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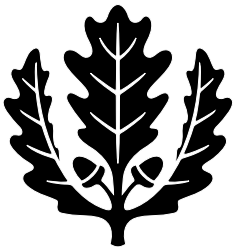

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Abstract

While Indias state-owned enterprises are widely believed to be inefficient, there is a dearth of studies that document such inefficiency on any rigorous basis. Yet, since improvement in firm efficiency is one of the basic objectives of privatization, it is important to assess whether efficiency is indeed lower in the public sector than in the private sector.

This paper compares the performance of state-owned enterprises with those of private sector firms in respect of technical efficiency. The comparison is made in eight different sectors over the period 1991-92 to 1998-99. We measure technical efficiency using the method of Data Envelopment Analysis. Judging by the average levels of technical efficiency, no conclusive evidence of superior performance on the part of the private sector is found.

Technical Efficiency in Public and Private Sectors in India: Evidence from the Post-Reform Years

1. Introduction

India's economic reforms launched in 1991 and continued over the years that followed have primarily been directed towards downsizing, although not dismantling, the ungainly public sector that is in many ways seen as a hindrance to efficient utilization of resources. There is a popular conviction that the private sector is more efficient and the problems faced by the public sector enterprises will be easily eliminated by the competitive market forces once these firms are privatized. Needless to say, the wisdom of the reform process has been challenged by the political Left primarily on polemical grounds. There has been surprisingly very little effort, however, at documenting the comparative performances of the public and private sectors with any degree of rigor, least of all in the most recent period.

Instead, there is a presumption, based on theory as well as on empirical studies carried out in other contexts, that the private sector will deliver better performance and hence privatization is desirable. As a result, in policy-making circles, privatization has to be viewed as an essential concomitant of the ambitious program of economic reforms introduced since 1991that include macro-economic stabilization as well as structural reforms embracing industry, the external sector, the financial sector and agriculture.

Yet, in formulating a policy of privatisation, it is important to know whether efficiency in the public sector is indeed lower than that in the private sector and whether this holds uniformly for the many sectors in which public sector enterprises operate. If this is not the case, then, privatization policy ought to focus on sectors in which the public enterprises have tended to under-perform. Such a result would also imply that public policy must address institutional factors – such as weak law enforcement, poor corporate governance and tardy bankruptcy procedures- that keep the private sector from realizing its fullest potential before embarking on full-blooded privatization.

In India, the public sector is present in a whole range of manufacturing sectors- chemicals, electronics, metals, electrical and non-electrical machinery, textiles, transport equipment, minerals etc- and also in services such as telecommunications and airlines. In basic metals and machinery, its share of output is around 25 per cent, while in chemicals and transport equipment, its share is 15-20 per cent. In areas such as energy and non-ferrous metals, its share was until recently close to 100 per cent. Given that the public sector in India is so ubiquitous, it is of great importance that the assets in the public sector today need be utilized efficiently,. Estimating the relative efficiency of the public and private sectors is, therefore, of considerable relevance to the ongoing debate on privatization in India.

The rest of the paper is organized as follows. In section 2, we briefly review the literature on comparative performance of public and private sectors and the impact of privatization.

Section 3 provides a brief description of the nonparametric method of Data Envelopment Analysis (DEA) employed in this paper. The empirical analysis is presented in section 4. Section 5 concludes with a discussion of our results and their implications for policy.

2. Review of relevant literature

A vast literature has grown on the relative performance of the public and private sectors and the impact of privatization. Among the better-known studies, Boardman and Vining (1989) compared performance measures for 500 non-US international firms and concluded that private sector performance was superior. However, other studies, such as Caves and Christensen (1980) and Fare, Grosskopf, and Logan (1985) have found evidence of superior performance by public sector firms. Martin and Parker (1997) review a number of other international studies that compared state and private sector enterprises and find that the evidence is mixed.

On privatization, there is the oft-cited study of Megginson et al (1994). They compared the pre- and post- privatization financial and operating performance of 61 companies from 18 countries and 32 industries during the period 1961 to 1990 and found improvements in various parameters of performance after privatization. Frydman et al (1999) find improvements in the performance of the 218 firms in the transition economies, although they emphasize that the improvement is contingent on getting the design of privatization right. LaPorta and Lopez-De-Silanes (1998) document similar improvements following privatization in Mexico.

