State Road Transport Undertakings, 1983-84 to 1996-97: A Multilateral Comparison of Total Factor Productivity*

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Abstract

This study is based on twenty-one State Road Transport Undertakings (STUs), which are selected on the basis of availability of data and volume of their operation. Output (measured in terms of pass.-kms) produced by the sample STUs are usually more than 80 percent of the produced output of all the STUs through out the sample period. This paper estimates the growth and relative levels of productivity (measured in terms of total factor productivity) for the STUs for the period 1983-84 to 1996-97 using index number approach. This paper also tries to investigate the sources of growth and differences in levels of productivity using regression analysis. Estimates of total factor productivity are also compared with more traditional indicators of transport productivity e.g., revenue pass.-kms per employee, and available pass.-kms per employee. Productivity indexes are also computed for the passenger road transport industry to evaluate the productivity growth in the industry for the period 1983-84 to 1996-97.

Key Words: Total Factor Productivity, State Road Transport Undertakings in India

JEL Classification: L92, M20, R40

Introduction

It is well known that mobility constitutes an extremely important role in our economic and social life. In a developing economy like India, passenger road transport deserves high priority as it forms the back-bone of the passenger mobility system. The State Road Transport Undertakings (henceforth, STUs) have a special responsibility in this regard as they are the biggest undertakings in the hands of the respective state governments. There are 67 STUs operating with more than a hundred thousands of vehicles and eight hundred thousands of workers; the total effective kilometers operated by the STUs are more than ten billion, the number of passengers carried are more than twenty three billion, and volume of operation have crossed 450 billion passenger-kms mark; but little is known about the productivity performance of the individual STU that constitute the industry.

The prime objective of this study is to analyze the productivity performance of the major STUs in India. Specifically, this paper estimates the growth and relative levels of productivity (measured in terms of total factor productivity) of the major twenty-one STUs for the period 1983-84 to 1996-97 using index number approach. This paper also tries to investigate the sources of growth and differences in the levels of productivity using regression analysis. Estimates of total factor productivity (henceforth, TFP) are also compared with more traditional indicators of transport productivity e.g., revenue pass.-kms per employee, and available pass.-kms per employee. Productivity indexes are also computed for the passenger road transport industry to evaluate the productivity growth in the industry for the period 1983-84 to 1996-97. It is hoped that the results will be useful in evaluating possible changes in public policies relating to the STUs.

Productivity Measurement

Productivity is generally defined in terms of the efficiency with which inputs are transformed into useful output within the production process. The earliest approach to productivity measurement was based upon ratios of a measure or index of aggregate output divided by the observed quantity of a single input, typically labor. These productivity ratios were usually normalized to some base year, resulting in a productivity index over time, and were used to measure aggregate productivity. This index-number approach based upon the use of single or partial factor productivity measures had the advantage of computational simplicity and feasibility, but made it difficult to identify the causal factors accounting for observed productivity growth. For example, the substitution of capital for labor, the introduction of more (labor) efficient vintages of capital, the realization of economies of scale, and the employment of better-trained manpower all show up in the form of increases over time in an index of output per worker.

It is well known that TFP is the broadest measure of productivity. TFP is the only measure whose increase is unambiguously beneficial, in the sense that is corresponds to a decline in the total unit cost of production. However, from a welfare point of view, output per worker ultimately limits per capita consumption. Therefore labor productivity retains a role in the family of productivity measures relevant to national economic policy. TFP measurement and modeling is based on the assumption that inputs are combined so as to minimize the cost of a given output. The more restrictive assumption of profit maximization is not required, nor is the assumption that output is sold in a competitive market. However, it is assumed that inputs are purchased at prices perceived to be constant. For this study, these assumptions seem to be reasonable.

