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ECONOMIC REFORMS AND INDUSTRIAL PERFORMANCE
An Analysis of Capacity Utilisation in Indian Manufacturing

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ABSTRACT

This paper examines the performance of Indian manufacturing sector in terms of economic capacity utilization (CU), over 1974-1998. 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. We observe cyclical movements in CU over the period. 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 (1991-1998), a variant of the fluctuations witnessed in the first phase is seen to have resurfaced. Interestingly, there has not been any significant correspondence between the observed phases of CU with the corresponding policy environment. While supply and demand side factors are significant in determining CU in Indian manufacturing, the impact of economic reforms *per se* is not remarkable.

Key words: India, Manufacturing, Capacity Utilization, Economic reforms

JEL Classifications: D24, L5, L60, O47

I. INTRODUCTION

The industrial sector in India has been undergoing significant changes both in its structure and pattern owing to the policy changes since the first industrial policy resolution of 1948 onwards. In pursuit of building an industrial base for the country, the policy makers advocated a series of guidelines characterized by pervasive licensing, reservation of key areas for public sector, inward oriented trade policy, control over large domestic firms, foreign direct investment, technology transfer and interventions in factor market. However, there emerged a view that the restrictive industrial policy regime, which roughly prevailed till 1985, created a high-cost industrial structure characterized by technological obsolescence, low rates of productivity, capacity utilization (CU) and growth. As the rough nature of this complex control system became more and more obvious, there emerged consensus over the need for a re-orientation in planning. The increasing skepticism over the success of the import-substituting regime in the country (see Bhagwati and Desai, 1970, Little et al, 1970) resulted in a shift in the policy thinking towards a more liberal policy regime, based on the grounds of achieving efficiency and competitiveness. This resulted in a shift in the policy sphere since the late seventies[1] , nevertheless, it witnessed further

1 In the second half of the 1970s the government started relaxing the foreign trade regime and a number of imported items were placed on the open general license list.

significant changes in its direction during the 1980s.[2] However, the key role played by the state in allocating resources remained decisive. The shift in the policy paradigm got further stimulus in 1991 with the introduction of new economic and industrial policies, where the market is allowed to play a decisive role.

These major changes in the policy regimes created debates among economists regarding the impact of the liberal policy environment on industrial performance in India. We, in this paper examine the performance of Indian manufacturing sector in terms of Capacity Utilization (CU), over 1974-98, a reasonable number of years that cover the highly restricted, the partially liberalized and the fully liberalized regimes. The study differs from earlier studies on two grounds. Firstly, we estimate economic capacity utilization for the Indian manufacturing sector using a theoretically pertinent methodology. Secondly we make an attempt to understand the impact of policy changes, *inter alia*, on the movements of CU.

The rest of the paper is organized as follows. A brief discussion on the relationship between economic reforms and capacity utilization is provided in the next section. The third section briefly reviews some of the recent studies on capacity utilization in Indian industry. Section four discusses the concept of economic capacity utilization and the methodology employed for estimating it. The fifth section explains the data and variables and the sixth section discusses the empirical results. Section seven examines the relationship between selected factors and CU. And the final section concludes the paper.

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2 For a discussion of the reforms in 1985 see Khullar (1991), and World Bank (1989). Following the major changes in the policy environment, the turn around in output growth during the eighties is often attributed to the changes in policy regime (Ahluwalia, 1985 and 1987).

II. ECONOMIC REFORMS AND CU: THE ANALYTICAL UNDERPINNINGS

The shift towards a liberal industrial policy paradigm during the late eighties and early nineties is justified by a number of arguments, both theoretical and empirical.[3] The micro economic arguments for a more liberal policy atmosphere stem from the potential gains accruing from increased competition and exploitation of scale economies. Then there are the macro economic arguments that link appropriate exchange rate policies with the exploitation of scale economies through increased exports, and with better capacity utilization (Srivastava, 1996). Industrial efficiency may be achieved through import liberalization by exposing domestic producers to greater competition, internal and external, and by improving access to imported intermediate inputs and capital goods. It is argued that the regulation regime, giving protection to any domestic producer of an import substitute, regardless of cost, efficiency and comparative advantage, clearly created a climate for the existence of excess capacity[4] in the sense that costs could be well above the technological minimum. By reducing the rate of export growth, the policy also affected CU with a low growth of export demand.[5] Further the policy of issuing import license based on the installed capacity

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3 See Bhagwati and Srinivasan (1975), Bhagwati and Desai (1970), Ahluwalia (1991) and Srivastava (1996).

4 It is argued that the restrictive import policy, if maintained for a number of years the artificially created high levels of profitability could lead to over investment in the industry resulting in a general fall in productivity and capacity utilization. See Winston (1974)

5 The central idea of the argument that more exports would increase aggregate output rests on the idea that domestic resources are under utilized. If all resources were fully utilized, any increase in one component of demand would necessarily lead to a fall in another.

induced firms to expand their capacity in order to get more licenses.[6] The controlled regime also allowed firms to maintain their monopoly power by shielding them from competition, both domestic and external, and thus making them to operate at high levels of profit even with excess capacity. As regards capacity utilization, apart from operating in a protected domestic market, highly subsidized inputs and controlled output prices further enable firms to make profits even at lower levels of utilization. Thus, it is viewed, that the limited threat of domestic entry and virtual absence of foreign competition allowed the existence of excess capacity in the Industrial sector in India.