However, there is an impressive body of literature now that casts doubts on whether privatization yields such improvements in general in less developed countries. Nellis (2000), after reviewing some of the literature, observes that "the further east one travels, the less likely is one to see rapid or dramatic returns to privatization". Others, such as Stiglitz (1998) have suggested the emphasis on privatization in some of the less developed economies might be misplaced. Stiglitz points out that the Chinese experience shows that ".. an economy might achieve more effective growth by focusing first on competition, leaving privatization until later."

More pertinently, perhaps, there is now growing recognition that in the absence of institutional and regulatory capacity- such as law enforcement, strong corporate governance, efficient capital markets- superior private sector performance cannot be taken for granted. A comparison of the relative efficiency and public and private enterprises in an emerging market such as India, should, therefore, merit attention.

On India, the literature on comparative performance of the public and private sectors is rather scanty, especially in relation to the most recent period. Bhaya (1990) compared performance over the period 1981-82 to 1985-86 by examining data published in the government's Annual Survey of Industries (ASI). He looked at fixed capital, working capital and inventory in relation to net value added, as also gross output and net value

added per employee and found no difference, although the private sector did better in terms of return on investment.

Ahluwalia (1995) cites a study by the Institute of Public Enterprises that compared the performance of 221 central public enterprises with that of 541 large companies in the private sector for the three years from 1983-84 to 1985-86. The average gross return on capital employed was found to be 13.9 per cent in the private sector and 12.3 per cent in the public sector. When petroleum enterprises were excluded from the public sector, the return for the public sector fell to 8 per cent.

Two studies that are most directly relevant to the present paper are by Ahuja and Majumdar (1998) and Majumdar(1999) that have analyzed the performance of state-owned enterprises (SOEs) in India, using DEA methods.

Ahuja and Majumdar (1998) examined the performance of 68 SOEs during the period 1987 to 1991. These enterprises were all drawn from the manufacturing sector and the relevant data were obtained from the Center for Monitoring Indian Economy (CMIE). The authors used net value added to measure output and the number of employees and fixed assets (gross as well as net) as measures of the labor and capital inputs, respectively. They used nominal as well as deflated values of gross and net fixed assets, using the whole price index for manufacturing as deflator. They obtained annual average values of mean efficiency in the range of 0.35- 0.39. They suggested that the low values of efficiency pointed to substantial scope for improvement through measures such as privatization.

There are several limitations to their study. First, as the authors acknowledge, they essentially compare efficiency of SOEs only relative to each other. For the study to be more meaningful, it is important to include a panel of private sector firms as well in the sample. Second, technical efficiency is measured across a highly heterogeneous sample of firms drawn from varied sectors and thus incorporating differing technologies. Technical efficiency comparisons are more meaningful when there is at least a modest degree of homogeneity in the firms being compared.

Yet another limitation is that it is based on a small sample, considering that there are over 200 firms owned by the central government alone (and, as mentioned, the authors examine only 68) and it leaves out sectors in industry other than manufacturing.

In a subsequent paper, Majumdar (1999) attempts a broader evaluation. He compares performance across four categories: central government SOEs, SOEs owned by state governments (India is a federation of states), enterprises jointly owned by the government and the private sector and private sector enterprises. The comparison is based on aggregate data obtained from the Annual Survey of Industries and covers the period of 1973-74 to 1988-89. In other words, there are four data points for each year and a total of 16 years. Output is defined again as net value added and inputs are staff employed and deflated values of book values of capital.

The author estimates mean technical efficiency for the categories of ownership and subjects the results to a Wilcoxon test. There is no significant difference between the central government-owned and state government enterprises; the central government-owned enterprises are less efficient than private enterprises and enterprises in the joint sector; and the joint sector is less efficient than the private sector. The results are not different over two sub-periods, 1973-1980 and 1981-88.

Majumdar concludes that the private sector clearly emerges a superior performer although he acknowledges that that the aggregate results may hide differences in performance within industrial sectors. (It is worth mentioning that the author also found that over the second period, in which various reforms in the public sector had been initiated, the annual rate of growth of efficiency was higher in the public sector than in the mixed sector or the private sector).

The problem of lumping together disparate industrial categories applies to this study as well. A more serious limitation is that technical efficiency is measured over a sixteen-year period, that is, there is one efficient frontier posited for the entire period, which clearly ignores the effect of technical change over such a long timeframe.

