JEKEM
An ICA Institute Publication

INDIA, CHINA AND AMERICA INSTITUTE
1549 CLAIRMONT ROAD, SUITE 202 ● DECATUR, GA 30033 USA
WWW.ICAINSTITUTE.ORG

Measuring Capacity Utilization and Evaluating the Impact of Liberalization on Capacity Utilization of the Indian Drug and Pharmaceutical Industry

Sarba P. Ray

Journal of Emerging Knowledge on Emerging Markets
Volume 3
November 2011

Measuring Capacity Utilization and Evaluating the Impact of Liberalization on Capacity Utilization of the Indian Drug and Pharmaceutical Industry

Sarba P. Ray
Shyampur Siddheswari Mahavidyalaya,
University of Calcutta

Journal of Emerging Knowledge on Emerging Markets
Volume 3
November 2011

The drug & pharmaceutical industry play a vital role in the health care of any country. Rapid growth of this industry requires further attention because even after 64 years of independence, India, with around 15 % of the world population, accounts for less than 2 % of the drug production in the world. Annual per capita consumption of medicine in India is less than 2% of that in Japan. Health care expense in India is a dismal 0.8 % of GDP compared with 12.4 % in U.S.A. 6.5% in Japan and 6.2 % in the U.K, despite higher incidence of disease and malnutrition. The poverty and disease in India on one hand calls for higher standard of healthcare and pharmaceuticals production and on the other, stultifies the growth of industry due to poor affordability of an average Indian. The drug and pharmaceutical industry has, therefore, encountered a tough situation which most industry have always found it difficult to provide abundant quantity of quality products at low prices.

India has undertaken a major economic reform program since 1991. By virtue of this program, intensive changes have been made in the industrial policy of the Indian

https://digitalcommons.kennesaw.edu/jekem/vol3/iss1/13
DOI: 10.7885/1946-651X.1045

government relaxation of licensing rules, reduction in tariff rates, removal of restrictions on import etc. are among those which have been initiated in the early stages. The policy reforms had the objectives to make Indian industries as well as the entire economy more efficient, technologically up-to-date and competitive. This was done with the expectation that efficiency improvement, technological up-gradation and competitiveness would ensure Indian industry to achieve rapid growth.

The Indian pharmaceutical sector is likely to witness major changes as a result of liberalization and pressure from GATT (General Agreement on Trade and Tariff) and WTO (World Trade Organization). Price controls are gradually being dismantled with less than 50% of the drugs coming under the purview of DPCO. This number is likely to decrease further. In addition, as a signatory to WTO by 2005, India will be required to follow the same product patent laws governing the west. MNCs (Multinational Companies) in the past have been constrained in launching new products because of strict patents enforcement law governing their home countries. They are now keenly awaiting the protection of product patent in 2005, which will provide greater freedom to introduce new advanced international portfolio products. Indian pharmaceutical companies on the other hands are likely to suffer as a result of patent protection. It will become increasingly difficult for them to introduce new product without investing in basic research. Intensive research requires large investment that can only be recovered by spreading costs over a greater volume, thereby reducing average costs. However, because of high industry fragmentation and a lack of research, few domestic companies are able to reap the benefit of scale. Drug manufacturers are currently the most aggressive overseas investors of all Indian industries. They are pursuing foreign acquisitions due to their need to: improved global competitiveness, move up the value chain, create and enter new markets, increase their product offering, acquire assets(including research and contract manufacturing firms, in order to further boost their outsourcing capabilities) and new products, consolidate their market shares, and compensate for continued sluggishness in their home market.

In view of greater openness in the Indian economy due to trade liberalization, the private sector can build and expand capacity without much regulation. There had been an investment boom in the manufacturing sector in the first half of 1990s (Uchikawa, 2001). The advocates of liberalization believe that these policy reforms will improve industrial growth and performance significantly while critics argue that total withdrawal of restrictions on several matters will have a negative effect on future growth and performance of the industry.

As a part and parcel of self-appraisal, each and every industry is constantly engaged in the search for tools for assessing its own current performance. This performance can be judged suitably by comparing it with the various targets, past achievements and operative capacity. Business decision making and policy formulation mostly depend on economic indicators. In a capital scarce economy like India, manufacturing capacity utilization is a key indicator of economic performance which not only determines how much more output can be obtained by fuller utilization of existing capacity but also defines the required expansion of capacity for a targeted output and also explains changes in investment, inflation, level of resource utilization etc. Higher unutilized capacity implies slower growth rates. 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.

Against this backdrop, this paper attempts to measure capacity utilization of the Indian pharmaceutical industry econometrically and analyze its trend over a period of 29 years- from 1979-80 to2007-08 .The article also assesses the impact of liberalization on capacity utilization. Another objective of this paper is to assess the influence of various explanatory industrial characteristics on capacity utilization in a significant manner during the reform period.