These arguments, *prima facia*, bring the notion that a more liberal policy atmosphere will lead to better capacity utilization. With regard to the external oriented policy measures, however, one may have views to the contrary which undermine any strong relationship between the policy environment and the CU. This is because the direction of change in CU, as a result of a policy change in the direction of more external orientation, is ambiguous, from the theoretical point of view. Variations in CU are the systematic outcome of the rational optimization procedure of firms depending on input availability and market situations. Persistent under-utilization of optimal capacity, therefore, appears to be puzzling in view of the fact that firms are expected to optimize through their decisions on capacity creation and utilization. In a liberalized regime, as the domestic market is more integrated with the international market and the demand fluctuations are likely to be more pronounced, there is

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6 Bhagwati and Desai (1970) argues that since Actual User licenses (import licenses) were allotted equitably on the basis of existing capacity there were incentives for expanding capacity so as to have access to more imports. Bhagwati and Srinivasan (1975) further argues that the system of import licensing might have led to the excessive holding of inventories of intermediates and raw materials by Indian firms.

likely to be more fluctuating movements in utilization. In such a context, the relationship between liberal economic reforms and the CU depends on the effectiveness of policy changes in relaxing both supply and demand bottlenecks. However, firms may still keep idle capacity even in a more competitive market condition, for different set of reasons. The recent theoretical works in industrial organization allude to the possibility that excess capacity may be used as a strategy for deterring entry, as firms have to assure their survival in the market. Spence (1977) observes that 'competitive profit maximizing' firms can carry excess capacity to deter a vigorous threat of entry.[7] Bulow et al (1985) further confirm this argument. The basic entry deterrence argument is that excess capacity enables incumbents to threaten to expand output and cut prices following entry thereby making entry unprofitable. However, in India the existence of excess capacity did not deter entry in the earlier regime, as the protected environment offered adequate profit opportunities for those who could obtain a license to enter (Bhagwati and Srinivasan, 1975); the entry was rather barred by the licensing policy. But in the changed policy environment one may not reject the possibility of firms investing in excess capacity for both strategic and non-strategic reasons.[8]

7 …Under incomplete markets, fixed cost must be covered if firms are to survive. Hence prices must exceed marginal cost, as different from the perfect situations, by a mark-up sufficient to cover fixed charges. This leads to average cost pricing hence downward price rigidities in the face of excess capacities. When a price is down ward rigid, quantity constraints comes into ration excess supply-capacities are unutilized (Dreze, 1999).

8 Profit maximizing firms hold non-strategic excess capacity in markets where demand is cyclical or stochastic, or where plants are inherently lumpy or subject to economies of scale. Strategic excess capacity may be built either to deter new entry or to pre-empt existing rivals (Liberman, 1987).

III. CU IN INDIA: A BRIEF REVIEW OF LITERATURE

While most recent studies examining the industrial performance in India after policy reforms focused on the analysis of total factor productivity growth, diminutive 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[9]. 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[10], recent studies (Ajit, 1993, Burange, 1992) also show the existence of excess capacity in the industrial sector. Studies that examined the determinants of CU found that most of the industries are demand constrained (Goldar and Renganathan, 1991, Srinivasan, 1992). Also there are a few studies that correlate utilization with public investment in infrastructure, capital and intermediary imports and the adoption of liberal policy (Seth, 1998). An examination of the literature reveals, however, that most studies have used conventional measures in measuring CU, and have paid insufficient attention to the possible theoretical problems. Since most of them followed the conventional engineering (installed capacity) and Wharton approaches, 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 CU; a theoretical investigation into the problem is hard to find.

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9 Hulten (1986), Morrison (1986) and Berndt and Fuss (1986) discuss the importance of adjusting total factor productivity measures by properly measured capacity utilization ratios.

10. Azeez (1999) provides a review of these studies.

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.[11] The economic capacity of a 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 is crucial. In India engineering CU figures are mainly based on the installed capacity data collected from firms and published by different agencies like DGTD. 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).[12] Additionally, these figures give highly exaggerated picture of actual capacity, mainly due to policy reasons and reporting errors.[13] 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.

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11 The pioneering contribution by Berndt and Morrison (1981) has clearly pointed out the importance of applying economic theory in estimating CU.

12 For details on the inadequacies of these data, see Bhagwati and Srinivasan (1975) and Slocum (1970).

13 Firms used to report an exaggerated picture of their actual capacity in order to obtain more import licenses.

The Wharton indices are also questioned on many theoretical grounds.[14] In this method, one first identifies the major peaks in a seasonally adjusted output series, assuming that the major peaks represent output where resources are utilized at full capacity. Joining these major peaks by linear interpolation, potential output is estimated for non-peak years. It is unrealistic to assume that each major peak represents the same intensity of resource utilization. Assuming a constant arithmetic growth rate of potential output between peaks is also not justifiable.

