Efficiency of State Transport Undertakings in India during 2000s

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Abstract: The main aim of this study is to analyze the level of relative efficiency of State Transport Undertakings (STUs) in India during 2000s. The analysis is based on estimation of a translog cost function using fixed effects model of the panel data method. In the context of this study, the prime advantage associated with this method is that it allows the cost function to be estimated by taking into account the variables peculiar to each STU. We find that, on an average, smaller STUs are more efficient than their larger counterparts. It seems that there is inverse relationship between ranking based on efficiency measures and size. We also found that the STU, which operates with larger route length per bus is more likely to experience a higher level of efficiency. Furthermore, a higher level of utilization of buses and their capacity would lead to a higher level of efficiency in STUs.

Keywords: Intercity Bus Transport, State Transport Undertakings, Efficiency, India.

JEL Classification: D24, L32, L38, L92, R40

I. INTRODUCTION

India's passenger transport for short and medium distances is essentially bus oriented. Buses even compete with railways on certain long-distance routes by offering night services. The Indian bus transport industry is dominated by publicly owned State Transport Undertakings (STUs) since private sector is highly fragmented. STUs operate in almost all the States of the country, and during the last three to four decades some of them have grown into giant-sized organizations. Currently, they are operating with more than a hundred thousand of buses and seven hundred thousand of workers. During the year 2010-11, the total bus-kilometers operated by the STUs were more than fifteen billion, the number of passengers carried was more than twenty five billion, and the volume of operation had crossed the mark of five hundred billion passenger-kilometers.

The main aim of this study is to examine the relative efficiency of STUs during 2000s. To examine the same, a translog cost function is estimated using fixed effects model of the panel data method. The statistical program NLOGIT 3.0 is used for estimating the cost function. Annual data for a sample of ten STUs, for which consistent data are available from 2000-01 to 2010-11, are used for the same. Sample STUs include Andhra Pradesh State Road Transport Corporation (APSRTC), Maharashtra State Road Transport Corporation (MSRTC), Karnataka State Road Transport Corporation (KnSRTC), North Western Karnataka Road Transport Corporation (NWKnRTC), Gujarat State Road Transport Corporation (GSRTC), Uttar Pradesh State Road Transport Corporation (UPSRTC), Rajasthan State Road Transport Corporation (RSRTC), South Bengal State Transport Corporation (SBSTC), Kadamba Transport Corporation Limited (KDTC), and Orissa State Road Transport Corporation (OSRTC). Sample STUs are publicly owned, have similar organizational structure, operate throughout their respective jurisdiction (often throughout the State), mainly provide intercity and rural bus transport services, do business in the field of passenger transportation only, produce more or less the same quality of service, but differ in size and the level of output produced.

Table 1 presents some indicators concerning the size of the sample STUs during 2010-11. The size of the undertakings, as measured by passenger-kilometers (PKm) in 2010-11, ranges from 900 million PKm for KDTC to 97393 million PKm for APSRTC. Fleet strength of sample STUs also varies drastically, from 334 buses for OSRTC to 21802 buses for APSRTC. In almost all respect, APSRTC is the largest STU whereas OSRTC is the smallest one.

The remainder of this study is organized as follows. Section 2 presents an outline of the methodology, section 3 deals with the data of the model and the principal productivity ratios, and section 4 estimates the cost function on the basis of which the efficiency analysis may be carried out. The final section presents the conclusion of the study.

Table 1. Some indicators concerning the size of the sample STUs during 2010-11

STUs	Pass.-Km (million)	Bus-Km (million)	Pass. carried (million)	No. of employees	No. of buses held	Diesel consumed (million liters)
APSRTC	97393	2895.8	4638.8	120566	21802	456.8
MSRTC	56098	1897.3	2536.8	104214	16211	387.5
KnSRTC	32964	870.8	807.7	34019	7164	187.5

NWKnRTC	16526	480.1	697.2	21458	4259	98.1
GSRTC	32578	948.5	805.3	40670	7692	145.2
UPSRTC	33023	1028.6	470.5	32883	8557	176.0
RSRTC	22170	599.2	339.1	20486	4476	117.0
SBSTC	1273	37.8	92.7	2388	507	9.9
KDTC	900	28.2	28.6	1881	410	6.4
OSRTC	1044	32.2	4.8	930	334	7.0