Recent theoretical development has occurred in the area of index-number theory and is related to a basic problem that has confronted productivity analysis from the very beginning, namely, the problem of output and input aggregation. It has been shown that there is a unique correspondence between the type of index used to aggregate over outputs and inputs and the structure of underlying technology. For example, the Laspeyres indexing procedure, used in many of the earlier productivity studies, has been shown to be exact for, or imply, a linear production function in which all inputs are perfect substitutes in the production process. Similarly, the Tornqvist index, a discrete approximation to the more general Divisia index, implies a homogeneous translog production function. In fact, any given index number implies a particular structure for the underlying production technology.[1]

An Outline of the Methodology

This study will be using index number approach to measure the productivity growth which have the advantage of not requiring direct estimation of the underlying technology and therefore, of not requiring econometric specification and estimation of technology. Typically, productivity is ratio of some function of outputs (Y_i) to some function of inputs (X_j). Where there is a single output, factor specific productivity indexes (often called partial factor

[1] There is linkage of the two approaches to TFP measurement, index number and neoclassical production and cost function, in that the problems of selecting an appropriate production function and a suitable index number can be shown to be dual to each other.

productivity indexes) can be constructed for each input and essentially describes the average product of labor, capital, etc. Partial factor productivity indexes are potentially misleading because what passes for a difference in productivity, may in fact merely represent a different mix of input use. For example, using a more labor intensive (less capital intensive) production technology would increase the partial factor productivity index for capital. This would result even if the more labor intensive technology was more costly, and consequently, a method that should be avoided.

In its simplest form TFP is a ratio of output to a weighted sum of inputs. Historically, two common ways of assigning weights for this index are used either an arithmetic or geometric weighted average of inputs. The arithmetic weighted average is due to Kendrick (1961), uses input prices as the weights; whereas the geometric weighted average of inputs, attributable to Solow (1957), uses input expenditure shares as the weights. As long as the changes in inputs and outputs is not too large, both Kendrick's and Solow's measures of TFP growth arrive at similar results (Nadiri, 1970).

Where multiple outputs exist, TFP can also be described as a ratio of an index number describing aggregate output levels divided by an index number describing aggregate input levels. The discrete Divisia index (which uses information from the previous time period as the reference), is extensively used in time series applications. This index can be computed as follows:

$$\ln TFP_k - \ln TFP_l = \Sigma_i[\{(R_{ik}+R_{il})/2\}.\{\ln(Y_{ik}/Y_{il})\}] - \Sigma_j[\{(W_{jk}+W_{jl})/2\}.\{\ln(X_{jk}/X_{jl})\}], \qquad \textbf{(1)}$$

where, 'k' and 'l' are adjacent time periods, the Y_{im} are output indexes, the X_{jm} are input indexes, the R_{im} are output revenue shares, and the W_{jm} are input cost shares; i signifies for different kinds of outputs, and j signifies for different types of inputs used in the production process.

The Divisia "chaining" approach [i.e., **(1)**] has severe limitations in some applications; for example, with cross-sectional or panel data there is no obvious way to chain the index and get comparisons between firms since "adjacent" makes little sense in the cross-section data set. For this study when we allow subscript 'k' and 'l' in **(1)** to represent both firms and time periods - 21 firms and 14 time periods, there will be 294 time-differentiated firm observations. The direct use of **(1)** for comparisons of STUs productivity would result in 43071 binary comparisons – the number of possible ways of choosing 2 of the 294 observations to compare. Unfortunately, there is no guarantee of transitivity in such comparisons. For example, in 1990-

91 firm F_1 might be found to be more productive than firm F_2 and less productive than firm F_3; yet a direct comparison of F_2 and F_3 might indicate that F_3 is less productive than F_2. This lack of transitivity is possible because weights R_{im} and W_{jm} specific to the two firms in question are used. Caves and Christensen (1980) address this issue and provide a solution which assumes a hypothetical firm whose sub-component expenditure shares are the arithmetic mean expenditure shares for all firms, and whose sub-component quantities are the geometric means of the sub-component quantities across all firms. This index has clear advantages in cross-sectional work as well as in panel data set. It is transitive (in case of cross-sectional analysis) in similar sense that the Divisia index is transitive (in case of time-series analysis). For a panel data set, the hypothetical firm approach provides an unambiguous basis for comparison for observations which have no natural ordering.

