output as Y** corresponds to the cost-minimization problem while Y* corresponds to the profit-maximization. As pointed out in Berndt, & Morrison(1981), this difference can affect short run equilibrium in the sense that it may or may not occur at the level of output were the SRATC reaches its minimum:Y* > Y** OR (Y*< Y**) when the output price greater than (lower than) the minimum level of SRATC. The authors address also the issue of how variations in input prices might affect the minimum point of the SRATC and hence Y**.

The economic approach was first analyzed by Cassels(1937) and latter on two more definitions have been introduced. The first was suggested by Klein(1960) and Friedman(1963) and recently Segerson & Squires(1990) who define the potential output as being the output level at which the long run and short run average total cost curves are tangent. Klein (1960) argued that long run average cost curve may not have a minimum and proposed the output level where the short run average cost curve is tangent to the long run average cost curve as an alternative measure of capacity output. This is also the approach adopted by Berndt and Morrison (1981). If technology exhibits constant return to scale, long run average cost curve is horizontal and the capacity level output is not defined, In this case, at the minimum point, the short run average cost curve is tangent to the long run average cost curve. This helps to determine the economic capacity output in the short-run. We prefer choice- theoretic model because it is firmly based in the behavioural concept of economic theory. The choice theoretic approach defines capacity output as the long run desired level of output given capital stock and input prices.

The second approach supported by Cassels (1937) and Hickman(1964) takes as reference the output level at which the short run average total cost curve reaches its minimum. Therefore, an economically more meaningful definition of capacity output originated by Cassel (1937) is the level of production where the firms long run average cost curve reaches a minimum. Cassel (1937) suggests that a firm's capacity output is the minimum of the long run average cost curve. Klein and Friedman suggest capacity output as that output level at which long run and short run average cost curves are tangent. Economic capacity is a short run concept. The fixed nature of some inputs like capital characterizes short run. For any amount of fixed input like capital, the output which can be obtained with the minimum long run cost method is capacity output which will require a higher cost method of production and therefore short run average cost of output is above the long run average cost curve except at the capacity output level. In the short run, higher cost methods are required to obtain additional output since only variable inputs may be increased. Therefore, a firm with fixed capital may choose to operate in the short run at a level of output that differs from the long run desired level and variation in CU is viewed as a short run phenomenon due to quasi-fixity of capital.

As we consider the long run average cost, no input is held fixed. For a firm with the typical 'U' shaped average cost curve, at this capacity level of output, economies of scale have been exhausted but diseconomies have not set in. The physical limit defines the capacity of one or more quasi-fixed input. Klein (1960)defined capacity as the maximum sustainable level of output an industry can attain within a very short time, when not constrained by the demand for product and the industry is operating its existing stock of capital at its customary level of intensity.

Hickman (1964) suggests that capacity is defined as that output which can be produced at minimum average total cost, given the existing stock of plant and equipment and existing techniques and factor prices. The level of capacity is inferred from observed investment behavior. Regression methods are used to estimate a relationship between desired capital stock and several explanatory variables including output, relative prices and time, on the hypothesis that net investment occurs in proportion to the excess of desired over actual stock. The relationship between desired capital stock and output is then inverted to yield a corresponding relationship between capacity and actual capital stock for given prices and techniques. The method is used to calculate aggregate capacity annually for 1949-60 and the properties of the resulting estimates are discussed. New estimates of capacity and its utilization in manufacturing are also presented and compared with those of other investigators.