2. An outline of the methodology

2.1. Defining technology on the basis of cost function

According to the duality theory, it is possible to characterize the technology of a firm on the basis of cost function. An estimation of the cost function assumes that the firm minimizes cost subject to a production function, taking the prices of inputs as given. In the case of STUs in India, these assumptions seem to be reasonable since public sector firms like STUs are expected to minimize cost of production rather than maximize profit. Since they cannot influence the input factor prices and take the output level as given, the actual situation fits the assumptions one must make to estimate the cost function.

Many research studies in transport economics have revealed that the unit cost depends not only on the output of the firm but also on the configuration of transport network (see, for example, Caves et al. (1985), Windle (1988), Matas & Raymond (1998), and Singh (2000) for bus transport companies). Accordingly, this study includes in the equation that variable which characterizes the network. Thus, cost function is defined as follows:

$$C = f(Y, W_i, N)$$

where *C* represents cost of each STU, *Y* is level of output, W_i is price of input *i*, and *N* is a network variable.

2.2. Specification and estimation of a fixed effects model

The methodology chosen for estimating the cost function is panel data method. In the context of this study, the prime advantage associated with this method is that it allows the cost function to be estimated, taking into account the variables peculiar to each STU: the characteristics and structure of the network, the special features of the state concerned, and the quality of service. That is, it takes care of the heterogeneous nature of output and the fact that unit cost differs from one STU to another, depending on the above mentioned variables. Therefore, the use of panel data method makes it possible to test the homogeneous parameters hypothesis for each STU.

The motive of this study and the availability of data guide us to work on the hypothesis that the heterogeneity of the sample is reflected only in the constant term. A common technology, although with different intercepts, is assumed for each STU.

The cost function, which is estimated from the panel data set, is defined as follows (all variables except dummies are in natural logarithms):

$$C_{it} = \alpha + \beta X_{it} + U_{it} \qquad \textbf{(1)}$$

where the disturbance term U_{it} is made up of a firm specific effect μ_i, a time specific effect λ_t, and a purely random term ε_{it} as follows:

$$U_{it} = \mu_i + \lambda_t + \varepsilon_{it};$$

$$\varepsilon_{it} \approx (0, \sigma^2)$$

The firm specific effects express that part of the cost, which varies according to STU but not over time. These costs are influenced by the variables such as the network configuration, the nature of demand, state in question, and the degree of productive efficiency. Although some of these variables can be observed, their identification and measurement are, in general, difficult. In this study, information on many of these variables – reported in section 3.1 – has been collected and they are shown to be quite constant over time within each STU. This facts support the decision of treating them as fixed in time and allowing their effect to be captured by the firm specific effect, μ_i.

The time specific effects, λ_t, is same for every STU and varies over the period of observation. This, λ_t, includes any possible technical change in the operations during sample period. In addition, it also reflects the price of inputs omitted in the equation if all STUs are faced with the same price, hence λ_t can be expressed as:

$$\lambda_t = \delta_t + \phi' P_t$$

where δ_t is the effect of the technical change and P_t is the vector of omitted input factor prices.

It should be noticed that if the input price is same for all the STUs and, a researcher tries to approximate the variable using a poor "proxy", the result will be biased and inconsistent estimates of all the coefficients of the model. This will happen because the new explanatory variable will be correlated with the disturbance term. We will obtain undesirable results even if global fit of the model improves and the added variable appears to be statistically significant. As a result, the corresponding estimation will not admit a sensible economic interpretation. Therefore, for the purpose of estimation, individual and time specific dummies are introduced.
Therefore, in line with equation **(1)**, cost function can be rewritten as:

$$C_{it} = \alpha + \mu_i + \lambda_t + \beta X_{it} + \varepsilon_{it} \quad (2)$$

In equation **(2)**, the "μ_i" which represent different intercepts, can be interpreted as approximating the overhead cost. This cost is fixed in the short-run but vary in long-run, depending on the size of the STUs.