Our study attempts to address some of the limitations in the earlier DEA studies on efficiency in public and private sector firms that we discussed above. First, unlike Majumadar (1999) we use firm-level rather than aggregate data. At the same time, unlike Ahuja and Majumdar (1998), we include both private and public sector firms in our sample.

Second, the technical efficiency of any firm from any particular industry is judged against a production frontier constructed from observed input-output data for firms from that industry only. This controls for technological heterogeneity across industries and provides a more meaningful measure of efficiency. We compare performance of public and private firms separately in eight different industrial sectors instead of lumping together firms in disparate industrial sectors.

Third, we use annual cross-section data from different industries for measurement of efficiency of firms in different years. This avoids confusing technical change with efficiency change over time.

We compare public and private sector firms using technical efficiency which measures the actual output of a firm with the maximum output that is theoretically feasible. It can be measured by the ratio of its actual output to the maximum output producible from its observed input bundle defined by the frontier production function.

While technical efficiency is only one of the factors determining financial performance- other factors would be allocative and scale efficiencies- a comparison of performance on technical efficiency is useful because it tells us whether public sector firms can get as much output out of a given input bundle as private firms. If this turns out to be true, then

differences in performance could well be the result of factors, such as choice of product-mix or inputs-over which managers in public sector firms have relatively less control.

If technical efficiency in the public sector is comparable to that in the private sector, it would, to some extent, undermine conventional perceptions about managerial and worker motivation and performance- for instance, the view that managers and workers in the public sector are more given to shirking than their counterparts in the private sector because the former lack incentives and effective monitoring.

3. Data Envelopment Analysis

We use Data Envelopment Analysis (DEA) to measure technical efficiency. In parametric models, one specifies an explicit functional form for the frontier and econometrically estimates the parameters using sample data for inputs and output. Hence the validity of the derived technical efficiency measures depends critically on the appropriateness of the functional form specified.

In contrast, the method of DEA introduced by Charnes, Cooper and Rhodes (CCR) (1978) and further generalized by Banker, Charnes, and Cooper (BCC) (1984) provides a nonparametric alternative to parametric frontier production function analysis.

In DEA, one makes only a few fairly weak assumptions about the underlying production technology. In particular, no functional specification is necessary. Based on these assumptions a production frontier is empirically constructed using mathematical programming methods from observed input-output data of sample firms. Efficiency of firms is then measured in terms of how far they are from the frontier.

Consider an industry producing a scalar output, y, from bundles of m inputs, $x=(x_1,x_2,\ldots,x_m)$. Let (x^j, y^j) be the observed input-output bundle of firm j $(j= 1,2,\ldots, n)$.
The technology is defined by the production possibility set

$T=\{(x, y)$: y can be produced from $x \}$.

An input-output combination (x^0, y^0) is feasible if and only if $(x^0, y^0) \in T$.
We make the following assumptions about the technology:

- All observed input-output combinations are feasible. Thus, $(x^j, y^j) \in T$ $(j = 1,2,\ldots,n)$.
- The production possibility set, T, is convex. Hence, if $(x^1, y^1) \in T$ and $(x^2, y^2) \in T$, then
  $(\lambda x^1+(1-\lambda)x^2, \lambda y^1+(1-\lambda)y^2)\in T$, $0\leq\lambda\leq 1$.
  In other words, weighted averages of feasible input-output combinations are also feasible.
- Inputs are freely disposable. Hence, if $(x^0, y^0)\in T$ and $x^1 \geq x^0$, then $(x^1, y^0)\in T$. This rules out negative
  marginal productivity of inputs.
- Output is freely disposable. Hence, if $(x^0, y^0)\in T$ and $y^1 \leq y^0$, then $(x^0, y^1)\in T$

Varian (1984) pointed out that the smallest set satisfying assumptions (1)-(4) is;

$$S = \{(x, y) : x \geq \sum_{j=1}^{n} \lambda_j x^j ; y \leq \sum_{j=1}^{n} \lambda_j y^j ; \sum_{j=1}^{n} \lambda_j = 1; \lambda_j \geq 0; j = 1,2,...,n\}.$$

Let $\bar{x} = \sum_{j=1}^{n} \lambda_j x^j , \bar{y} = \sum_{j=1}^{n} \lambda_j y^j ; \sum_{j=1}^{n} \lambda_j = 1; \lambda_j \geq 0.$ By virtue of convexity $\{\bar{x}, \bar{y}\}$ is feasible.