It is, thus, observed that the earlier studies on capacity utilization has left unaddressed several theoretical and data problems in measuring CU. This motivates us to have an inquiry into the economic capacity utilization in Indian manufacturing using a more reliable database and also to examine how CU is affected *inter alia* by policy changes.

IV ECONOMIC CAPACITY UTILIZATION: CONCEPT AND MEASUREMENT

Capacity utilization has been extensively used in the literature as an indicator of industrial performance as it pictures both the use of scarce resources as well as the state of demand. It has been defined as the ratio of actual output to capacity or potential output; it captures the output gap between actual output and capacity output. While potential output can broadly be defined as the maximum possible output given the level of inputs and technology, there is little consensus on its measurement. Economists recognize that such a level of output "is conditioned in most cases by economic circumstances and must be

14 A detailed review of different measures of capacity utilization and associated problems is seen in Christiano (1981).

interpreted as being the 'optimum output' from the economic point of view". Cassel (1937) and Hickman (1964) define it as the output (Y*) at which the short run average total cost curve reaches its minimum; a measure of potential output given a firm's short-run stock of capital and perhaps other fixed inputs in the short run (Nelson, 1989).[15] We follow this definition of economic capacity.

Consider a firm with a well-behaved production function

$$Y = f(L, F, M, K, T) \quad (1)$$

where Y is the level of output, L, F, M and K are the inputs of labor, fuel, material and capital respectively. T is the time trend to represent the disembodied technical change. Let the capital stock be a quasi-fixed input.[16] Then the optimization problem is to maximize variable profits, i.e revenue minus variable costs, conditional on output price P, prices of variable input prices P_i, and fixed input K (Lau, 1976). Following the theory of duality the optimization problem may be reformulated as that of minimizing variable cost (Berndt and Morrison, 1981) conditional on Y, P_i, K and T. Then we have a dual variable cost function.

$$VC = f(Y, P_i, K, T) \quad (2)$$

Where VC is the total variable cost and P_i represents the vector of variable input prices. Estimation of optimal or potential output from the above-specified cost function requires a suitable functional form.

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15 Changes in such economic variables as input prices, and the short-run fixity of certain factors (such as capital) may influence capacity output defined by the economic approach (Morrison, 1985). In other words, the potential may be defined as the maximum output that can be produced with existing plant and equipment, provided that the availability of variable factors of production is not restricted.

16 Since capacity output is inherently a short run notion, it is necessary that the modeling framework incorporates the short run constraints facing the firms (Berndt and Hesse, 1986)

Exploiting the recent developments in the theory of short run equilibrium we employ a translog short run cost function or variable cost function, following Berndt and Morrison (1981), Berndt and Hesse (1986) and Nelson (1989).

$$\ln VC = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln P_i + 0.5 \sum_{i=1}^{n} {}_i \sum_{j=1}^{n} {}_j \alpha_{ij} \ln P_i \ln P_j + \beta_Y \ln Y + 0.5 \beta_{YY} (\ln Y)^2$$

$$+ \sum_{i=1}^{n} {}_i \beta_{Yi} \ln Y \ln P_i + \gamma_K \ln K + 0.5 \gamma_{KK} (\ln K)^2 + \sum_{i=1}^{n} {}_i \gamma_{Ki} \ln K \ln P_i \qquad (3)$$

$$+ \gamma_{KY} \ln K \ln Y + \delta_T T + 0.5 \delta_{TT} T^2 + \sum_{i=1}^{n} {}_i \delta_{Ti} T \ln P_i + \delta_{TK} T \ln K + \delta_{TY} T \ln Y$$

Imposing the parameter restrictions:

a) $\Sigma\alpha_i = 1$, b) $\Sigma\alpha_{ij} = \Sigma\alpha_{ji} = 0$, c) $\Sigma\beta_{Yi} = 0$, d) $\Sigma\gamma_{Ki} = 0$ (A)

for homogeneity, and differentiating equation (3) with respect to the exogenous variables, input prices P_i, given K and Y, we have,

$$\frac{\partial \ln VC}{\partial \ln P_i} = \alpha_i + \sum_{j=1}^{n} {}_j \alpha_{ij} \ln P_j + \beta_{Yi} \ln Y + \gamma_{Ki} \ln K + \delta_{Ti} T = \mu_i ; i = 1, \ldots, n \qquad (4)$$

Where μ_i, following Shephard's lemma, is the cost share of i[th] input.