The relationship between the two economic measures of capacity utilization (CU) depends on the degree of scale economics for the unit that is being analyzed. Berndt and Hesse(1986) advocate that under the assumption of prevailing constant return to scale in the long run , the tangency point between the long run and short run curves will coincide with the point where the long run and short run average total cost curve reach their minimum. Hence, two economic measures of CU would be equivalent. Nelson (1989) argued that Capacity utilization (CU) is usually defined as the ratio of actual output to the output corresponding to (i) the minimum point on the SRATC curve, (ii) the point of tangency between the LRATC and SRATC curves. In practice, however, CU is often measured as the ratio of actual to the maximum potential output consistent with a given capital stock. This paper demonstrates how to estimate the theoretical measures of CU, and examines the correlation between the three measures of CU, and the McGraw-Hill estimates of CU, using data from a sample of US privately owned electric utilities for 1961-83. Nelson(1989,p274), using data from a sample of US privately owned electric utilities reaches the conclusion that : 'The choice of a particular measure of CU may be little consequence if all of the measure are highly correlated, and if the correlation is constant over time and across firms. If this is not the case, however, the choice may influence the conclusions to be drawn from a study".

Questions about the definition and construction of capacity utilization measure are often based on distinctions between "engineering" or "technical" as compared to "economic" measures, "maximum" versus "optimal" usage of capacity, and "primal" as contrasted to "dual" representations of the notion of "best", or optimum. The many combinations and permutations of these concepts offered in the literature often differ in terms of the definition and treatment of the stocks defining the capacity base, and the variable inputs determining their utilization. The basic conceptual issue is that engineering or technical measures represent the most output that can physically be produced given the existing input base, whereas one might think a policy-relevant measure of potential output should instead be founded on some notion of (economic) "optimization" rather than (physical) "maximization".By contrast, economic measures are founded on the idea of an optimum amount of output that might be produced, in terms of the costs or profits emanating from production. This alternative perspective can be represented by a dual cost (or profit) function, defined in terms of the minimum possible input costs required to produce a given amount of output, taking both technological and behavioral optimization into account.

Methodology

This paper covers a period of 30 years from 1979-80 to 2008-09. The entire period is divided into two phases as pre-reform period (1979-80 to 1991-92) and post-reform period (1991-92 to 2008-09).

Bearing in mind variations in CU as a short-run phenomenon caused by the quasi-fixed nature of capital, an econometrically tractable short-run variable-cost function which assumes capital as a quasi-fixed input has been used to estimate CU.

Econometric Model

We have considered a single output and three input framework (K, L, E) in estimating CU and assume that firms produce output within the technological constraint of a well-behaved production function. A production function is considered to be well-behaved if it has positive marginal product for each input and it is quasi concave and also satisfies the conditions of monotonocity. Quasi-concavity required that the bordered Hessian matrix of first and second partial derivatives of the production function be negative semi definite.

Y = f (K, L, E) where K, L and E are capital, labour and energy respectively. Since capacity output is a short-run notion, the basic concept behind it is that firm faces short-run constraints like stock of capital .Firms operate at full capacity where their existing capital stock is at long-run optimal level. Capacity output is that level of output which would make existing short-run capital stock optimal.

Rate of CU is given as

$$CU = Y/Y^* \qquad (1)$$

Y is actual output and Y* is capacity output.

In association with variable profit function, there exist variable-cost functions which can be expressed as

$$VC = f(P_L, P_E, K, Y) \qquad (2)$$

Short run total cost function is expressed as

$$STC = f(P_L, P_E, K, Y) + P_K .K \qquad (3)$$

PK is the rental price of Capital.

Variable cost equation which is variant of general quadratic form for (2) that provide a closed form expression for Y* is specified as

$$VC = \alpha_0 + K_{-1} (\alpha_K + ½ \beta_{KK} \left[\frac{K_{-1}}{Y}\right] + \beta_{KL} P_L + \beta_{KE} P_E) + P_L (\alpha_L + ½\beta_{LL} P_L + \beta_{LE} P_E + \beta_{LY} Y) + P_E (\alpha_E + ½\beta_{EE} P_E + \beta_{EY} Y) + Y(\alpha_Y + ½ \beta_{YY} Y) \qquad (4)$$

K_{-1} is the capital stock at the beginning of the year which implies that a firm makes output decisions constrained by the capital stock at the beginning of the year. Similar functional form has been previously estimated by Denny et al (1981). The variable cost function is based on the assumption that some input like capital cannot be adjusted to their equilibrium level. Therefore, the firm minimizes variable cost given the output and the quasi-fixed inputs.