This study is conducted for the aggregates of an industry where capacity utilization has been taken as a yard stick in measuring performance assuming that all the firms in an industry behave alike and, therefore, industry level characteristics could be attributable to all the firms operating in that industry. It is not claimed that capacity utilization is the only yard stick for measuring the performance of an industry where there exist profitability and productivity variables for evaluating industrial performance.

This paper is divided into the following sections: Section II depicts brief overview of pharmaceutical industry and conceptual issues related to capacity. Section III provides data base and methodology. Section IV estimates capacity and its utilization and interprets the results and Section V assesses and analyzes the impact of liberalization on capacity utilization and section VI analyzes the impact of various factors that influences capacity utilization. Section VII presents summary and conclusions.

Brief overview of Pharmaceutical Industry

The annual turnover of the Indian pharmaceutical industry is estimated to be about US $ 17 billion (over Rs. 68,000 crore) during the year 2006-07. The share of export of drugs, pharmaceuticals and fine chemicals is more than Rs. 24,000 crore (around US $ 6 Billion).This segment of Industry has shown tremendous progress in terms of infrastructure development, technology base and wide range of products. The industry now produces bulk drugs belonging to all major therapeutic groups requiring complicated manufacturing processes and has also developed excellent GMP (Good Manufacturing Practices) compliant facilities for the production of different dosage forms. The strength of the industry is in developing cost effective technologies in the shortest possible time for drug intermediates and bulk activities without compromising on quality. This is realized through the country's strengths in organic chemicals' synthesis and process engineering.

The Indian pharmaceutical industry has come a long way from being almost non-existent in the 1970s to being one of the largest and most advanced pharmaceutical industries in the world. The domestic pharmaceutical output has increased at a CAGR (Compound annual growth rate) of 13.4%.Currently, the Indian pharmaceutical industry is valued at $8 billion

https://digitalcommons.kennesaw.edu/jekem/vol3/iss1/13
DOI: 10.7885/1946-651X.1045

(approx).Globally, the industry ranks 4th in terms of volume and 13th in terms of value. It provides employment to millions and ensures that essential drugs are available to the vast population of India at affordable prices. Indian pharmaceutical industry has attained wide ranging capabilities in the complex field of drug manufacture and technology developed through a range of governmental incentives and the industry has been declared a knowledge based industry. This Industry is a highly organized sector and is extremely fragmented with severe price competitions and governmental price control. The major players in the Industry are Ranbaxy, Dr. Reddy's Laboratories, Cipla, Sun Pharmaceutical Industries, Lupin Lab, Glaxo Smith Kline Pharmaceutical, Cadila Healthcare, Aventis etc.

India has the highest number of manufacturing plants approved by US FDA, which is next only to that in the US. More than 85% of the formulations produced in the country are sold in the domestic market. Over 60% of India's bulk drug production is exported. India holds the lion's share of the world's contract research business, as activity in the pharmaceutical market continues to explode, over 15 prominent contract research organizations (CROs) are now operating in India attracted by her ability to offer efficient R&D on a low- cost basis. Thirty five percent of business is in the field of new drug discovery and the rest 65 percent of business is in the clinical trials arena. India offers a huge cost advantage in the clinical trials domain compared to Western countries. India got a major boost with the signing of Trade Related Intellectual Property Rights (TRIPS) under the General Agreement on Tariffs and Trade (GATT) in January 2005 with which it began recognizing global patents. The acceptance of patent laws and the rise of Contract Research and Manufacturing Sourcing (CRAMS) have led to the diversification of revenue streams, enabling the Indian pharmaceutical industry to experience high market growth.

India is today recognized as one of the leading global players in pharmaceuticals. Europe accounts for the highest share of over 23% of Indian pharma exports followed by North America and Asia. Exports to the USA have crossed the land mark figure of US $1 billion during 2006-07. Internationally recognized as amongst the lowest-cost-producers of drugs, India holds fourth position in terms of volume and thirteenth position in terms of value of production in pharmaceuticals. It is estimated that by the year 2010, the Indian pharmaceutical industry has the potential to achieve over Rs.1,00,000 crore production of formulations and bulk drugs. Exports constitute a substantial part of the total production of pharmaceuticals in India. The formulations contribute nearly 55% of the total exports and the rest 45% comes from bulk drugs. Pharmaceutical exports clocked $7.2 billion in 2007-08, accounting for six per cent of the country's total exports. Indian companies export drugs to over 200 countries, but the top 25 markets, which include the US, Germany, Russia, China and a few European and African countries, account for about half of the total. Indian drug makers exported medicines worth Rs 31,608 crore during April 2008-January 2009 and exports shot up 30.7% as compared to last year due to a weak Indian currency and increased demand for low-cost generic medicines. US is the largest importer of drugs followed by Russia and Germany. Pharmaceutical industry accounts for about 2.91% of total FDI into the country.