For this study, we will follow a compromise formula for binary comparison which is proposed by Caves and Christensen (1980):

$$\ln TFP_k - \ln TFP_l = \sum_i[\{(R_{ik} + \bar{R}_i)/2\}.\{\ln (Y_{ik}/\tilde{Y}_i)\}] - \sum_i[\{(R_{il} + \bar{R}_i)/2\}.\{\ln (Y_{il}/\tilde{Y}_i)\}]$$
$$- \sum_J[\{(W_{jk} + \bar{W}_J)/2\}.\{\ln (X_{jk}/\tilde{X}_j)\}] + \sum_J[\{(W_{jl} + \bar{W}_j)/2\}.\{\ln (X_{jl}/\tilde{X}_j)\}], \qquad \textbf{(2)}$$

where, a bar over a variable indicates the arithmetic mean and a tilde over a variable indicates the geometric mean. The use of **(2)** for binary comparisons results in transitive multilateral comparisons that retain high degree of characteristicity. The weights used to compute the productivity comparisons reflect the economic conditions faced by all economic entities, but at the same time more than half of each weights is specific to 'k' or 'l'.

Equation **(2)** can be derived directly from a translog transformation structure by taking the difference between each firm's transformation function and function resulting from averaging arithmetically the transformation functions across all observations. This procedure uses the geometric level of the productivity as the norm. We can derive equation **(2)** in an alternative manner by considering a representative firm that produces the geometric means of the outputs from the geometric means of the inputs. This firm will be in equilibrium when its revenue and cost shares are equal to the arithmetic means computed over the full set of observations being considered. Transitive comparisons are achieved by using this representative firm as the basis for making all possible binary comparisons, i.e., any two firms are compared with each other by comparing them both with the representative firm.

In this study we have used one output and three inputs to calculate the TFP index for STUs. *Revenue passenger-kilometers* is considered as produced output by the STUs. *Total number of buses held*, *total number of employees*, and *total fuel (diesel) consumed* are taken as used inputs for producing the output. So, accordingly **(2)** is modified as follows:

$$\ln TFP_k - \ln TFP_l = \ln(Y_k/Y_l) - \sum_J[\{(W_{jk}+\bar{W}_J)/2\}.\{\ln(X_{jk}/\tilde{X}_j)\}] + \sum_J[\{(W_{jl}+\bar{W}_j)/2\}.\{\ln(X_{jl}/\tilde{X}_j)\}], \quad \textbf{(3)}$$

j = b, e, f.

where, 'b' is total no. of buses held, 'e' is total no. of employees, and 'f' is total fuel (diesel) consumed. TFP_k is total factor productivity of k^{th} firm (or time-period). W_{jk} is cost share of j^{th} input for k^{th} firm (or time-period) and W_{jl} is cost share of j^{th} input for l^{th} firm (or time-period).

Equation **(3)** is used to compute the TFP index for major STUs in India over the period 1983-84 to 1996-97. Total expenditure on employees and total spending on diesel is taken as cost of labor and cost of fuel respectively. Considerable difficulty is faced in computing bus cost; here it is essential to know the purchase price of the bus, its useful running life, and the residual value, but none of the information is readily available. Although, almost all the STUs report annual depreciation cost on buses but they adopt different policies and practices to compute it. Indeed, the yearly fluctuations in the depreciation figures reported by STUs are sometimes difficult to explain. Therefore, we felt that maintenance cost[2] would be a good approximation for bus cost. Total operating cost per annum is calculated as sum of cost of bus, labor, and fuel per annum. Input cost shares are calculated with respect to total operating cost. For example, labor cost share for firm 'f' in year 't' will be the ratio of labor cost to the total operating cost associated with firm 'f' in year 't'.

Data

In this section I would like to provide a description of the sources and methods used in the construction of required data set. The primary source of data is *Performance Statistics of STUs,* 1983-84/1984-85 to 1995-96/1996-97 published for the ASSOCIATION OF STATE ROAD TRANSPORT UNDERTAKINGS, NEW DELHI by the CENTRAL INSTITUTE OF ROAD TRANSPORT, PUNE, INDIA. There were 71 members of *Association of State Road Transport Undertakings* including one associate member, Sri Lanka Central Transport Board, in 1996-97.