Capacity output (Y*) for a given level of quasi-fixed factor is defined as that level of output which minimizes STC. So, the optimal capacity output level, for a given level of quasi-fixed factors, is defined as that level of output which minimizes STC. So, at the optimal capacity output level, the envelop theorem implies that the following relation must exist.

$$\partial STC/\partial K=\partial VC/\partial K+PK=0 \qquad (5)$$

In estimating Y*, we differentiate VC equation (4) w.r.t K-1 and substitute expression in equation (5)

$$Y^* = \frac{-\beta_{KK.} K_{-1}}{(\alpha_{K} + \beta_{KL}P_L + \beta_{KE}P_E + P_K)} \qquad (6)$$

The estimates of CU can be obtained by combining equation (6) and (1).

Description of data and variables

It is the intricacy which is often faced by researchers in conducting studies on CU in Indian industries is that available official data on Industrial capacities are quite unsatisfactory. The present study is based on industry-level time series data taken from several issues of Annual Survey of Industries, NAS and Economic Survey ,Monthly statistics of foreign trade, Govt. of India, Statistical Abstracts (various issues), RBI bulletin, CMIE etc covering a period of 30 years commencing from 1979-80 to 2008-09. Selection of time period is largely guided by availability of data. Till 1988 – 89, the classification of industries followed in ASI was based on the National Industrial classification 1970 (NIC 1970). The switch to the NIC-1987 from 1989-90 and also switch to NIC-1998 requires some matching. For price correction of variable, wholesale price indices taken from official publication of CMIE have been used to construct deflators.

Output and Variable cost

Output is measured as real value added produced by manufacturers (Y = PLL+ PK.K-1+ PE.E) suitably deflated by WIP index for manufactured product (base 1981-82 = 100) to offset the influence of price changes variable cost is sum of the expenditure on variable inputs (VC = PLL+ PE.E). Griliches and Ringstad (1971) have preferred GVA to gross output and reasons for imposing preference have been mentioned in their study.

Labour and price of labour

Total number of persons engaged in Indian rubber industry is used as a measure of labour inputs. Price of labour (PL) is the total emolument divided by number of labourers which includes both production and non-production workers. One serious limitation of this assumption is that this does not take into account variations in quality and the composition of labour force.

Energy and Price of energy

Deflated cost of fuel has been taken as measure of energy inputs. Industry level time series data on cost of fuel of Indian rubber sector have been deflated by suitable deflator (base 1981-82 = 100) to get real energy inputs. An input output table provides the purchase made by manufacturing industry from input output sectors. These transactions are used as the basis to construct weight and then weighted average of price index of different sectors is taken. Taking into consideration 115 sector input -output table (98-99) prepared by CSO, the energy deflator is formed as a weighted average of price indices for various input-output sectors which considers the expenses incurred by manufacturing industries on coal, petroleum products and electricity as given in I-O table for 1998-99. The WIP indices (based 1981- 82) of Coal, Petroleum and Electricity have been used for these three categories of energy inputs. The columns in the absorption matrix for 66 sectors belonging to manufacturing (33- 98) have been added together and the sum so obtained is the price of energy made by the manufacturing industries from various sectors. The column for the relevant sector in the absorption matrix provides the weights used.

Due to unavailability of data regarding periodic price series of energy in India, some approximations become necessary. We have taken weighted aggregative average price index of fuel (considering coal, petroleum and electricity price index, suitably weighted, from statistical abstract) as proxy price of energy. To compute the price of energy inputs, some studies have aggregated quantities of different energy inputs using some conversion factors (say British Thermal units or coal replacement etc.) and then take the ratio of expenditure on energy to the aggregate quantity of energy. This method is criticized because it assumes different types of energy inputs to be perfect substitutes.

Capital stock and price of capital

Deflated gross fixed capital stock at 1981-82 prices is taken as the measure of capital input. The estimates are based on perpetual inventory method. The procedure for the arriving at capital stock series is depicted as follows:

First, an implicit deflator for capital stock is formed on NFCS at current and constant prices given in NAS. The base is shifted to 1981-82 to be consistent with the price of inputs and output.