The share equations are included in the model in order to incorporate the economic optimization behavior of firms. The economic measure of capacity output (*Y**) and utilization (*Y/Y**) are defined in terms of short run average total cost (SATC) which includes both average total variable cost and average total fixed cost. The total fixed costs are defined as the expenditures on the fixed input, capital. Then the short run total cost, $SRTC = VC + P_K K$, where P_K is the price of capital. Subsequently the short run average total cost, *SATC* is

$$SATC = (VC/Y) + (P_K K/Y) \qquad (5)$$

Now if the potential output $Y = Y^*$ is defined at the point where SATC is minimized, then $(\partial SATC/\partial Y^*) = 0$, which in terms of (5) implies that

$$(1/Y^*)(\partial VC/\partial Y^*) - (VC/Y^{*2}) - (P_k K/Y^{*2}) = 0 \tag{6}$$

Since $\partial lnVC/\partial lnY^* = (\partial VC/\partial Y^*)(Y^*/VC)$, the required estimate of $\partial VC/\partial Y^*$ is $(\partial \ln VC/\partial \ln Y^*)(VC/Y^*)$, where

$$\frac{\partial \ln VC}{\partial \ln Y^*} = \beta_Y + \beta_{YY} \ln Y^* + \sum_{i=1}^{n} {}_i \beta_{Yi} \ln P_i + \gamma_{Ki} \ln K + \delta_{Ti} T = \mu_Y \tag{7}$$

Substituting (7) in (6), we have

$$\frac{\partial\, SATC}{\partial\, Y^*} = VC\,(\mu_Y - 1) - P_K K = 0 \tag{8}$$

Where μ_y and *VC* are functions of both ln Y^* and Y^* and therefore, it is not possible to obtain an analytical or closed model solution for Y^* in (8). Instead, numerical or iterative computational procedure must be employed. Then the estimate of CU will be the ratio of Y to Y^*.

V. DATA AND VARIABLES

The study covers the organized segment of the manufacturing sector in India at the aggregate level, which includes 18 two-digit industries, for the period 1974-98. The selection of time period is largely guided by the availability of data as well as the policy changes occurred during this period. The data on output, capital, labor, fuel and materials required for the analysis are taken from various issues of the Annual Survey of Industries (ASI) published by the Central Statistical Organization. The variables are constructed as follows.

Output is defined as gross value of output deflated by the wholesale price index (WPI) of manufactured products (1981-2=100). For the construction of a series on *capital stock* the perpetual inventory method is followed. Using the gross net ratio provided in Hashim and Dadi (1973), we construct a benchmark year capital stock for 1960. Then a perpetual inventory component is added to this benchmark year estimate in order to obtain the consistent series of *capital stock* for the subsequent years. [17] *Total cost* is defined as the sum of compensation to labor, fuel, material and capital inputs. *Capital cost* is defined as the gross operating surplus after adjusting for emoluments.[18] The value of total emoluments is considered as the *labor cost* and the total emoluments divided by number of employees as the *wage rate*. For the *price of fuel*, we construct a composite price index by combining price indices of different components of total fuel consumed by the manufacturing sector. The input components are classified according to the availability of WPI and are then clubbed to a single price using appropriate weights. The weights are calculated from the Input Output Transaction Matrix, 1989-90. The value of total fuel consumed, as per ASI definition, is taken as the *fuel cost*. The value of total purchase of materials is used as the *cost of materials*. For constructing the *price of material* we follow the same procedure as in the case of fuel.

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17 Azeez (1999) discusses the capital stock estimation procedure in detail.

18 It may be noted here that sum of labor and capital cost is identically equal to gross value added at factor cost (Berndt and Hesse, 1986). However, a high gross operating surplus does not make it less profitable to employ more capital. There exists some skepticism on whether the capital cost is sufficiently exogenous or not, however, the absence of any other better data makes us to rely on this. I am grateful to Prof. J.S Cubbin for making me aware of this problem, while reading through the discussion on data and variables in Azeez (2001).

VI. EMPIRICAL RESULTS

We estimate the equations (3) and (4) simultaneously, subject to the parameter restrictions (A). Since $\sum\mu_i=1$,[19] we estimate the model after dropping the labor share equation (by normalizing all the prices and variable cost). For estimation we follow an iterative version of the Zellner's Seemingly Unrelated Regression Estimation (SURE) technique[20], which are equivalent to maximum likelihood estimates, in order to ensure invariance with respect to the choice of which share

Table 1: SURE Estimates of Translog Cost Function

Parameters	Estimates		Parameters	Estimates	
α_0	0.009	(0.023)	γ_{KF}	0.153	(0.031)
α_F	0.056	(0.004)	γ_{KM}	-0.348	(0.047)
α_M	0.801	(0.007)	γ_{KY}	-2.636	(0.459)
α_{FF}	0.060	(0.006)	δ_T	0.020	(0.019)
α_{MM}	0.109	(0.006)	δ_{TT}	-0.009	(0.008)
α_{FM}	-0.076	(0.005)	δ_{TF}	-0.010	(0.003)
β_Y	0.417	(0.105)	δ_{TM}	0.024	(0.004)
β_{YY}	8.757	(0.441)	δ_{TK}	0.565	(0.096)
β_{YF}	-0.026	(0.022)	δ_{TY}	-0.431	(0.041)
β_{YM}	0.069	(0.038)	DW (VC)	1.73	
γ_K	0.425	(0.251)	DW (μ_F)	1.60	
γ_{KK}	-5.796	(1.317)	DW (μ_M)	1.37	
Log likelihood	318.4				