This study assumes that size category of STUs can be classified on the basis of their produced output. In this case when size category of the STUs shows little variation over time, the estimation of "μ_i" should be carried out, taking into account the cross-sectional (or inter-firm) variation. Hence, this study postulates:

$$\mu_i = \gamma_0 + \gamma_1 \bar{X}_{1i} + \eta_i \quad \textbf{(3)}$$

where, "$\overline{X}_{1i}$" is intertemporal average of passenger-kilometers for i^{th} STU.

2.3. Measuring the efficiency

The estimation of cost function according to equation **(2)** allows us to calculate two relative measures of productive efficiency. Firstly, the coefficients estimated for the firm specific effects provide an initial efficiency measure that does not take into account the size of the STUs; the most efficient firm will be the one with the lowest "μ_i". Secondly, the residuals of equation **(3)** provide a second measure of efficiency related to size of the STUs; the most efficient firm will be the one with the lowest "η_i".

3. The Data

3.1. Sample selection and measurement of the variables

The primary source of required data is *Performance Statistics of STUs, 2000-01 to 2010-11* published for the Association of State Road Transport Undertakings (ASRTU), New Delhi, India by the Central Institute of Road Transport (CIRT), Pune, India. This study uses the information on a total of 10 STUs which operated during the period 2000-01 to 2010-11. Table 1 shows the STUs included in the sample, together with some indicators concerning their size. All the STUs are publicly owned.

The explained variable in the model is operating cost i.e., total cost minus taxes. Specifically, operating cost comprises of labor cost, diesel cost, and bus cost. In relation to the price of inputs, labor price is annual total labor cost per employee. The diesel price is more or less same for all STUs and equal to the price of a liter of diesel. The diesel price is hence included in the time specific effects, which vary over time but are common for all different STUs. The prime difficulty is faced in computing the price of bus; here it is essential to know the purchase price of the bus, its useful running life, and the residual value, but none of this information is readily available. It was decided to regard the time specific effects as a reasonable approximation to the cost of bus. Therefore, model is estimated using a single input, labor, which absorbs 40-50 percent of the operating cost of the STUs in the sample. It is felt that the useful measure of output would be passenger-kilometers. Total route length (defined as, total number of routes multiplied by average route length) is chosen as a network variable. We also collected information on the variables exerting *a priori* impact on what could be interpreted as structural or short-run fixed costs, as well as on the relative efficiency of the STUs. These variables, for which data is available, are: available route length per bus (in kms), load factor (defined as percentage of pass.-kms to capacity-kms), and fleet utilization (defined as percentage of buses on road to the buses held). These variables are practically unchanged within each STU, but they are varying across the STUs.

3.2 Productivity ratios

Table 2 reports some physical productivity ratios for the sample STUs during the latest year of the sample period. The productivity ratios are computed with respect to three most important inputs: labor, diesel, and bus. These partial factor productivity indicators do not reveal very similar results. For example, during the year 2010-11, OSRTC experienced the highest level of labor productivity (1.12 million passenger-km per employee), but was the third least productive STU according to fuel productivity (4.59 bus-km per liter of diesel) and bus productivity (96,000 bus-km per bus held). Similarly, GSRTC ranked first according to fuel productivity (6.53 bus-km per liter of diesel), but third according to bus productivity (123,000 bus-km per bus held) and sixth according to labor productivity (0.80 million passenger-km per employee) whereas RSRTC ranked first according to bus productivity (134,000 bus-km per bus held) and second according to labor productivity (1.08 million passenger-km per employee), but fourth according to fuel productivity (5.12 bus-km per liter of diesel). It seems that there is no clear pattern between partial factor productivity indicators and firm size.