Second, an estimate of net fixed capital stock (NFCS) for the registered manufacturing sector for 1970-71 (benchmark) is taken from National Accounts Statistics. It is multiplied by a gross-net factor to get an estimate of gross fixed capital stock (GFCS) for the year 1970-71. The rate of gross to net fixed asset available from RBI bulletin was 1.86 in 1970-71 for medium and large public Ltd. companies. Therefore, the NFCS for the registered manufacturing for the benchmark year (1970-71) as reported in NAS is multiplied by 1.86 to get an estimate of GFCS which is deflated by implicit deflator at 1981-82 prices to get it in real figure. In order to obtain benchmark estimate of gross real fixed capital stock made for registered manufacturing, it is distributed among various two digit industries (in our study, rubber industry) in proportion of its fixed capital stock reported in ASI, 1970-71)

Third, from ASI data, gross investment in fixed capital in rubber industries is computed for each year by subtracting the book value of fixed in previous year from that in the current year and adding to that figure the reported depreciation on fixed asset in current year. (Symbolically, It = $(\beta_t - \beta_{t-1} + D_t) / P_t$) and subsequently it id deflated by the implicit deflator to get real gross investment.

Fourth, the post benchmark real gross fixed capital stock is arrived at by the following procedure. Real gross fixed capital stock (t) = real gross fixed capital stock (t – 1) + real gross investment (t). The annual rate of discarding of capital stock (Dst) is assumed to be zero due to difficulty in obtaining data regarding Dst.

Rental price of capital is assumed to be the price of capital (PK) which can be estimated following Jorgenson and Griliches (1967):

$$PtK = rt + d\,t - \frac{P^{\bullet}_k}{P_k}$$

Where rt is the rate of return on capital in year t, d t is the rate of depreciation of capital in the year t

and $\frac{P^{\bullet}_k}{P_k}$ is the rate of appreciation of capital.

Rate of return is taken as the rate of interest on long term government bonds and securities which is collected from RBI bulletin (various issues). Prime lending rate is generally viewed as an opportunity cost of capital, but problem is that there is no unique lending rate available for use. So, we have used rate of interest on long term government bond and securities as rate of return on capital [as previously used by Jha, Murty and Paul (1991)].Alternatively, one can use the gross yield on preferential industrial shares, if available, as Murty (1986) has done.

The rate of depreciation is estimated from the reported figures on depreciation and fixed capital as available in ASI which Murty (1986) had done earlier. However, we have not tried corrections for the appreciation of value of capital in the estimates of price of capital services. As Jorgenson and Griliches note capital gains should be deducted from ($r_t + d_t$) but several studies have not done so and adjustment for capital gains does not seem to make much difference to the result.

Analysis of capacity and its utilization

In this section, we present the analysis of the results regarding measurement and trend in capacity utilization of rubber industry in India under our consideration. For easy comparison of the estimates, we have also subdivided the entire period into 1979-80 to 1991-92 which is termed as pre-reform period and 1991-92 to 2008-09 as post-reform period.

Initially, we have tries to depict the results of a multiple regression analysis applied to measure capacity output and the trend in capacity utilization. The variable cost equation shown as equation (4) has been estimated by the ordinary least square methods (OLS). Our model assumes that capacity utilization (CU) is a function of input prices, output and quasi-fixed capital. We find that capacity utilization and input prices have a negative relationship and capacity utilization (CU) and output have a positive one. The derivative of VC (equation 4) with respect to K is negative since capital will substitute labour and energy. In order to test for the concavity of the variable cost function with respect to variable input prices , its Hessian matrix for negative semi-definiteness is evaluated and it is found that concavity condition is fulfilled at all observation points. Therefore, the partial derivative with respect to each of input prices is negative. The partial derivative of VC with respect to output is positive because in our empirical results, $\beta_{KK} > 0$ and $(\alpha_K + \beta_{KL}P_L + \beta_{KE}P_E + P_K) < 0$ for all data points. Therefore, positive relation between output and capacity utilization (CU) is an indication that an increase in demand will lead to higher levels of capacity utilization.