Concept of Capacity

The concept of capacity has played an important role in economic analysis. Unlike many well-defined concepts, capacity has been subjected to alternative definition and misconceptions. The economists' definition differs from the engineers' idea of capacity since what is technically possible may not be economically desirable. Simply, capacity output is defined as the maximum feasible level of output of the firm. 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. 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 inputs. Klein 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. 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[1] because it is firmly based in the behavioral 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 difference between engineering and economic capacity can be termed as intended excess capacity and that between economic capacity and actual output as unintended excess capacity.

III. Data base and methodology:

[1] Cassel (1937) first suggests that a firm's capacity output is the minimum of the long run average cost curve. Klein (1960) and Friedman (1963) 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.

https://digitalcommons.kennesaw.edu/jekem/vol3/iss1/13
DOI: 10.7885/1946-651X.1045

This paper covers a period of 29 years from 1979 – 80 to 2007 – 08. The entire period is divided into two phases as pre- reform period (1979 – 80 to 1990 – 91) and post- reform period (1991- 92 to 2007 – 08).

Viewing variations in capacity utilization 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 capacity utilization.

Econometric Specification:

Considering a single output and three input framework (K, L, E) in estimating capacity utilization where K, L and E are the capital, labor and energy inputs respectively, we assume that firms produce output within the technological constraint of a well behaved [2] production function.

Y = f (K, L, E) where K, L and E are capital, labor 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 capacity utilization is given as

$$CU = Y/Y^* \quad \ldots\ldots\ldots (1)$$

Y is actual output and Y* is capacity output. Our model assumes that capacity utilization is a function of input prices, output and quasi-fixed capital .

Therefore, in association with variable profit function, there exists variable cost function which can be expressed as

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

P_L and P_E are the price of labor and price of energy respectively and P_K is the rental price of capital.

Short run total cost (STC) function is expressed as

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

P_K is the rental price of Capital.

[2] 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.

Variable cost equation [3] which is variant of general quadratic form for (2) that provide a closed form expression for Y* is specified as

$$VC = \alpha_0 + K_{-1} \left[\alpha_K + \tfrac{1}{2} \beta_{KK} \left(\frac{K_{-1}}{Y} \right) + \beta_{KL}.P_L + \beta_{KE}.P_E \right]$$

$$+ \; P_L (\alpha_L + \tfrac{1}{2}\beta_{LL}.P_L + \beta_{LE}.P_E + \beta_{LY}.Y)$$

$$+ \; P_E (\alpha_E + \tfrac{1}{2}\beta_{EE}.P_E + \beta_{EY}.Y) + Y(\alpha_Y + \tfrac{1}{2} \beta_{YY}.Y) \quad \ldots\ldots\ldots (4)$$

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. 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.

$$\partial STC/\partial K = \partial VC/\partial K + P_K = 0 \quad \text{--------------------} (5)$$

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

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

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

Description of data and variables:

[3] 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.

https://digitalcommons.kennesaw.edu/jekem/vol3/iss1/13
DOI: 10.7885/1946-651X.1045

A difficulty faced by researchers in conducting studies on capacity utilization 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 , Statistical abstracts (various issues), RBI bulletin etc. covering a period of 29 years commencing from 1979-80 to 2007-08. Selection of time period is largely guided by availability of data. [4]

Output and Variable cost:

Details of methods employed for the measurement of variables are given in Appendix. Output is measured as gross output ([Appendix-A1]) produced by manufactures 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 = $P_L.L + P_E.E$).

Labor and price of labor:

The total number of persons engaged in the pharmaceutical sector is used as a measure of labor inputs. Price of labor (P_L) is the total emolument divided by number of laborers which includes both production and non-production workers (Goldar & others, 2004) [5]

Energy and Price energy:

Deflated cost of fuel [(Appendix-A2)] has been taken as measure of energy inputs. 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. [6]

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. [(Appendix-A3)] Rental price of capital is

---

[4] Until 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 NIC1998 requires some matching. For price correction of variable, wholesale price indices taken from official publication of CMIE have been used to construct deflators.

[5] One serious limitation of this assumption is that this does not take into account variations in quality and the composition of labor force.

[6] 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.

assumed to be the price of capital (P_K) which can be obtained from the ratio of interest paid to capital invested.

Empirical Estimation of Capacity and its Utilization

This section presents the results of a multiple regression analysis applied to measure capacity output. The variable cost equation as shown in equation (4) above has been estimated by the ordinary least square method (OLS). In Tables 1 and 2, we reproduce measure of capacity utilization by economic measure for Indian pharma industry at aggregate level during pre and post-reform period respectively. From the estimate, we get a broad picture regarding variation in CU ratios.