[2] Maintenance cost includes costs on auto spare parts, springs, lubricants, tyres & tubes, batteries, general items, and reconditioned items.

Remaining 70 firms include 21 corporations, 10 municipal undertakings, 8 government departments, and 31 companies. This study is based on 21 firms, which are selected on the basis of availability of data and volume of their operation. STUs chosen for the study are as follows (in descending order of their volume of operation in 1996-97):

Andhra Pradesh State Road Transport Corporation (APSRTC), Maharashtra State Road Transport Corporation (MSRTC), Gujarat State Road Transport Corporation (GSRTC), Karnataka State Road Transport Corporation (KnSRTC), Uttar Pradesh State Road Transport Corporation (UPSRTC), Rajasthan State Road Transport Corporation (RSRTC), Kerala State Road Transport Corporation (KSRTC), Bombay Electricity Supply & Transport Undertakings (BEST), Delhi Transport Corporation (DTC), Pandiyan Roadways Corporation Limited (PRC), Cheran Transport Corporation Limited (CTC), Pallavan Transport Corporation Limited (PTC), Madhya Pradesh State Road Transport Corporation (MPSRTC), Thanthai Periyar Transport Corporation Limited (TPTC), State Transport Punjab (STPJB), Cholan Roadways Corporation Limited (CRC), Thiruvalluvar Transport Corporation Limited (TTC), Pattukkottai Azagiri Transport Corporation Limited (PATC), Jeeva Transport Corporation Limited (JTC), Anna Transport Corporation Limited (ATC), and Marudhu Pandiyar Transport Corporation Limited (MPTC).

There are 9 corporations (APSRTC, MSRTC, GSRTC, KnSRTC, UPSRTC, RSRTC, KSRTC, DTC, and MPSRTC), 1 municipal undertaking (BEST), 10 companies (PRC, CTC, PTC, TPTC, CRC, TTC, PATC, JTC, ATC, and MPTC), and 1 government department (STPJB) among these 21 STUs.

All the companies of Tamil Nadu State have changed their names. Though for the purpose of this study old names will be used to denote a particular STU, the new name of the following companies operating in Tamil Nadu are as follows (new name is reported in parentheses):

PRC – (Tamil Nadu State Transport Corporation Limited (Madurai Division – I)), CTC – (Tamil Nadu State Transport Corporation Limited (Coimbatore Division – I)), PTC – (Metropolitan Transport Corporation Limited (Chennai Division – I)), TPTC – (Tamil Nadu State Transport Corporation Limited (Villupuram Division – I)), CRC – (Tamil Nadu State Transport Corporation Limited (Kumbakonam Division – I)), TTC – (State Express Transport Corporation Limited (Tamil Nadu Division – I)), PATC – (Tamil Nadu State Transport Corporation Limited (Villupuram Division – II)), JTC – (Tamil Nadu State Transport Corporation Limited (Coimbatore Division – II)), ATC – (Tamil Nadu State Transport

Corporation Limited (Salem Division – I)), and MPTC – (Tamil Nadu State Transport Corporation Limited (Kumbakonam Division – III)).

Output indexes are based on revenue passenger-kilometers (RPKm) where all values can be shown relative to any one STU for chosen year. Pallavan Transport in 1996-97 is taken as reference for this study. *Aggregate input indexes* (X_k's) are based on the following equation:

$$\ln X_k - \ln X_l = \sum_J[\{(W_{jk}+\bar{W}_J)/2\}.\{\ln(X_{jk}/\tilde{X}_j)\}] - \sum_J[\{(W_{jl}+\bar{W}_j)/2\}.\{\ln(X_{jl}/\tilde{X}_j)\}], \qquad \textbf{(4)}$$

Where, X_{jk} is quantity index for j^{th} input at k^{th} period (or firm), W_{jk} is cost share of j^{th} input (w.r.t. total operating cost) for k^{th} period (or firm), and X_k signifies aggregate input index for k^{th} period (or firm).