Note: standard errors are given in parentheses.
DW = Durbin Watson statistic

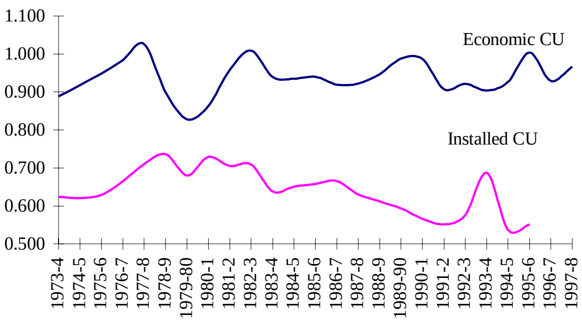
19 The input shares in variable cost must sum to unity, by definition. This will give a singular disturbance covariance matrix

20 Kmenta et al. (1968) has shown that iteration of the Zellner estimation procedure until convergence results in maximum-likelihood estimates and is a computationally efficient method.

equation we drop. The estimated SURE coefficients together with their test statistics and the maximized value of log likelihood are recorded in table 1. The fit is generally good for the variable cost equation and fuel share equation, though not quite good for the material share equation (the R-square values are 0.97, 0.72 and 0.09 respectively for the variable cost function, share equations of fuel and of materials). The Chi-square value (1606.7) produced by the Wald test (for testing the validity of imposed restrictions) and insignificant auto correlation exhibits the robustness of the model. However, the estimated cost function is well behaved only if it is concave in input prices and its input share functions are positive. It is found that the estimated variable cost shares are positive at all observations and the Hessian matrix based on the parameter estimates are negative semi-definite, thereby satisfying the first and second order conditions.

The estimated parameters and the time series data are employed with (8) to calculate the potential output (Y*), the output where the short run average total cost is minimized, which is used to estimate economic CU. As a closed form solution is not possible for (8) a numerical iterative technique is followed. The ensuing estimates of CU ratios,

Figure 1
Economic and Installed Capacity Utilization in Indian Manufacturing



CU≡Y/Y*, together with the ratios based on the installed capacity[21] are plotted in figure 1.

A comparison of two measures shows that in all the years capacity utilization estimates using the cost function exceed the traditional engineering approach (or installed capacity). This does not come as a surprise because the level of capacity depends on the relative proportion in which the fixed and variable inputs are combined. The volume, intensity and cost of variable inputs, therefore, may restrict the economic capacity. Thus, the engineering measures of capacity utilization significantly underestimate the more relevant economic capacity utilization. Apart from the differences in the level, there are differences in the movements also. We have calculated the simple correlation between CU measures based on dominant methods in the literature, the engineering approach, the Wharton index and the minimum capital output ratio (K/Y) approach (see table 2). The economic capacity utilization is found to have high correlation with Wharton indices throughout the period. The highest average utilization in all the measures has been observed during 1985-91 period, except in installed CU, where it is during 1980-85. In the case of lowest average utilization, while minimum capital output ratio and installed CU figures show it during 1992-98, economic CU and Wharton indices show it during 1974-80 (table 3). While the economic CU reached its peak in 1976-7 it registered a sharp decline in 1979-80.[22] In most years the estimated economic CU are below unity.[23]

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21 The data on installed CU are taken directly from Burange (1992), till 1986-7 and thereafter we calculated the simple averages for the companies reported in PROWESS, the database provided by Centre for Monitoring Indian Economy.

22 Incidentally, this sharp decline in the CU in the 1980s is observed in many other countries as well. See for example Berndt and Hesse (1986).

23 CU greater (less) than one is informative for it insinuates that production is to the right (left) of the minimum cost point, thereby inducing cost reducing net investment (disinvestment).

Table 2: Correlation between different measures of CU

1974-85	Installed CU	Wharton CU	K/Y CU	Economic CU
Installed CU	1.000			
Wharton CU	0.122	1.000		
K/Y CU	0.179	0.990	1.000	
Economic CU	0.067	0.979	0.987	1.000
1986-91				
Installed CU	1.000			
Wharton CU	-0.900	1.000		
K/Y CU	-0.638	0.826	1.000	
Economic CU	-0.867	0.993	0.884	1.000
1992-98				
Installed CU	1.000			
Wharton CU	-0.472	1.000		
K/Y CU	-0.574	0.684	1.000	
Economic CU	-0.409	0.971	0.545	1.000

Table 3: Average CU in Indian Manufacturing, Different methods

Period	Installed	Wharton	+ K/Y ratio	Economic
1974-98	0.640*	0.928	0.895	0.938
1974-80	0.674	0.897	0.890	0.919
1974-85	0.675	0.917	0.907	0.933
1980-85	0.685	0.916	0.904	0.922
1985-91	0.625	0.948	0.924	0.948
1992-98	0.580*	0.929	0.846	0.937

Notes : *This figure is only up to 1995-6

+ CU = Y/[K/(min(k/y))]

Over the period as a whole, both potential and actual output grew at a similar rate say around 7.3 percent. However, the expansion of potential shows a significant acceleration. It is also observed, while looking at the growth rates of inputs that the non-accelerating output growth has been mainly due to the intensive use of capital input. Whereas the growth rate of capital input is significant and accelerating, the growth of employment is very negligible (see table 4). The significant growth of capacity output, therefore, may be attributed to the accelerating growth of additional investment in the sector.