Table – 1

Trend in utilization of capacity of Indian Pharmaceutical industry at aggregate level. (Pre-reform period -1979-80 to 1991-92)

Year	Economic capacity output (Y*)(Cr. Rs)	Actual output (Y) (Cr. Rs)	Economic CU = Y/Y*	Growth in capacity (%)	Growth in output (%)
1979-80	3142	2397	0.7629	-	-
80-81	3293	2803	0.8512	4.81	16.94
81-82	3724	3361	0.9025	13.09	19.91
82-83	3899	3649	0.9359	4.70	8.57
83-84	3988	4069	1.0203	2.28	11.51
84-85	4331	4312	0.9956	8.60	5.97
85-86	4619	4175	0.9039	6.65	-3.18
86-87	5064	5274	1.0415	9.63	26.32
87-88	5312	5192	0.9774	4.90	-1.55
88-89	5277	5421	1.0273	-0.66	4.41
89-90	5598	5643	1.0080	6.08	4.10
90-91	5989	5879	0.9816	6.98	4.18
91-92	6739	5982	0.8877	12.52	1.75
Average			0.9458	6.63	8.24

Source: Created by author from Annual Survey of Industries (several issues).

https://digitalcommons.kennesaw.edu/jekem/vol3/iss1/13
DOI: 10.7885/1946-651X.1045

Table – 2

Trend in utilization of capacity of Indian Pharmaceutical industry at aggregate level. (Post-reform period-1991-92 to 2007-08)

Year	Economic capacity output (Y*)(Cr. Rs)	Actual output (Y) (Cr. Rs)	Economic Cu = Y/Y*	Growth in capacity (%)	Growth in output (%)
91-92	6739	5982	0.8877	-	-
92-93	7058	6236	0.8835	4.73	4.25
93-94	6172	6425	1.0410	-12.55	3.03
94-95	8956	9293	1.0376	45.11	44.64
95-96	9562	9142	0.9561	6.77	-1.62
96-97	11438	10248	0.8960	19.62	12.10
97-98	11726	10783	0.9196	2.52	5.22
98-99	12452	12846	1.0316	6.19	19.13
99-00	12789	12874	1.0066	2.71	0.22
00-01	13589	13985	1.0291	6.26	8.63
01-02	14578	14027	0.9622	7.28	0.30
02-03	14129	11433	0.8092	-3.08	-18.49
03-04	6739	5982	0.8877	-52.30	9.76
04-05	14785	12549	0.8488	119.39	2.75
05-06	14524	12894	0.8878	-1.77	10.57
06-07	14623	14257	0.9750	0.68	5.93
07-08	15743	15102	0.9593	7.66	4.25
average			0.9423	9.95	6.92

Source: Created by author from Annual Survey of Industries (several issues).

From the analysis, we notice a number of important findings.

First, it has been noticed that if capacity output is taken to be the economic capacity derived from optimization process, the CU ratio could exceed one in more general cases indicating that production is to the right of the minimum point of short-run average total cost curve inducing cost-reducing net-investment. The implication of economic CU exceeding unity is that when there is a sudden increase in demand and immediate rise in price may not be feasible and in the short run, it might be necessary to operate at a point beyond the cost minimizing or profit maximizing point. This may so happen when firms attempt to maintain their reputation or market share, bear some of the cost burdens in the short run and oblige their customers through an increased supply of goods at unchanged prices. Our study shows that some of the years, both in pre and post- reform periods, have shown CU exceeding one. This finding induces us to conclude that the firms could have reduced their production cost by moving to the minimum point of short run average cost curve.

Second, economic measure of CU shows much more variation which is apparent from our study that the economic CU index ranges from about 0.76 to 1.04. Standard deviation of economic CU during pre and post-reform period are 0.081 and 0.072 respectively which signifies greater variation of economic CU in both segments of time period.

Third, the estimate in table-1 and 2 shows that industry's average economic CU slightly declined from 0.9458 to 0.9423 during post-reform period but reverse trends have been noticed in the average growth rate of capacity. During pre-reform period, capacity expansion was poor probably due to licensing restriction and demand grows at very rapid pace at that period but abolition of license raj during post-reform period paved the way for expansion of capacity abruptly. The growth rate in demand shows a declining trend during post-reform period as compared to pre-reform period.

Fourth, it is important to note that the significant improvement in the rate of capacity utilization of the industry was accomplished up to mid-90s despite substantial growth in its economic capacity indicating more efficient use of capital and other resources in this particular industry.