Then, for any $x \geq \bar{x}, (x, \bar{y})$ is feasible. Finally, for any $y \leq \bar{y}, (x, y)$ is also feasible. Technical efficiency of any firm producing output y^0 from input x^0 is $1/\varphi^*$, where

$$\varphi^* = \max \varphi : (x^0, \varphi y^0) \in S.$$

Note that this is an output-oriented measure of efficiency. Alternatively, one could use an input-oriented approach, where efficiency lies in conserving inputs while producing the observed output quantity. To compute output-oriented efficiency one solves the following linear programming problem:

$$Max \quad \phi_t \qquad t \in (1,...,N) \qquad (1)$$

$$\text{s.t} \quad \sum_{n=1}^{N} \lambda_n x_{nj} \leq x_{tj} \qquad j = 1,...,J \qquad n = 1,...,N \qquad (2)$$

$$\sum_{n=1}^{N} \lambda_n y_n \geq \phi_t y_t \qquad (3)$$

$$\sum_{n=1}^{N} \lambda_n = 1 \qquad (4)$$

$$\lambda_n \geq 0. \qquad (5)$$

This BCC model allows increasing, constant, or diminishing returns to scale along the frontier of the production possibility set at different levels of inputs.

4. The Empirical Analysis

4.1 The Data

Our study is based on firm-level data obtained from the CMIE database and covers the period, 1991-92 to 1998-99, coinciding with initial years of the post-reform era in India. We use a balanced panel of data over the entire period ((as in Majumdar (1998), except that our sample comprises both public and private firms)). While this leads to a sample that is smaller than the complete set of firms in a given year, it eliminates distortions in comparisons that could be created by the entry or exit of firms in parts of the total period.

As explained before, we compare performance of public and private firms separately in eight different industrial sectors instead of lumping together firms in disparate industrial sectors. The eight sectors, based on the CMIE's classification, are: chemicals, electronics, iron and steel, non-electrical machinery, minerals, textiles, service industry and transport.

The CMIE's classification is based on whether 50 per cent or more of a firm's output falls within a given category. The CMIE's classification does contain sub-categories for the industrial sectors we have chosen. However, we chose to carry out our analysis at the overall sectoral level as sub-categories do not produce sufficiently large balanced panels of private and public firms. The descriptive statistics for these firms are provided in table 1. The sample size varies from 34 to 173.

Table 1: Descriptive statistics for the sample firms

Sector	No of firms	Mean Output	Standard Deviation	Minimum	Maximum
Chemical	173	163.42	258.43	1.40	1700.08
Electronics	61	181.06	332.36	1.03	1598.50
Steel	86	360.81	1474.58	1.23	12806.24
Mineral	34	2743.85	7387.35	3.33	39312.91
Non-electrical	96	153.58	489.50	0.54	4524.73
Service	102	382.06	977.33	0.49	5731.89
Textiles	141	118.43	150.92	1.01	966.33
Transport	91	282.53	755.57	2.17	5162.91

Note: All figures are eight year averages; financial figures are presented in Rupee millions (Rs47=$1)

The output and input variables used in our study were constructed in the following way. For gross output, we use net sales of firms (that is sales net of excise duties) adjusted for changes in inventories. For inputs, we use: wages, raw materials, energy and capital. As energy and raw materials are included separately as inputs, the use of gross output, rather than net value added, is appropriate. (Net value added is used when the only inputs are labor and capital). All nominal values have been appropriately deflated. In the case of output, the deflator is the wholesale price index for the relevant industrial sector; for wages, it is the consumer price index for industrial workers; for energy, it is the wholesale price index for energy; for capital, it is the wholesale price index for equipment. Different raw material price indexes were constructed for individual industry codes.

For capital, we do not use gross or fixed assets, unlike the studies cited here. Instead, we denote capital to mean the summation of four items: interest, depreciation, repairs and other rent. In other words, we prefer a measure for capital that is based on flows to one that is based on stock, as measures for output and other inputs are all based on flows.

Further, we use wages instead of number of employees, as the database does not provide the latter. Wages, deflated by the price index, yield quantities of labor.