Previous discussions of the relative performance of individual road transport companies have invariably attributed considerable importance to differences in route structure. The cost of serving differing configuration of network may vary for several reasons, but route length is generally considered the leading indicator of route structure. There is substantial agreement that average cost declines with increasing average route length. There was great difficulty with 'average route length' data for Indian State Transport Undertakings; CIRT didn't collect 'average route length' data for four years, from 1992-93 to 1995-96 periods. Due to unavailability of proper data set related to network structure, this study ignores the effect of route structure on productivity.

Productivity

Using eq. **(3)**, TFP indexes are computed for 21 STUs. These indexes, normalized so that the level of TFP for PTC (Pallavan) in 1996-97 is 1.000, are presented in Table 1 along with their percentage rates of growth (see also Figure 2A).[3] In Table 2 I rank the STUs by their level of TFP in 1996-97. I also include in the table their 1983-84 rank, average annual percentage growth from 1983-84 to 1996-97 and a measure of size of the firm. The wide disparity in growth rates over the 1983-84 to 1996-97 period resulted in substantial changes in the ranking of the firms. For example, from 1983-84 to 1996-97 period PATC (Pattukkottai Azhagiri) rose from 12th to 1st , ATC (Anna) rose from 13th to 8th, PTC (Pallavan) rose from 16th to 10th,

[3] We adopt the convention that growth is continuously compounded and therefore compute compounded percentage growth rates.

STPJB (Punjab) fell from 8th to 16th, DTC (Delhi) fell from 10th to 20th, and KnSRTC (Karnataka) fell from 11th to 15th. During the sample period, TPTC (Thanthai Periyar) seems to be most consistent performer and most of the period it was among the most productive firm.[4]

In terms of TFP growth the STUs fall in four distinct categories. Two STUs achieved very high growth rates of productivity: PATC (5.46%) and ATC (4.16%). PATC achieved first rank (in 1996-97) from 12th rank (in 1983-84) by experiencing very high productivity growth during sample period. Five STUs achieved very low (i.e., negative) productivity growth: DTC (-3.15%), STPJB (-1.41%), BEST (-0.84%), PRC (-0.66%), and MPSRTC (-0.14%). Eight STUs achieved productivity growth which is relatively modest ranging from 1.96% (KSRTC) to 3.11% (PTC) per year. The remaining six STUs can be categorized as low productivity growth category which ranges from 0.15% (KnSRTC) to 1.82% (RSRTC).

PATC (Pattukkottai Azagiri) experienced a decline in TFP for a single year during period 1991-92 to 1992-93 in the entire sample period. MSRTC (Maharashtra), CTC (Cheran), MPTC (Marudhu Pandiyar), and PTC (Pallavan) faced decline in productivity for three years. Six STUs, namely- APSRTC (Andhra Padesh), KSRTC (Kerala), TPTC (Thanthai Periyar), JTC (Jeeva), ATC (Anna), and CRC (Cholan Roadways) experienced decline in TFP for four years. GSRTC (Gujarat), RSRTC (Rajasthan), MPSRTC (Madhaya Pradesh), STPJB (Punjab), PRC (Pandiyan Roadways), TTC (Thiruvalluvar), and BEST faced decline in productivity for five years out of thirteen years. There are two State Transport Undertakings, KnSRTC (Karnataka) and UPSRTC (Uttar Pradesh), which experienced decline in productivity for six years. Delhi Transport Corporation's TFP declined for seven years and that is the reason why it's productivity ranking slipped from 10th to 20th from 1983-84 to 1996-97 period.[5]

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[4] It was most productive firm for seven years (during 1984-85 to 1988-89, 1990-91, and 1991-92). In 1990-91 it was most productive firm jointly with PATC.

[5] It should be noted that decline in productivity is usually not in the same year for different STUs.