The variations in capacity utilization in Indian rubber industry are presented in Table1. The key observations emerged out of the analysis of Table 1 are depicted below.

First, it has been obviously found from the estimated results that CU ratios are less than unity for all observations. There is a prominent diminishing trend in capacity utilization over years because average CU declined from 0.6608 in pre-reform period to 0.6154 in post-reform period implying a decline of 6.87% as well as same declining trend was set in average growth rate of CU(as is evident from table 1,it declines from 2.71% in 1991-92 to -0.42% in 2008-09).This implies that actual output fell far short of capacity output of Indian rubber industry which in turn signifies a widening difference between capacity output and actual output. Trend in capacity utilization indicates the presence of idle or excess capacity in the industry for the entire study period.

Second, if capacity output is taken to be the economic capacity derived from optimization process, the CU ratio could exceed one or it may be less than one. The implication of economic CU less than unity (as our result suggests) is that production is to the left of the minimum point of short-run average total cost curve which further signifies that Indian rubber sector could have reduced its short run generation costs with gradually moving to the tangency point or minimum point of the short run average cost curve.

Third, it is apparent from our study that the economic CU index ranges from about 0.5229 to 0.8202. Capacity expansion varies from 10.08% to 4.66% during these two time frames.

Fourth, a comparison of the average utilization of capacity in the two periods (table-1 below) showed a

Table1. Capacity utilization of Rubber industry in India at aggregate level, 1979-80 to 2008 -09.

Pre-reform period(1979-80 to 1991-92)							*Post-reform period(1991-92 to 2008-09)*						
Year	Actual output (Cr. Rs)	Capacity output (Cr.Rs)	CU	Output growth	Capacity growth	Growth rate of CU	Year	Actual output	Capacity output	CU	Output growth	Capacity growth	Growth rate of CU
79-80	197	349	0.5644	-	-	-	91-92	677	995	0.6804	-2.81	2.68	-5.57
80-81	221	324	0.6820	12.18	-7.16	20.84	92-93	658	1024	0.6425	7.29	2.91	-4.20
81-82	292	356	0.8202	32.13	9.88	20.26	93-94	706	1147	0.6155	5.67	12.01	-5.69
82-83	297	391	0.7596	1.71	9.83	-7.39	94-95	746	1285	0.5805	6.43	12.03	9.77
83-84	299	452	0.6615	0.67	15.60	-12.91	95-96	794	1246	0.6372	5.29	-3.04	0.22
84-85	374	521	0.7178	25.08	15.27	8.51	96–97	836	1309	0.6386	-2.63	5.06	-5.51
85-86	469	684	0.6857	25.40	31.29	-4.47	97–98	814	1349	0.6034	7.99	3.06	3.83
86-87	376	683	0.5505	-19.83	-0.15	-19.72	98–99	879	1403	0.6265	5.01	4.00	1.47
87-88	386	567	0.6808	2.66	-16.98	23.67	99–00	923	1452	0.6357	6.72	3.49	-0.61
88-89	419	783	0.5351	8.55	38.10	-21.40	00–01	985	1559	0.6318	-1.12	7.37	-1.99
89-90	508	854	0.5948	21.24	9.07	11.16	01–02	974	1573	0.6192	-14.58	0.90	-15.55
90-91	637	969	0.6574	25.39	13.47	10.52	02-03	832	1591	0.5229	17.91	1.14	14.32
91-92	677	995	0.6804	6.28	2.68	3.50	03–04	981	1641	0.5978	8.87	3.14	-0.97
							04-05	1068	1804	0.5920	1.69	9.93	-1.59
							05-06	1086	1864	0.5826	8.56	3.33	9.61
							06-07	1179	1846	0.6386	7.89	-0.97	-2.32
							07-08	1272	2039	0.6238	3.93	10.46	-2.39
							08-09	1322	2171	0.6089	4.24	6.47	-5.57
average			0.6608	11.79	10.08	2.71				0.6154	-2.81	4.66	-0.42

Source: Own study

lower average utilization in the post- reform period as compared to pre- reform period. The CU trends have also registered a gradual decline since the beginning of the decades. Declining trends have been noticed in the average growth rate of capacity output and actual output during those two periods but actual growth rate in output declined more rapidly than capacity output.