Table 2. Productivity ratios during the year 2010-11

STUs	Pass.-km per employee ($\times10^3$)	Pass.-km per liter of diesel	Pass.-km per bus held ($\times10^3$)	Employees per bus held	Bus-km per liter of diesel	Bus-km per bus held ($\times10^3$)
APSRTC	808	213	4467	5.53	6.34	133
MSRTC	538	145	3460	6.43	4.90	117
KnSRTC	969	176	4601	4.75	4.64	122
NWKnRTC	770	168	3880	5.04	4.89	113
GSRTC	801	224	4235	5.29	6.53	123
UPSRTC	1004	188	3859	3.84	5.85	120
RSRTC	1082	189	4953	4.58	5.12	134
SBSTC	533	129	2510	4.71	3.84	75
KDTC	479	140	2196	4.59	4.39	69
OSRTC	1122	149	3125	2.78	4.59	96

4. Estimation of cost function and relative efficiency analysis

4.1. Estimation of cost function and results

Estimation of cost function requires that we specify a functional form. We adopt the translog functional form proposed by Christensen et al. (1973). The translog is a flexible form in the sense of providing a second-order approximation to an unknown cost function (for a further analysis of the translog approach and its advantages over earlier approaches, one may refer to Christensen et al. (1973), Christensen and Green (1976), Fuss (1977), Gillen and Oum (1984), McMullen and Stanley (1988), and Singh (2014)). We estimated a translog cost function, as given in equation **(4)**, which includes firm specific and time specific effects and pass.-kms, price of labor, and total route length as explanatory variables.

$$lnC = \alpha + \sum_i \mu_i + \sum_t \lambda_t + \beta_Y lnY + 0.5\beta_{YY}(lnY)^2 + \beta_w lnW + 0.5\beta_{ww}(lnW)^2 + \beta_n lnN + 0.5\beta_{nn}(lnN)^2 + \beta_{Yw}(lnY)(lnW) + \beta_{Yn}(lnY)(lnN) + \beta_{wn}(lnW)(lnN) + \varepsilon \quad \textbf{(4)}$$

where C is operating cost; Y is pass-kms; W is labor price; N is total route length; μ_i is firm specific effect; λ_t is time specific effect; and ε is purely random term. Operating cost and labor price is at constant 2010-11 prices.

Model 1 of Table 3 presents the estimated coefficients for the cost function as defined in equation **(4)**. Table 3 presents four more models; all of them are estimated by applying OLS. APSRTC (2000-01) is chosen as reference. That is, coefficients estimated for the firm specific effects will be seen in relation to APSRTC. If the coefficient is negative, this means that efficiency is higher than that of APSRTC. The results of Model 1 reveal a good degree of fit. However, none of the coefficients of time dummies is statistically significant at 5% level of significance. Therefore, we need to test the joint significance of time specific effects. To test the degree of joint significance of time specific effects, the following translog cost function is estimated which does not include time dummies.

$$lnC = \alpha + \sum_i \mu_i + \beta_Y lnY + 0.5\beta_{YY}(lnY)^2 + \beta_w lnW + 0.5\beta_{ww}(lnW)^2 + \beta_n lnN + 0.5\beta_{nn}(lnN)^2 + \beta_{Yw}(lnY)(lnW) + \beta_{Yn}(lnY)(lnN) + \beta_{wn}(lnW)(lnN) + \varepsilon \quad \textbf{(5)}$$

where variables have their previous meanings. Within the context of the translog cost function presented in equation **(4)**, this implies the following coefficient restrictions, $\lambda_t = 0, \forall\, t$.

Model 2 of Table 3 presents the estimated coefficients for the cost function as defined in equation **(5)** i.e., cost function with coefficient restrictions. Result shows that the coefficient restrictions could not be rejected. The log of the restricted likelihood function is 140.13 and the log of the unrestricted likelihood function is 147.14. The log likelihood ratio test yields a test statistic of 14.02, which is significantly less than 18.31 - the critical value of χ^2 distribution with 10 degrees of freedom at 5% level of significance. Due to this, hypothesis that $\lambda_t = 0, \forall\, t$ could not be rejected. This implies that Model 1 is not superior to Model 2. Model 2, which does not include time dummies, is also compared with three other models (Model 3, Model 4, and Model 5) having possible alternate specifications. Among these four models, Model 3 which does not include firm and time dummies is nested in Model 2, and is statistically dominated by Model 2. The log likelihood ratio test between Model 3 and Model 2 yields a test statistic of 114.52 (=2*(140.13-82.87)), which is significantly higher than 16.92 - the critical value of χ^2 distribution with 9 degrees of freedom at 5% level of significance. Similarly, Model 4 is nested in Model 2, and is statistically dominated by Model 2. The log likelihood ratio test between Model 4 and Model 2 yields a test statistic of 51.90 (=2*(140.13-114.18)), which is significantly higher than 9.49 - the critical value of χ^2 distribution with 4 degrees of freedom at 5% level of significance. Model 5, which is a Cobb-Douglas cost function with firm dummies, is also nested in Model 2. The log likelihood ratio test between Model 5 and Model 2 yields a test statistic of 28.38 (=2*(140.13-125.94)), which is significantly higher than 12.59 - the critical value of χ^2 distribution with 6 degrees of freedom at 5% level of significance. Therefore, none of the four models - Models 1, 3, 4, and 5, are statistically preferred over Model 2.