4.2 Results

We measure the output-oriented BCC model to compute VRS technical efficiency for each firm with reference to a frontier constructed from the input-output data of firms from the same industry in any one particular year. This is obtained for a pooled sample of public and private firms in a given industrial sector separately for each year, that is, relative to an efficient frontier for that year. We thus obtain the average technical efficiency for public and private firms for each of eight years. (The technical efficiency score for any given firm would range from 0 to 1.) These eight observations for public and private sectors are subjected to a t-test for difference in means.

4.2.1 t-test for differences in average efficiency

The technical efficiency results obtained for the public and private sectors in each of the eight industrial categories are presented in tables 2-9.

Table 2: Technical efficiency scores in chemical sector

	Private	Public
1991-92	0.82	0.77
1992-93	0.79	0.73
1993-94	0.79	0.74
1994-95	0.81	0.73
1995-96	0.80	0.69
1996-97	0.80	0.70
1997-98	0.80	0.68
1998-99	0.83	0.67
Average	0.81	0.71
Av 1992-95	0.80	0.74
Av 1996-99	0.81	0.68

Table 3: Technical efficiency scores in electronics sector

	Private	Public
1991-92	0.84	0.87
1992-93	0.82	0.88
1993-94	0.84	0.90
1994-95	0.85	0.91
1995-96	0.84	0.91
1996-97	0.81	0.91
1997-98	0.82	0.87
1998-99	0.80	0.74
Average	0.83	0.87
Av 1992-95	0.84	0.89
Av 1996-99	0.82	0.86

Table 4: Technical efficiency scores in steel sector

	Private	Public
1991-92	0.91	0.87
1992-93	0.90	0.85
1993-94	0.86	0.79
1994-95	0.92	0.86
1995-96	0.91	0.83
1996-97	0.85	0.75
1997-98	0.89	0.78
1998-99	0.86	0.79
Average	0.89	0.81
Av 1992-95	0.90	0.84
Av 1996-99	0.88	0.79

Table 5: Technical efficiency scores in mineral sector

	Private	Public
1991-92	0.78	0.77
1992-93	0.71	0.76
1993-94	0.72	0.74
1994-95	0.73	0.77
1995-96	0.75	0.79
1996-97	0.67	0.75
1997-98	0.65	0.68
1998-99	0.63	0.54
Average	0.71	0.73
Av 1992-95	0.73	0.76
Av 1996-99	0.68	0.69

Table 8: Technical efficiency scores in textile sector

	Private	Public
1991-92	0.88	0.89
1992-93	0.87	0.76
1993-94	0.84	0.70
1994-95	0.86	0.67
1995-96	0.85	0.73
1996-97	0.84	0.69
1997-98	0.84	0.57
1998-99	0.82	0.58
Average	0.85	0.70
Av. 1992-95	0.86	0.76
Av 1996-99	0.83	0.64

Table 9: Technical efficiency scores in transport sector

	Private	Public
1991-92	0.80	0.81
1992-93	0.92	0.95
1993-94	0.88	0.93
1994-95	0.90	0.89
1995-96	0.91	0.88
1996-97	0.77	0.72
1997-98	0.88	0.87
1998-99	0.91	0.93
Average	0.87	0.87
Av. 1992-95	0.88	0.90
Av 1996-99	0.87	0.85

Table 6: Technical efficiency scores in non-electrical machinery sector

	Private	Public
1991-92	0.84	0.84
1992-93	0.43	0.36
1993-94	0.68	0.61
1994-95	0.53	0.42
1995-96	0.71	0.64
1996-97	0.83	0.79
1997-98	0.82	0.81
1998-99	0.72	0.69
Average	0.70	0.64
Av 1992-95	0.62	0.55
Av 1996-99	0.77	0.74

Table 7: Technical efficiency scores in services sector

	Private	Public
1991-92	0.56	0.70
1992-93	0.56	0.72
1993-94	0.39	0.59
1994-95	0.43	0.61
1995-96	0.36	0.60
1996-97	0.37	0.60
1997-98	0.31	0.58
1998-99	0.32	0.52
Average	0.41	0.61
Av 1992-95	0.48	0.66
Av 1996-99	0.34	0.57

The averages for technical efficiency in each sector and the t-statistics for differences in means are summarized in table 10.