Trends growth rate of capacity utilization of Indian rubber industry at aggregate level are presented in table 2 to support the above mentioned result. The semi-log function was finally selected to explain the trend. The semi-log model is log Y = a + bt, where Y = Capacity utilization, a = Constant, t = Time in years, b = Regression coefficient and in this model, the growth rate will be (b x 100) in terms of percentage.

Estimated results in table 2 are in favour of the argument that capacity grows in a declining mode in post reform period, simultaneously output goes on declining more rapidly than capacity growth. This results in declining growth rate in capacity utilization. It is expected that no single explanation for variations in capacity utilization in this industry group will hold true. Nevertheless, it seems that due to heavy investment in the 1990s, unaccompanied by commensurate expansion of demand, capacity utilization went on worsening in this manufacturing industry.

Now, we analyze how capacity expansion of Indian rubber industry over time are correlated with past CU rates and production level and whether there is any correlation between actual and capacity output over time.

Table 2. Trend Growth rate of capacity, output and capacity utilization

Pre- reform period (1979-80 to 1991-92)				*Post- reform period (1991-92 to 2008-09)*			
Industry/year	Capacity	output	Capacity utilization	Industry/year	Capacity	output	Capacity utilization
Indian Rubber Industry	4.31*(13.22)#	3.93 (10.20)	-0.3830 (2.94)	**Indian Rubber Industry**	1.79 (25.02)	1.63 (14.05)	-0.166 (-2.55)
Adjusted R^2	0.94	0.90	0.47		0.97	0.92	0.31

Source: Own study

* trend growth rate,
\# t values

Table 3. Correlation Analysis

Correlation between CE and CU_L	1. Correlation between CE and Q_L	Correlation between Q and CQ
0.22	0.19	0.99

Source: Own study

CE = Capacity expansion CQt - CQt-1
CU_L = Lagged capacity utilization ratio = CUt-1
Q_L = Lagged production = Qt-1
Q = observed output
CQ = capacity output
No. of observation = 25 years.

Table 3 exhibits that correlation coefficient between actual output and capacity output is quite-high (0.99) for Indian rubber sector implying major part of under utilization of capacity is intended and low correlation (0.22) between capacity expansion (CE) and past utilization(CU_L) seems to suggest that under utilization, if any, is mainly of the unintended nature, capacity expansions do not move in line with past utilization rates and it also indicates that abolition of restrictions on licensing due to trade liberalization do not help industry to expand capacity. On the other hand, low correlation (0.19) between capacity expansion (CE) and lagged output (Q_L) indicates that unintended excess capacity is varying from year to year in an unsystematic matter.

Summary and conclusions

The article tries to assess the utilization efficiency of capacity in terms of econometric framework for the period,1979-80 to 2008-09.The result suggests that there has been declining growth rate of capacity utilization in rubber industry of India during the post reforms period accompanied by declining output growth as well as capacity growth. There exists some excess capacity in the rubber industry which remains unutilized during our study period. The result exhibits that high correlation coefficient between actual output and capacity output for Indian rubber sector implies that major part of under utilization of capacity is intended and low correlation between capacity expansion (CE) and past utilization(CU_L) seems to suggest that under utilization, if any, is mainly of the unintended nature, capacity expansions do not move in line with past utilization rates and it also indicates that abolition of restrictions on licensing due to trade liberalization do not help industry to expand capacity. On the other hand, low correlation between capacity expansion (CE) and lagged output (Q_L) indicates that unintended excess capacity is varying from year to year in an unsystematic matter.

In conclusion, it can be expected that more comprehensible insight is attainable if analysis is conducted on the basis of disaggregated firm level data base.

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