Hence, Model 2, which is based on equation **(5)**, is used to analyze the relative efficiency of STUs in India. Here, it is important to mention that Hausman test favors firm specific fixed effects model (Model 2) over random effects model (Hausman test statistic = 40.64, critical $\chi^2_{9,\,0.05}$ = 16.92). Results of Model 2 reveal a good degree of fit. When taken as a whole, the coefficients estimated for output, network variable, and wage are significant, even though when taken individually, some of them lack statistical significance. Moreover, the magnitude and sign of the coefficients cannot be directly interpreted since the translog specification is used. However, the cost function expresses a long-run equilibrium relation, and in this case it is doubtful whether the data reflects such a relation. The estimation of cost function assumes that STUs minimizes their costs for each level of output and input prices. However, as we know, STUs in India are publicly owned and annual losses of the STUs are frequently partially or fully covered by the government subsidies. In these circumstances, in general, the STUs have no incentive to act swiftly to adjust their cost to change in the network or in the price of inputs and the necessary adjustment may take a long time. Therefore, there is a possibility that annual data may not reflect situations of long-run equilibrium.

Equation **(6)** shows the relationship between firm specific effects and firm size, which is essential to know the long-run behavior of the firms. This regression result shows the variation in overhead cost in relation with STUs' size. The result of regression equation is shown below (with t-statistic in parentheses):

$$\mu_i = -0.3969 + 0.0053\bar{Y}_i;\ R^2 = 0.25, S.E. = 0.26, N = 9 \quad \textbf{(6)}$$

(3.36) (1.61)

Table 3. Estimated coefficients for the cost function (dependent variable: logarithm of operating cost; t-values are given in parentheses)