Table 4: Growth of inputs and output, Aggregate Manufacturing, 1974-98

Output	7.39
NVA*	6.79
Fixed Capital*	8.75
Capital Stock*	7.65
Investment*	7.67
Employment	1.55
Fuel	6.43
Material	6.49
Potential Output*	7.28

Notes: Growth rates are estimated from ASI data using an exponential fit. All are significant at 1 % level.
Variables with * mark show a significant acceleration in their growth rates.

CU in Indian Manufacturing: Analyzing the trends

From the Figure 1, we also observe three distinct phases in the movements of economic CU. Phase one, from 1973-4 to 1983-4, is characterized by relatively wide fluctuations. In phase two, covering the period 1983-4 to 1989-90, CU is roughly stable with very little fluctuations. In the final phase, 1990-1 to 1997-8, CU shows a fluctuating tendency.

To examine phase one, CU shows an increasing trend from 1973-4 to 1977-8, following an increase in the domestic demand due to an increase in the national income. The gross domestic expenditure during this period registered an average growth rate of 4.8 per cent per annum. After the peak growth of CU in 1977-8, it shows a declining trend in 1978-9 and 1979-80 following a slump in the demand for which already different explanations have been provided in the literature. [24] This together with the impact of second and third oil shocks might have resulted in a drop in utilization. The period 1980-83 clearly marked a significant recovery in utilization. This was also the period in which the highly debated turn around in Indian industry occurred. [25] In addition to the revival in agricultural production, the policy reforms during this period that regularized the excess plant capacity might also have helped improve the CU.

The beginning of second phase coincides with the partial liberalization of the mid eighties. The period witnessed the gradual replacement of the protected regime with ambitious schemes for modernization and capacity rejuvenation. The industrial licensing was further liberalized in 1987-8. To encourage production and to provide flexibility to manufacturers to adjust their product mix to market demand, the concept of broad banding was introduced. However, CU remained almost stable, except for a slight improvement after 1988.

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24 It is identified that this was a period of stagnant demand for manufactured products (Krishnaji, 1984), and decline in agricultural real wages (Anandraj, 1996) resulting a reduction in the demand for industrial products from the agricultural sector.

25 See Ahluwalia (1985)

During the third phase beginning the early nineties, CU figures show a slightly declining trend in the first half and thereafter an increase, though it came down again in the end-years. One of the arguments for liberalizing the industrial sector was that a more open economy provides the impetus for stimulating capacity utilization. It is worth mentioning here that the process of liberalization and macro economic stabilization is observed to involve a large decline in output in the early stages of transition. Further a considerable under-utilization of capacity may also be expected in the early stages of transition. [26] Our results indicate that the adoption of liberal economic policies have caused fluctuations in capacity utilization. This may be attributed to the increased role of market forces in an open economy, which triggers the demand fluctuations and the corresponding expectations which may force firms to keep part of capacity idle in order to meet future demand exigencies. It, however, requires a more rigorous analysis incorporating the anticipatory expectations (Morrison, 1985) and market imperfections, to arrive at firm conclusions, which is beyond the scope of present study.

VII. FACTORS AFFECTING CU

It may be noted that the observed variations in CU over the years are in consonance with the ups and downs in the growth of the economy. It is seen that the variation in the level of gross domestic product (GDP) and the level of output in the manufacturing sector have also been relatively high during the first and third phases (Table 5) compared to that of second phase. For a rigorous understanding, we have carried out a simple regression analysis, where we regress capacity utilization on the growth of GDP and two dummy variables to capture the effect of

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26 See Hernandez Cata (1997).

macro policy changes. The first dummy takes the value one for post 1985 period and zero otherwise, and the second one takes the value one for post 1991 period and zero otherwise. Interestingly these results are in concurrence with our observations.[27] While GDP, a proxy for the demand, has shown a positive and significant impact on CU, both dummy variables show no significant impact on CU. Thus the principal observation from the above analysis is that the sector witnessed a cyclical movement in the capacity utilization, which is in concurrence with the growth of the economy. This cyclicality has been observed regardless of the changes in policy sphere, implying that CU does not show any significant response to the policy changes.