Impact of Liberalization on Economic CU

In investigating the issue of whether there exists any positive or negative impact of economic reforms on capacity utilization more precisely, we use a piecewise linear regression equation (popularly known as Spline function) where it is assumed that capacity utilization increases linearly with the passage of time until the threshold time period (t_0). [Here, t_0=1990-91 being last year of pre-reform period after which post-liberalization era begins] after which also it changes linearly with the passage of time but at a much steeper rate. Therefore, we have a piecewise linear regression consisting of two linear pieces or segments. The CU function changes it slope at the threshold value (t_0=12). Given the data on capacity utilization, time period and the value of threshold level, the technique of

https://digitalcommons.kennesaw.edu/jekem/vol3/iss1/13
DOI: 10.7885/1946-651X.1045

dummy variables can be used to estimate the slopes of the two segments of the piecewise linear regression. The piecewise linear regression equation is as follows:

$l_{n.}Y_t = \alpha + \beta t + \beta'(t - t_0)\, D_t$

Result of the Regression Equation is as follows:

$l_{n\,.}Y_t$ = -0.1470 + 0.01215t – 0.0174Dt

(-3.46) (2.59) (-2.64)

$R^2 = 0.22$

Figures in the parenthesis are usually t values. Here β gives the slope of the regression line in pre-reform period which is positive and significant at 5% level. This implies that growth in capacity utilization shows positive trend immediately before liberalization starts.

But as co-efficient of the difference between two time period is significant at 5% level and negative (coefficient being –0.0174), conclusive inference can be drawn in that liberalization has its significant negative impact on capacity utilization during post-reforms period.

Table – 3

Trend in Growth rate of Capacity utilization (1979-80 to 2007-08)

Pre- reform period(1979-80 to 1991-92)		**Pre- reform period(1991-92 to 2007-08)**	
Year	**Growth rate (%)**	**Year**	**Growth rate (%)**
1979-80	-	91-92	-9.57
80-81	11.57	92-93	-0.47
81-82	6.03	93-94	17.83
82-83	3.70	94-95	-0.33
83-84	9.02	95-96	-7.85
84-85	-2.42	96-97	-6.29
85-86	-9.21	97-98	2.63
86-87	15.22	98-99	12.18
87-88	-6.15	99-00	-2.42
88-89	5.11	00-01	2.24
89-90	-1.88	01-02	-6.50
90-91	-2.62	02-03	-15.90
91-92	-9.57	03-04	9.70
		04-05	-4.38
		05-06	4.59
		06-07	9.82
		07-08	-1.61
Average	1.57		0.83

Source: Created by author from Annual Survey of Industries (several issues).

It is visible from the estimated average growth rate in capacity utilization as shown in Table – 3 that there is a significant drop in average growth rate of capacity utilization from 1.57% in pre-reform period to 0.83% in post- reform period.

https://digitalcommons.kennesaw.edu/jekem/vol3/iss1/13

DOI: 10.7885/1946-651X.1045

Factors influencing capacity utilization

It is well recognized that utilization of capacity reflects the influences of markets supply and demand conditions, government policies, the degree of monopolization within an industry and the attitude of the managers of the firms in under developed countries (S. Paul, 1974). Demand deficit, labor problem, transport bottlenecks, failure in power supply, mechanical/ maintenance trouble, strikes etc. are major cause responsible for under-utilization of Industrial capacity in India. Apart from the above mentioned factors, industry characteristics like demand pressure, capital intensity, market concentration, scale of operation, etc. and policy variables influence capacity utilization rates of an industry. Paul (1974) found that industry characteristics explaining 40% of inter-industry variation in CU rates and policy variables explaining 32% of the inter-industry variation comprise nearly 72% of the total inter-industry variations in CU.

In this section, we have attempted to explain the nature of relationship between capacity utilization and different industrial characteristics (excluding other explanatory policy variables like import substitution, effective rate of protection etc. due to unavailability of reliable, comparable data) based on industry level and company wise time series data in the context of Indian pharmaceutical Industry.

We analyze econometrically the effect of demand pressure, capital intensity, market concentration and scale of operation on capacity utilization. It employs multiple regression analysis technique (OLS) considering all explanatory variables in the same equation. Similar attempts were made earlier in the study of S. Paul (1974), Srinivasan (1992) and Goldar and Renganathan (1991).

Independent variables considered in the present study are demand pressure, capital intensity, market concentration and scale of operation. These explanatory variables can be interpreted as under:

Demand Pressure (GO): Demand Pressure is measured by growth rate of production over the time period.

A positive relationship is expected between demand pressure and capacity utilization on the assumption that high demand pressure will enable the firms within a particular industry to make better utilization of productive capacity.

Capital Intensity (K/L): Capital intensity is expressed as the productive capital used per person engaged. It is obtained by dividing productive capital by number of persons engaged.

A positive relationship between capacity utilization and capital intensity is expected because high capital intensive firms of an industry enjoy better economies of scale inducing higher utilization rates.