	Model 1 (translog cost function with firm and time dummies)	**Model 2** (translog cost function with firm dummies)	**Model 3** (translog cost function without firm and time dummies)	**Model 4** (translog cost function with firm dummies and without output)	**Model 5** (Cobb-Douglas cost function with firm dummies)
Constant	11.08 (0.60)	23.19 (1.39)	0.11 (0.01)	43.80 (3.55)	-0.86 (0.81)
(lnY)	-3.59 (1.30)	-1.98 (0.80)	2.22 (0.77)	-	0.70 (8.05)
(lnW)	-2.95 (2.58)	-4.71 (1.99)	-1.10 (0.36)	-4.25 (1.78)	0.13 (2.17)
(lnN)	4.53 (3.17)	2.87 (1.00)	-0.21 (0.07)	-2.25 (2.51)	0.16 (2.44)
$(1/2)(lnY)^2$	0.026 (0.10)	0.166 (0.73)	-0.323 (1.64)	-	-
$(1/2)(lnW)^2$	0.411 (2.11)	0.547 (3.00)	0.173 (0.77)	0.412 (1.97)	-
$(1/2)(lnN)^2$	0.094 (0.28)	0.276 (0.97)	-0.692 (2.52)	0.263 (4.09)	-
$(lnY)(lnW)$	0.354 (2.09)	0.282 (1.75)	-0.499 (2.49)	-	-
$(lnY)(lnN)$	-0.031 (0.11)	-0.188 (0.76)	0.597 (2.53)	-	-
$(lnW)(lnN)$	-0.424 (2.36)	-0.352 (2.05)	0.303 (1.36)	-0.034 (0.91)	-
MSRTC	-0.075 (0.68)	-0.009 (0.09)	-	-0.471 (7.58)	0.077 (1.32)
KnSRTC	-0.358 (2.58)	-0.209 (1.76)	-	-0.587 (5.64)	-0.314 (2.97)
NWKnRTC	-0.539 (3.17)	-0.345 (2.36)	-	-1.025 (11.14)	-0.379 (2.76)
GSRTC	-0.423 (3.20)	-0.338 (2.69)	-	-1.030 (21.95)	-0.227 (2.45)
UPSRTC	-0.335 (2.48)	-0.174 (1.54)	-	-0.586 (6.51)	-0.245 (2.44)
RSRTC	-0.492 (3.07)	-0.343 (2.42)	-	-0.963 (9.99)	-0.403 (3.13)
SBSTC	-0.469 (1.01)	-0.016 (0.04)	-	-1.989 (7.38)	-0.099 (0.26)
KDTC	-0.688 (1.31)	-0.203 (0.41)	-	-2.378 (7.47)	-0.304 (0.74)
OSRTC	-1.511 (3.30)	-0.952 (2.32)	-	-2.700 (10.68)	-0.787 (2.13)
2001-02	0.004 (0.11)	-	-	-	-
2002-03	-0.017 (0.52)	-	-	-	-
2003-04	-0.037 (1.10)	-	-	-	-
2004-05	-0.015 (0.42)	-	-	-	-
2005-06	0.032 (0.89)	-	-	-	-
2006-07	0.026 (0.75)	-	-	-	-
2007-08	0.025 (0.68)	-	-	-	-
2008-09	0.032 (0.84)	-	-	-	-
2009-10	0.062 (1.41)	-	-	-	-
2010-11	0.092 (1.90)	-	-	-	-
R^2	0.9983	0.9981	0.9945	0.9969	0.9975
Adjusted R^2	0.9977	0.9977	0.9940	0.9964	0.9972
Log-Likelihood	147.14	140.13	82.87	114.18	125.94
No. of observations	110	110	110	110	110

4.2. Relative efficiency

As already explained in the section 2.3, estimated firm specific effect is a measure of relative efficiency. Residuals of the equation (6), which we shall refer to as corrected fixed effect is another measure of relative efficiency, contingent on size of the STU.

Table 4 shows ranking of the STUs according to different measures of efficiency. It seems that there is inverse relationship between ranking based on fixed effect and size. According to ranking based on fixed effect, the smallest STU (OSRTC) is the most efficient whereas the largest STU (APSRTC) is the least efficient among the sample STUs. Top five largest STUs do not include any firm from the list of three most efficient firms. In general, smaller STUs are more efficient than their larger counterparts. When the size effect is eliminated, there is reduction in dispersion in the level of relative efficiency. Ranking based on corrected fixed effect reveals that OSRTC, GSRTC, and RSRTC are the three most efficient STUs whereas SBSTC, KDTC, and MSRTC are the three least efficient ones. APSRTC, NWKnRTC, and KDTC experienced most significant change in their ranking when size effect is taken into account to measure the relative efficiency. APSRTC improved its ranking significantly from the least efficient to fourth most efficient STU whereas NWKnRTC and KDTC fell from second to fifth rank and sixth to ninth rank, respectively. When size effect is eliminated, three STUs - APSRTC, MSRTC, and GSRTC improved their ranking whereas others either faced deterioration or no change in their ranking. There was no change in the rank of OSRTC, RSRTC, and UPSRTC.

In equation (6), it is assumed that variation in overhead cost is explained by the variation in pass.-kms, a variable expressing the size of the STUs. However, there are other variables related with network characteristics and individual STU as mentioned in section 3.1, which may also explain the variation in overhead cost. Given the small number of observations, it was decided to calculate correlation coefficient between firm specific effect and the variables, which may also explain the variation in overhead cost such as load factor, fleet utilization, and available route length per bus. The values used for these variables correspond to the mean of the sample period.