Table 10: Technical efficiency results

	Private	Public	t-statistic
Chemicals	0.81	0.71	**6.97a**
Electronics	0.83	0.87	**-2.2a**
Steel	0.89	0.81	**4.01a**
Minerals	0.71	0.73	-0.59
Non-electrical	0.70	0.64	0.61
Service	0.41	0.61	**-4.76a**
Textile	0.85	0.70	**4.12a**
Transport	0.87	0.87	-0.04

Note: Technical efficiency scores are averages over the period 1991-92 to 1998-99; significant values are bold faced; subscript a significance at 5 per cent level of confidence

Table 10 reveals the following:

- In three sectors- chemicals, iron and steel and textiles, the private sector's technical efficiency scores are superior
- In two sectors- electronics and services- the public sector's scores are superior
- In three sectors- minerals, non-electrical machinery and transport- there is no difference between the two sectors

Thus, out of eight sectors, only in three does the private sector exhibit superior technical efficiency. This would seem to refute the notion, commonly expressed in the popular press in India, that the public sector tends to uniformly under-perform the private sector.

We have separately computed technical efficiency averages for the first four years and the last four years of the period under study. We note the following:

- In five sectors- electronics, steel, minerals, services and textiles- the average for the last four years is lower than in the first four
- In two sectors- chemicals and transport- it is almost the same for the private sector and lower for the public sector
- Only in one sector- non-electrical machinery- do we find that technical efficiency is higher in the second half of the period covered

The above findings are of interest because they appear to be consistent with the general deceleration in growth in industry in the later years of economic reforms, a matter that has been the subject of much comment in the media and among policy-making circles in India.

4.2.2 Comparing performance after controlling for scale and time

It is often contended that if at all some public sector firms in India do better than their private sector counterparts it is only because they have the advantages of size. In other words, private sector performance would be superior to that of the public sector once we adjust for scale effects. This would imply that, while public sector firms in some industries might be doing better than the private sector, if the same firms were to be handed over to private ownership, the performance of these firms would be even better.

We examine whether these propositions about the advantages of size in the public sector are correct. We do by using a Tobit model with technical efficiency as the dependent variable and scale and time as independent variables, with dummy variables for ownership, industry and industry interacted with ownership.

The specified Tobit model is

$$\ln TE_{it} = \alpha_0 + \beta_1 \ln y^j{}_{it} + \beta_2 (\ln^j y_{it})^2 + \sum_{j=2}^{8} \delta_j D_j + \gamma Pub_i + \sum_{j=2}^{8} \rho_j D_j Pub_i + \sum_{t=93}^{98} \tau_t T_t + \varepsilon_{it}.$$

where

$y^j{}_{it}$ = output of firm i in industry j in the year t

D_j = 1 if firm is from industry *j* (industry code 1 is the reference)

Pub = 1 if firm is a PSU

= *0* if firm is in the private sector

T_t = 1 if observation is from year t (year 1992 is the reference).

We initially ran the model for all eight industries. As reported in Table 11, the coefficient of ownership in industry code 1, γ, turned out to be insignificant. So did ρ_j, the coefficient of the industry interacted with ownership variable, in the case of four industries. We then ran the model after omitting the ownership variable *Pub* and also the industries in which ρ_j was insignificant and then examined what the effects of ownership were in the remaining four industries.

Table 11. Tobit Regression Estimates

Parameter	Estimate	Standard Error	Chi-Square	Pr > ChiSq
Intercept	-0.3129	0.0247	160.56	<.0001
d2ind (δ_2)	-0.0064	0.0198	0.1	0.7474
d3ind (δ_3)	-1.0359	0.0224	2142.12	<.0001
d4ind (δ_4)	-0.2984	0.0219	186.35	<.0001
d5ind (δ_5)	-0.1602	0.0426	14.13	0.0002
d6ind (δ_6)	0.0162	0.0223	0.53	0.467
d7ind (δ_7)	-0.1963	0.0245	64.03	<.0001
d8ind (δ_8)	-0.0609	0.0191	10.15	0.0014
dtype (γ)	-0.0581	0.0542	1.15	0.2835
dt2ind(ρ_2)	-0.1551	0.0729	4.53	0.0334
dt3ind(ρ_3)	0.2419	0.064	14.29	0.0002
dt4ind(ρ_4)	-0.0416	0.0776	0.29	0.5917
dt5ind(ρ_5)	-0.1272	0.0776	2.69	0.1012
dt6ind(ρ_6)	-0.1871	0.0926	4.08	0.0434
dt7ind(ρ_7)	0.0262	0.0802	0.11	0.7437
dt8ind(ρ_8)	-0.1761	0.0684	6.64	0.01
ln(y)(β_1)	0.0477	0.0083	32.88	<.0001
$\ln(y)^2$(β_2)	0.0009	0.0012	0.53	0.4679
dyr93(τ_{93})	-0.1163	0.0203	32.81	<.0001
dyr94(τ_{94})	-0.142	0.0203	48.74	<.0001
dyr95(τ_{95})	-0.1429	0.0204	49.32	<.0001
dyr96(τ_{96})	-0.1145	0.0203	31.82	<.0001
dyr97(τ_{97})	-0.1372	0.0203	45.7	<.0001
dyr98(τ_{98})	-0.1512	0.0203	55.38	<.0001
dyr99(τ_{99})	-0.1602	0.0203	62.43	<.0001