Table 1

Total Factor Productivity for State Transport Undertakings, 1983-84 to 1996-97, Indexes; PTC (1996-97) = 1.000

	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97
MSRTC	0.594	0.629	0.694	0.713	0.724	0.745	0.740	0.690	0.702	0.709	0.699	0.733	0.783	0.790
APSRTC	0.677	0.706	0.751	0.771	0.788	0.801	0.823	0.758	0.778	0.816	0.805	0.860	0.852	0.803
KnSRTC	0.761	0.798	0.787	0.725	0.772	0.815	0.826	0.820	0.849	0.843	0.804	0.868	0.946	0.776
GSRTC	0.805	0.821	0.812	0.895	0.824	0.849	0.890	0.840	0.829	0.858	0.698	0.740	0.926	0.985
UPSRTC	0.510	0.466	0.532	0.598	0.555	0.583	0.604	0.598	0.646	0.609	0.640	0.597	0.646	0.629
KSRTC	0.554	0.594	0.557	0.604	0.662	0.678	0.685	0.678	0.717	0.729	0.763	0.767	0.748	0.713
RSRTC	0.716	0.743	0.698	0.701	0.748	0.725	0.736	0.665	0.749	0.850	0.830	0.915	0.896	0.905
MPSRTC	0.545	0.551	0.483	0.500	0.562	0.603	0.632	0.645	0.596	0.562	0.604	0.573	0.530	0.535
STPJB	0.866	0.825	0.852	0.804	0.816	0.828	0.883	0.736	0.769	0.772	0.749	0.749	0.799	0.720
CTC	0.915	0.931	0.928	0.818	0.819	0.851	0.874	0.910	0.949	0.970	1.170	1.109	1.180	1.228
PRC	1.337	1.007	1.018	0.982	0.964	1.036	1.006	1.101	1.005	1.017	1.033	1.116	1.166	1.227
TTC	0.874	0.933	0.866	0.990	0.938	1.013	1.050	0.497	0.984	1.094	1.024	0.888	0.981	1.024
TPTC	1.045	1.135	1.144	1.199	1.129	1.155	1.111	1.175	1.164	1.141	1.169	1.219	1.356	1.362
JTC	0.902	0.833	0.885	0.863	0.891	1.011	0.993	1.074	1.041	1.099	1.158	1.184	1.242	1.284
ATC	0.717	0.691	0.735	0.716	0.995	1.004	0.994	1.107	1.046	1.057	1.100	1.109	1.179	1.218
CRC	0.977	1.018	1.029	0.994	0.924	1.005	0.998	1.057	1.079	1.111	1.035	1.109	1.291	1.350
PATC	0.723	1.024	1.045	1.045	1.055	1.057	1.173	1.175	1.156	1.166	1.239	1.308	1.359	1.444
MPTC	1.047	1.016	1.033	0.964	0.980	0.984	0.986	1.087	1.144	1.185	1.367	1.407	1.486	1.368
DTC	0.771	0.872	0.779	0.902	0.962	0.731	0.866	0.759	0.766	0.640	0.789	0.549	0.516	0.509
BEST	0.519	0.570	0.702	0.784	0.583	0.623	0.568	0.570	0.497	0.454	0.476	0.489	0.496	0.465
PTC	0.672	0.724	0.721	0.751	0.728	0.788	0.776	0.778	0.794	0.828	0.833	0.924	0.988	1.000

Total Factor Productivity for STUs, 1983-84 to 1996-97, Growth rates (%)[6]