Table 5 reports correlation coefficient between estimated firm specific effect and available route length per bus, load factor, and fleet utilization. It seems that there is a weak relationship between estimated fixed effect and reported variables. Firstly, the results show that the STU, which operates with larger route length per bus would more likely to experience a higher level of productivity. Secondly, results related with load factor and fleet utilization reveal that better utilization of buses and their capacity would result in reducing the unit operating cost. This implies that the STU, which have better supply-side management, is more likely to experience a higher level of productive efficiency.

Table 4. Ranking of the STUs according to different measures of efficiency

STUs	Corrected fixed effect	Ranking based on corrected fixed effect	Fixed effect	Ranking based on fixed effect	Sample period average output (billion passenger-km)	Ranking based on sample period average of output
APSRTC	-0.048	4	0.000	10	83.592	1
MSRTC	0.108	8	-0.009	9	52.709	2
KnSRTC	0.050	6	-0.209	5	25.885	4
NWKnRTC	-0.035	5	-0.345	2	16.344	7
GSRTC	-0.112	2	-0.338	4	32.220	3
UPSRTC	0.086	7	-0.174	7	25.843	5
RSRTC	-0.053	3	-0.343	3	20.145	6
SBSTC	0.375	10	-0.016	8	1.054	8
KDTC	0.189	9	-0.203	6	0.876	9
OSRTC	-0.560	1	-0.952	1	0.906	10

Table 5. Some determinants of the overhead cost in STUs (correlation coefficient between estimated firm specific effect and reported variables)

Variables	Correlation coefficient	t-statistic	No. of observations
Available route length per bus	-0.796	-3.72	10
Load factor	-0.19	-0.57	10
Fleet Utilization	-0.11	-0.29	10

5. Conclusion

The main findings of the paper can be stated as follows. First, it seems that there is inverse relationship between ranking based on fixed effect and size. Therefore, on an average, smaller STUs appear to be more efficient than their larger counterparts. Second, when the size effect is eliminated, there is reduction in dispersion in the level of relative efficiency of STUs. Third, it is found that the STU which operates with larger route length per bus is more likely to experience a higher level of productive efficiency. Fourth, there is scope for managerial manpower to improve efficiency of the respective STUs. A higher level of utilization of buses and their capacity would lead to a higher level of productive efficiency. Therefore, the STU, which have better supply-side management, is more likely to experience a higher level of efficiency.

References

[1] Caves et al. (1985), "Network Effects and the Measurement of Returns to Scale and Density for US Railroads", In Daughety AF (ed) Analytical Studies in Transport Economics (pp. 97–120). Cambridge University Press.
[2] Christensen et al. (1973), "Transcendental Logarithmic Production Frontiers", Review of Economics and Statistics 55(1): 28-45.
[3] Christensen L. R. and Greene W. H. (1976), "Economies of Scale in U.S. Electric Power Generation", Journal of Political Economy 84(4): 655-676.
[4] Fuss M. A. (1977), "The Demand for Energy in Canadian Manufacturing, An Example of the Estimation of the Production Structures with Many Inputs", Journal of Econometrics 5(1): 89-116.
[5] Gillen D. W. and Oum T. H. (1984), "A Study of the Cost Structures of the Canadian Intercity Motor Coach Industry", Canadian Journal of Economics 17(2): 369-85.
[6] McMullen B. S. and Stanley L. R. (1988), "The Impact of Deregulation on the Production Structure of the Motor Carrier Industry", Economic Inquiry 26(2): 299-316.
[7] Matas Anna and Raymond Jose-Luis (1998), "Technical Characteristics and Efficiency of Urban Bus Companies: The Case of Spain", Transportation 25(3): 243-263.
[8] Performance Statistics of STUs: 2000-01 to 2010-11, Central Institute of Road Transport (CIRT), Pune, India.
[9] Singh S. K. (2000), "Technical Characteristics and Efficiency of the Indian State Road Transport Undertakings", Indian Journal of Transport Management 24(8): 533-543.
[10] Singh S. K. (2014), "An Inquiry into the Cost Structure of State Transport Undertakings in India", Transport Policy 32(2014): 1-8.
[11] Windle R. J. (1988), "Transit policy and the Cost Structure of Urban Bus Transportation", In Dogson and Topham (eds) Bus Deregulation and Privatisation: An International Perspective (pp. 119–140). Gower.