Market Concentration (CONR): Market concentration is defined as the percentage of the sale value accounted for by the top 4 companies in the total sales of the industry. Top 4 companies have been chosen from CMIE data book in accordance with highest sales volume.

Greater efficiency of some firms within the industry ensures better market concentration. A few firms capture a larger portion of market share due to their excellent efficiency resulting in increase in market concentration. Gradually, inefficient firms are wiped out of competition as a result of generating poor quality and charging high prices of products (due to increase in cost of production). Consequently, efficient firms expand their capacity as well as utilization rates to cope-up with the growing market demand thereby expecting a positive relationship between capacity utilization and market concentration.

Scale of operation (MS): Scale of operation is defined as the value of its sale as a percentage of the total sales of the manufacturing industry.

Capacity utilization can be influenced by the scale of operation of individual firms. As the scale of operation increases, there may be fewer bottlenecks and the lumpiness of the individual machine is more easily balanced, thereby increasing the average CU (Lecraw, D.J, P-145). Therefore, one would expect a positive relationship between CU and scale of operation.

In order to examine the effect of various forces (that affect CU) on capacity utilization, we estimate a linear multiple regression equation for all firms taken together using industry level and company wise time series data over a period of 29years. The single equation model with CU as dependent variables and demand pressure (GO), capital intensity (K/L), market concentration (CONR), scale of operation (MC) along with time variable (T) as explanatory variables is depicted as under :-

$$U = \alpha + \beta_1 GO + \beta_2 (K/L) + \beta_3 (CONR) + \beta_4 (MS) + \beta_5 T$$

Where GO = Growth in production.

K/L = Capital intensity.

CONR = Concentration ratio.

MS = Market share representing scale of operation.

T =Time variable ,U = capacity utilization rate.

The regression equation is estimated by ordinary least square (OLS) technique. CU is regressed separately on each independent valuable in different equations and then all explanatory variables are regressed in a single equation.

https://digitalcommons.kennesaw.edu/jekem/vol3/iss1/13
DOI: 10.7885/1946-651X.1045

Table – 4

Regression Result for Pharmaceutical Sector relating CU to GO, K/L, CONR, MS and T.

Dependent Variable: Capacity Utilization

Equation	Intercept Term	GO	K/L	CONR	MS	T	R^2
1.	-0.11 (-0.197)*	0.6277 (2.627)	4.794 (1.96)	1.415 (1.94)	0.8041 (0.287)	-0.064 (-2.82)	0.7426
2.	-	0.6054 (3.06)	4.55 (2.26)	1.30 (2.82)	0.44 (0.222)	-0.0632 (-3.01)	0.7412
3.	-0.0072 (-0.018)	0.5928 (3.06)	4.62 (2.07)	1.41 (2.04)	-	-0.065 (-3.04)	0.7396
4.	1.27 (3.42)	-	-	-	-2.73 (-0.87)	-0.026 (-1.94)	0.3772
5.	0.7839 (6.53)	0.5505 (2.46)	3.633 (1.43)	-	-	-0.0597 (-2.43)	0.6033
6.	0.581 (0.91)	-	1.57 (3.39)	1.23 (2.66)	-2.95 (-0.92)	-0.03 (-1.38)	0.4888
7.	0.69 (1.19)	-	-	1.13 (2.41)	-2.93 (-0.97)	-0.0235 (-1.78)	0.46
8.	0.9172 (6.98)	-	0.881 (1.9)	-	-	-0.0232 (-0.97)	0.3365
9.	0.3789 (0.786)	-	-	1.088 (2.36)	-	-0.0127 (-1.78)	0.4144
10	0.9417 (19.15)	0.41 (1.96)	-	-	-	-0.0264 (-3.24)	0.5134

Source: Created by author from Annual Survey of Industries & CMIE (several issues).

* t values are given in the parenthesis below

GO =Growth in output indicating demand pressure

K/L = Capital intensity

CONR = Market concentration ratio

MS= Market Share representing scale of operation

T= Time variable

Table 4 above presents the estimated regression equations. We find a significant positive relationship between CU and demand pressure variable which supports our hypothesis. The coefficient of demand pressure variable is positive and is statistically significant in all equations at 0.05 level. The major implication of this result is that as the growth rate of production indicating demand pressure increases, pressure is expected to come upon the firms within the industry that have idle capacities to enhance their utilization rates. This suggests that with growing demand for products, pharmaceutical industry has been gradually moving towards fuller utilization of capacity.