Table 5: Variation in CU, Output and Gross Domestic Product

Year	CU	Output	GDP
1974-84	6.53	24.91	13.42
1985-90	2.62	15.48	11.41
1991-98	4.00	20.38	14.93

Note: Figures are coefficient of variation

Input Prices and CU

The framework we followed permits us to calculate the effects of input price changes on potential output and capacity utilization. The effect of variations in input prices on Y* and CU depends on the substitutability/complementarity of variable inputs with capital (Berndt and Morrison, 1981). If the variable input and capital are Hicks-Allen

27 The regression result is $ln\ CU=$

$$-0.09338 + 0.6337(ln\ GDP_t - lnGDP_{t-1}) + -0.00522D1 - 0.0124D2$$

(-3.57) (1.75) (0.235) (-0.720)

R^2=0.18, and t ratios in parenthesis.

substitutes (complements), then the predominant effect of an increase in variable input price is to decrease (increase) *Y**; if however, they are independent inputs, the variations in input prices do not affect *Y**. Therefore, an important way of evaluating the effect of input prices on *Y** and CU is to calculate the elasticity of optimal output with respect to input prices, i.e. $e_{yi} = \partial \ln Y^* / \partial \ln P_i$. Following the approaches suggested by Brown and Christensen (1981) and Berndt and Hesse (1986), we calculate the elasticities in the following way.

We have at the minimum point of the *SATC*,

$$SATC = VC/Y^* + P_K.K/Y^* = f(Y^*, P_i, K, T)$$

And equation (8)

$$\partial SATC/\partial Y^* = \partial f/\partial Y^*, = VC(\mu y-1)-P_K K = 0 = f_y$$

Taking the total differential of f_y

$$df_y = 0 = \frac{\partial f_y}{\partial Y^*} dY^* + \sum_i \frac{\partial f_y}{\partial P_i} dP_i + \frac{\partial f_y}{\partial K} dK + \frac{\partial f_y}{\partial T} dT \;\; ; i = L, F \; and \; M. \qquad (9)$$

Setting $dK=dT=dP_j \; (i \neq j) = 0$ and dividing both sides of the equation by dP_i, we get

$$\frac{\partial f_y}{\partial Y^*} \frac{dY^*}{dP_i} + \frac{\partial f_y}{\partial P_i} = 0$$

Then

$$\frac{\partial Y^*}{\partial P_i} = \frac{-\partial f_y / \partial P_i}{\partial f_y / \partial Y^*} \qquad (10)$$

Now following equation (8), $\partial f_y/\partial P_i$ and $\partial f_y/\partial Y^*$ for the translog cost function may be derived as

$$\partial f_y / \partial P_i = (\mu y\text{-}1)\mu i(VC/P_i) + (VC/P_i)\beta_{yi}$$

$$= (VC/P_i)[(\mu y\text{-}1)\mu_i + \beta_{yi}] \quad (11)$$

$$\partial f_y / \partial Y^* = VC[\beta_{yy}(1/Y^*)]+[(\mu_y\text{-}1)\mu_y(VC/Y^*)]$$

$$= (VC/Y^*)[\beta_{yy} + (\mu_y\text{-}1)\mu y]$$

Substituting (11) in (10) we have,

$$\frac{dY^*}{dP_i} = -\left(\frac{Y^*}{P_i}\right)\left[\frac{(\mu_y - 1)\mu_i + \beta_{yi}}{\beta_{yy} + (\mu_y - 1)\mu_y}\right] \quad (12)$$

Potential output elasticity with respect to i [th] input is defined as $e_{yi} = \partial lnY^*/\partial lnPi = (\partial Y^*/\partial P_i)(P_i/Y^*)$; *for i =L, F and M*, i.e.

$$e_{yi} = \frac{-[\beta_{yi} + (\mu_y - 1)\mu_i]}{\beta_{yy} + (\mu_y - 1)\mu_y}$$

The above result is important that it shows the substitutability/ complementarity between the variable inputs and capital i.e.

$$e_{yi} = -\frac{\partial \ln K}{\partial \ln P_i}$$

For example, if the material inputs and capital are substitutes, then $e_{ym}<0$, i.e. increases in material prices, *ceteris paribus*, will reduce the capacity output level. In other words, increases in P_M would increase the firm's long run optimal *K/Y* ratio from, say, K_0/Y^* to K_1/Y^*, implying a smaller *Y** corresponding to the given level of capital K_0. In such a case, given current *K*, the larger long run (*K/Y**) ratio can be preserved by reducing current capacity output *Y** by operating on a new *SRAC* curve with minimum point to the left of the original minimum cost output level. Hence in this case, given *K* and *Y*, increases in P_M would reduce *Y** and therefore increase *CU* (Berndt and Hesse, 1986).