Selected coefficient estimates from the model after omitting the ownership variable, Pub, and the industries in which the ownership effects were insignificant are reported in table 12.

Table 12 (selected coefficients from the revised model)

Industry/Output	Coefficient ρ_{j*}	Level of significance
Chemical	-0.2328	.0001
Service	0.1865	.0001
Steel	-0.2098	.0043
Minerals	-0.3276	.0001
ln (y)	0.0540	.0001

*ρ_j is an estimate of the difference between public and private ownership within a given industry

The output coefficient is significant which implies that technical efficiency increases with size. In three industries, chemical, steel, and minerals, private ownership is seen to be significantly superior when we have controlled for scale and time effects. In one industry, service, the public sector is seen to be significantly superior. In four industries, there are no differences.

This means that, even after adjusting for scale, we do not find evidence of across-the-board superiority in private sector performance. The score is 3-1 in favor of the private sector with a tie in four industries. This does undermine the proposition that public sector performance would be uniformly inferior to that of the private sector but for the advantages of scale that public sector firms enjoy. It also implies that we cannot hope to see improvements in performance in all industries through a transfer of ownership from government to the private sector.

5. Discussion of results

We have attempted in this paper to compare the performance of public and private sectors in the period since economic reforms, using DEA methods. We have examined measures of efficiency based on quantities of inputs and outputs used. Our analysis covers balanced panels of private and public firms over the period 1991-92 to 1998-99 and includes eight industrial sectors, based on CMIE's classification.

Our findings would call into question the presumption of superior private performance that is common in policy debate in India today and that certainly underlies the clamor for privatization in the Indian context. It is worth noting that the private enterprises in our sample comprise both domestic and foreign firms, so the results cannot be ascribed to the quality of management at domestic private firms alone.

Nor can the results be ascribed to absence of competition. It is true that, in the mineral sector, there are some sub-sectors, notably petroleum, where the public sector had a monopolistic presence for much of the period under review. But this is not true of the two other sectors where the performance of the public sector is not significantly lower, namely, non-electrical machinery and transport. Within the services sector, there have

been some sub-sectors, such as telecommunications, where there have been public sector monopolies for a portion of the period under review but these sub-sectors again have been exposed to competition in recent years.

While not central to our objective, our findings lend support to the perception, reflected in the media, that the gains of economic reforms in terms of accelerated growth and higher productivity have tended to taper off in the second half of the nineties.

We also do not find private sector performance to be uniformly superior when we have controlled for scale effects- such superiority is manifest only in three industries This would imply that in five out of eight industries, handing over public sector firms to private ownership will not make for any significant improvement in technical efficiency.

Our results could have important implications for privatization policy. It could be plausibly argued that, to start with, the cause of lifting overall economic performance would be better served by focusing on industrial sectors in which the private sector has done better or in which it could do better, given the advantages of scale that public sector firms enjoy. It is public sector firms in these industries that should be the focus of privatization efforts.

The government has withdrawn or curtailed budgetary support to several firms in the years consequent to economic reform. Nor has it allowed many of these firms to raise capital on their own. Budgetary constraints apart, an oft- cited argument is that providing capital to public sector firms is "money down the drain". This argument is hard to sustain in cases where the public sector is seen to do as well as or better than the private sector

Given that the private sector has not demonstrated clear superiority in performance, it may be appropriate to address underlying structural factors, such as poor governance, weak law enforcement and tardy bankruptcy procedures that tend to keep the private sector from realizing its fullest potential.

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