The regression coefficient of capital intensity variable is all positive. The regression coefficient is statistically significant at 0.05 level in four equations, one at 0.10 level and another at 0.20 level. It indicates that pharma sector with relatively more capital intensive units tend to have higher rates of capacity utilization. Capital intensity is generally considered to be the proxy for technology level. With the relaxation of import restrictions due to reform process, firms have resorted to more foreign capital – intensive technologies inviting huge opportunity cost of unused capital. The result suggests that capacity utilization rate is more in high capital intensive firms because unless these type of firms operate at higher utilization rate, they cannot recover the higher cost of capital.

The estimated coefficient of market concentration variable indicates a positive relationship between market concentration and CU as coefficient in all equations are positive and statistically significant at 0.05 and 0.10 level. The result implies that increase in concentration ratio leads to higher utilization of capacity.

This shows that higher seller concentration creates barriers on entry of new firms in the industry which assists concentrated firms to utilize its capacity at its fullest possible level thereby ensuring most effective utilization of scare capital resources.

Our regression result reveals that scale of operation variable represented by market share is found to be confusing and statistically insignificant. This reveals that firms with sizable portion of market share do not have significant stimulation regarding utilization of its installed capacity. The result is contrary to our hypothesis.

The explanation for not finding any significant relationship between CU and market share lies in the fact that there has not much change in market share of this sector over our study period, especially during 90's.

Summary and findings

As discussed earlier, India has undertaken various reform programs since 1991 in order to make the economy competitive and to meet the global challengers. This paper tries to examine the trends in capacity utilization in the Indian pharmaceutical sector during pre and post-reform period. The major findings of the present study may be summarized below. First, there was a slight decrease in average capacity utilization rate in post-reform period as compared to pre-reform period. Secondly, annual average growth rate of capacity output

https://digitalcommons.kennesaw.edu/jekem/vol3/iss1/13
DOI: 10.7885/1946-651X.1045

reveals increasing trend in growth rate at a much steeper rate but actual output shows declining trend . Therefore, the trend in capacity expansion reflects that capacity expanded more rapidly in post-reform period than in pre-reform period. Thirdly, there is a sharp decline in the average annual growth rate of capacity utilization during the post-reform period in comparison with pre-reform period. Fourth, the estimates obtained indicate that the liberalization process is found to have a significant adverse impact on capacity utilization since there is a fall in average growth rate of capacity utilization during the post-reform period. Fifth, it is obvious from our estimate that utilization rate of capacity fell gradually after 1995-96. Removal of industrial licensing restriction might have encouraged the entrepreneurs to invest more and expand their plant capacity. Actual output being an indicator of public demand was expanding gradually up to first half of 90s and thereafter demand did not expand as much as increase of capacity. Sixth, the high correlation observed, in the sector, between the actual and capacity output (r=0.97) suggests that a substantial part of capacity could have been kept unutilized by the firms within the industry to cope up with the unforeseen excessive demand shock coming from customers' front.

From our regression analysis, it is evident that there exists a significant positive relationship between CU and the explanatory of variables such as demand pressure (GO) capital intensity (K/L) and market concentration (CONR). Although scale of operation variable reflected by sizable portion of market share was expected to exhibit a positive relationship, the result obtained from our analysis is contradictory as well as unsatisfactory. With regard to the “why’s” of what is revealed from our empirical result, it happens probably due to limitation and inadequacies of data. The present study lends strong support to earlier works conducted by Paul. S (1974) Goldar and Renganathan (1991), Srinivasan (1992).

In a liberalized regime, abolition of licensing rule encouraging new entrants, and at the same time, growing demand inducing existing firms to expand and utilize its capacity to the fullest possible, larger firms having greater access regarding import of capital goods coupled with domestic capital goods inducing higher capital intensity contributed towards favorable impact on CU.

But there are some important lessons that can be learnt from our analysis in that high demand pressure, high capital intensity and high market concentration leading higher CU may have adverse impact on scare resources, employment and distribution system.

In a nut shell, the empirical results presented in this study leave wider scope for further improvement and refinement. It is suggested that while making policy decisions on the basis of aggregate, the consideration of intra-sectoral analysis may be attempted in order to have more valuable results because generalization based on aggregative analysis sometimes fails to pave the way for improved decision making.

In conclusion, as far as India’s pharmaceutical industry is concerned, various options are possible in the WTO regime. These are to: (a) manufacture of patented generic drugs, (b) produce patented drugs under compulsory licensing or cross licensing, (c) invest in R&D to engage in new product development, (d) produce patented and other drugs on contract basis, (e) explore the possibilities of new drug delivery mechanisms and alternative use of existing drugs, and (f) collaborate with multinationals to engage in R&D, clinical trials, product development or marketing the patented product on a contract basis and so on. Besides these strategies, India's strength lies in process development skills. This expertise utilized within the WTO framework with emphasis on quality standards will provide India a competitive advantage over other Asian countries.

REFERENCES

Ahluwalia, I.J.1985: Industrial Growth in India, *Oxford University Press, Delhi*.