Table 6: Estimated Potential output Elasticities with respect to inputs

Year	e_{yf}	e_{ym}	e_{yl}
1973-4	0.00290	–0.00969	0.00464
1979-80	0.00201	–0.02085	0.00323
1984-5	0.00220	–0.01718	0.00387
1989-90	0.00215	–0.01781	0.00399
1994-5	0.00198	–0.01912	0.00387
1997-8	0.00143	–0.02097	0.00361

The estimated elasticities are reported in table 6. The table brings many issues of interest. It shows that the effect of increase in the price of material is to reduce the potential output. But in the case of labor and fuel the effect is positive. This may imply that the fuel and labor are long run complements to the capital. The quantitative magnitude of the

Figure 2
Input shares in Variable cost

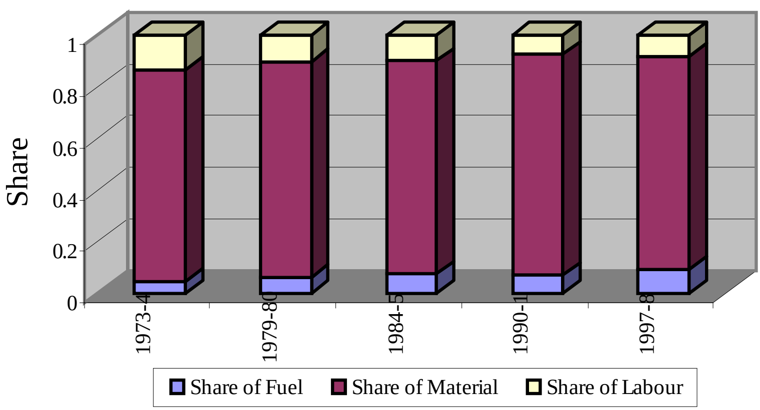
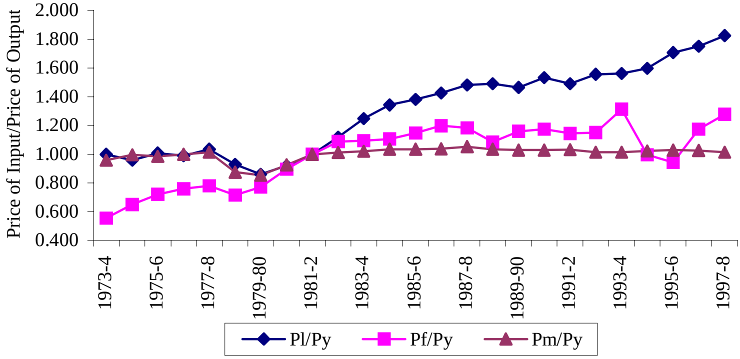


Figure 3
Relative Input Prices, 1981-2=100



material elasticity is higher than that of the other two. This may be because of the fact that outlays on materials are much higher than that on labor and fuel. The average share of material in total variable cost is 84 percent while that of fuel and labor are only 8 per cent each (see figure 2 also). It implies that increases in the material prices have much larger impact on potential output and thereby CU than do proportional increase in wage rates and fuel prices. Thus it may be seen from the above observations that, given K and Y, the effect of changes in wage rate and fuel prices on CU is negative, while that of material is positive. It is, however, worth mentioning here that if the changes in variable input prices are easily transformed into output price, the production may not be affected by the input price changes, provided the market demand is not altered. It is seen that while the relative prices of material remained almost stable, it has been increasing in the case of fuel and labor prices with the wage rates registering a relatively high rate of increase (figure 3). That is, the input price shocks are almost transformed into output price in the case of material while it is not true with fuel prices and wage rate. Therefore, given the substitutability/

complementarity relationship between variable inputs and capital, the material price shocks are unlikely to have negative effect on CU, while fuel and labor prices are likely to have a modest negative impact. Also note that the quantitative magnitude of potential output elasticity with respect to labor price is always higher than that of fuel price implying a relatively larger effect of wage rates on CU.

The principal inference that may be drawn from the above exercise is that CU is an outcome of firms' optimization procedure depending upon simultaneous factors. We observe, on top of the findings of earlier studies, that along with demand side factors, supply side factors are also important in deciding the movements of capacity utilization.

VIII. IN LIEU OF CONCLUSION

To summarize, we have examined the trends in and the factors affecting economic capacity utilization (CU) in Indian manufacturing sector over 1974-1998. The CU is estimated employing a translog variable 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. Further, the Indian manufacturing sector experienced a cyclical pattern of economic capacity utilization over the period of study. It has also identified three distinct phases of economic CU movements. While phase one (1974-1984) has marked relatively wide fluctuations the phase two (1985-1990), shown more or less a stable level of utilization. A mild variant of the fluctuations of the sort witnessed in the first phase is seen to have resurfaced in the third phase (1991-1998). Interestingly, there has not been any significant correspondence between the observed phases of CU with the corresponding policy environment. While phase one is characterized by a restrictive policy regime, phase two and three are characterized by partial and further liberalization policies. Thus, it can be said that the initiation of liberalization, which roughly coincides with the second and third phases, has shied to exert a favorable impact on CU though the stimulation of CU has been one of the major grounds for introducing liberal policy reforms in the nineties. Perhaps, this is not a surprising outcome of liberalization. For, the economic theory mentions of different possible reasons for keeping idle capacity in a competitive economy. Therefore, it can be said in lieu of conclusion that the tendency to attribute all economic outcomes in a period, which coincide with economic reforms may not match with the empirical facts. The 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.

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