Berndt, E.R. and Fuss, M.A. (1981): Productivity measurement using capital asset valuation to adjust for variation in utilization (*Paper presented at the Econometric society Summer Meetings, San Diego, C.A.)*

Berndt, E.R. and Fuss, M.A. (1981): Capacity utilization : Underlying economic theory and an alternative approach, *American Economic Review*, vol. 71, no22, pp 48-52

Chaturvedi, D.N and Amaresh Bagchi(1984): Age Structure of Fixed capital in the Indian Economy, 1970-71 to 1980-81, *Journal of Income and Wealth*, vol. 7 ,no.1 pp 82-83.

Cassel, J.M. (1937): Excess capacity and monopolistic competition, *Quarterly Journal of Economics*, vol. 51, pp 426-443.

Denny, M, Fuss ,M and Waver man , L(1981): 'Substitution possibilities for Energy: Evidence from U.S. and Canadian manufacturing Industries in E.R. Berndt and B.C. Field, Modeling and measuring national Resources Substitution (*Cambridge M.A., MIT Press).*

Friedman. M (1963): 'More on Archibald versus Chicago', *Review of economic studies*, vol. 30, pp 65-67.

Gasper. A. Garofalo and Devinder. M. Malhotra (1997): Regional measure of capacity utilization in the 1980s. *The Review of Economics and Statistics* vol. 34, pp 415-421.

Goldar, and V.S. Renganathan (1991): Capacity utilization in Indian Industries, *The Indian economic Journal*, vol. 39, no2, Oct – Dec, pp 82-92.

Hickman, B.G (1964): 'On a new method of capacity estimation', *Journal of the American Statistical Association*, vol.59, pp 529-549.

Jorgenson, Dale. W and Zvi Griliches (1967): The explanation of productivity change, *Review of Economic Studies*, vol. 34, pp 249-282.

Jorgenson, D.W (1988): 'Productivity and Post War US Economic Growth ', *Journal of Economic Perspective*, vol.2, no 4, pp 23-41 .

Klein, L.R (1960): 'Some theoretical issues in the measurement of capacity', *Econometrica*, vol.28, no.2 , pp272-286.

https://digitalcommons.kennesaw.edu/jekem/vol3/iss1/13
DOI: 10.7885/1946-651X.1045

Krishna K, L (1972): 'Industrial capacity and production in C.R.Rao *Data base of Industrial Economy, vol. 1, New Delhi*.

Lecraw, D.J. (1978): Determinants of capacity utilization by firms in less developed countries, *Journal of development Economics*,,vol.5, pp 139-153 .

Morrison, C.J, (1985): 'On the Economic Interpretation and measurement of optimal capacity, *Review of Economic studies,vol.* LII, pp295 – 310.

Paul, S. (1974): 'Growth and utilization of Industrial capacity , *Economic and Political weekly,* vol .9 , no. 49,December 7, pp 2025 -2032.

Paul, S. (1974): Industrial performance and Government control in J.C Sandesara (ed.), *The Indian Economy: Performance and Prospects, University of Bombay.*

Sastry, D.U (1984): 'The cotton mill industry in India', *Oxford University Press, Delhi.*

Srinivasan, P.V (1992): 'Determinants of Capacity utilization in Indian Industries', *Journal of Quantitative Economics,* vol. 8, no. 1, pp 139 – 156.

Uchikawa, S (2001): Investment boom and under-utilization of capacity in the 1990s, *Economic and Political weekly,* August 25, pp 3247 – 3253.

APPENDIX:

Appendix-A1: In industry level analysis, it is a recent practice to utilize gross output rather than value-added as a measure of product at the industry level. Jorgenson (1988) has shown that in a three input production framework, the contribution of intermediate input is the significant source of output growth in US economy. Intermediate input in our study consists of energy only. The yearly fuel consumed is taken as measure of energy input.

Appendix-A2: Energy Inputs: Industry level time series data on cost of fuel of Indian Drug & pharmaceutical 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 (1998 – 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.

AppendixA3: Capital Stock: The procedure for the arriving at capital stock series is depicted as follows :

First, an implicit deflator for capital stock is formed on Net Fixed Capital Stock(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 price 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, pharmaceutical industry) in proportion of its fixed capital stock reported in ASI, (1970-71).

Third, from ASI data, gross investment in fixed capital in pharmaceutical industry is computed for each year by subtracting the book value of fixed capital in previous year from that in the current year and adding to that figure the reported depreciation fixed asset in current year. (Symbolically, $I_t = (\beta_t - \beta_{t-1} + D_t) / P_t)$ and subsequently it is 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 (D_{st}) is assumed to be zero due to difficulty in obtaining data regarding D_{st}.

DOI: 10.7885/1946-651X.1045