	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1984-97
MSRTC	5.9	10.3	2.7	1.5	2.9	-0.7	-6.8	1.7	1.0	-1.4	4.9	6.8	0.9	2.2
APSRTC	4.3	6.4	2.7	2.2	1.6	2.7	-7.9	2.6	4.9	-1.3	6.8	-0.9	-5.8	1.3
KnSRTC	4.9	-1.4	-7.9	6.5	5.6	1.3	-0.7	3.5	-0.7	-4.6	8.0	9.0	-18.0	0.2
GSRTC	2.0	-1.1	10.2	-7.9	3.0	4.8	-5.6	-1.3	3.5	-18.6	6.0	25.1	6.4	1.6
UPSRTC	-8.6	14.2	12.4	-7.2	5.0	3.6	-1.0	8.0	-5.7	5.1	-6.7	8.2	-2.6	1.6
KSRTC	7.2	-6.2	8.4	9.6	2.4	1.0	-1.0	5.8	1.7	4.7	0.5	-2.5	-4.7	2.0
RSRTC	3.8	-6.1	0.4	6.7	-3.1	1.5	-9.6	12.6	13.5	-2.4	10.2	-2.1	1.0	1.8
MPSRTC	1.1	-12.3	3.5	12.4	7.3	4.8	2.1	-7.6	-5.7	7.5	-5.1	-7.5	0.9	-0.1
STPJB	-4.7	3.3	-5.6	1.5	1.5	6.6	-16.6	4.5	0.4	-3.0	0.0	6.7	-9.9	-1.4
CTC	1.7	-0.3	-11.9	0.1	3.9	2.7	4.1	4.3	2.2	20.6	-5.2	6.4	4.1	2.3
PRC	-24.7	1.1	-3.5	-1.8	7.5	-2.9	9.4	-8.7	1.2	1.6	8.0	4.5	5.2	-0.7
TTC	6.8	-7.2	14.3	-5.3	8.0	3.7	-52.7	98.0	11.2	-6.4	-13.3	10.5	4.4	1.2
TPTC	8.6	0.8	4.8	-5.8	2.3	-3.8	5.8	-0.9	-2.0	2.5	4.3	11.2	0.4	2.1
JTC	-7.6	6.2	-2.5	3.2	13.5	-1.8	8.2	-3.1	5.6	5.4	2.2	4.9	3.4	2.8
ATC	-3.6	6.4	-2.6	39.0	0.9	-1.0	11.4	-5.5	1.1	4.1	0.8	6.3	3.3	4.2
CRC	4.2	1.1	-3.4	-7.0	8.8	-0.7	5.9	2.1	3.0	-6.8	7.1	16.4	4.6	2.5
PATC	41.6	2.1	0.0	1.0	0.2	11.0	0.2	-1.6	0.9	6.3	5.6	3.9	6.3	5.5
MPTC	-3.0	1.7	-6.7	1.7	0.4	0.2	10.2	5.2	3.6	15.4	2.9	5.6	-7.9	2.1
DTC	13.1	-10.7	15.8	6.7	-24.0	18.5	-12.4	0.9	-16.4	23.3	-30.4	-6.0	-1.4	-3.1
BEST	9.8	23.2	11.7	-25.6	6.9	-8.8	0.4	-12.8	-8.7	4.8	2.7	1.4	-6.2	-0.8
PTC	7.7	-0.4	4.2	-3.1	8.2	-1.5	0.3	2.1	4.3	0.6	10.9	6.9	1.2	3.1

[6] 1984-85 signifies 1983-84 to 1984-85 and so on; where as 1984-97 indicates 1983-84 to 1996-97. Growth rates are rounded-off after one decimal point.

Table 2
STUs ranked by 1996-97 & 1983-84 level of productivity and size

	TFP rank 1996-97	TFP level 1996-97	TFP rank 1983-84	TFP level 1983-84	TFP growth rate Rank	TFP growth rate Level (%)	Output rank 1996-97	Output level 1996-97	Output rank 1983-84	Output level 1983-84
PATC	1	1.444	12	0.723	1	5.46	18	0.920	19	0.320
MPTC	2	1.368	2	1.047	8	2.08	21	0.582	20	0.297
TPTC	3	1.362	3	1.045	9	2.06	14	0.936	17	0.397
CRC	4	1.35	4	0.977	5	2.52	16	0.929	14	0.584
JTC	5	1.284	6	0.902	4	2.76	19	0.874	21	0.234
CTC	6	1.228	5	0.915	6	2.29	11	1.131	15	0.570
PRC	7	1.227	1	1.337	18	-0.66	10	1.200	13	0.947
ATC	8	1.218	13	0.717	2	4.16	20	0.849	18	0.354
TTC	9	1.024	7	0.874	15	1.22	17	0.929	16	0.505
PTC	10	1.000	16	0.672	3	3.11	12	1.000	11	1.049
GSRTC	11	0.985	9	0.805	13	1.57	3	5.634	4	2.989
RSRTC	12	0.905	14	0.716	11	1.82	6	2.548	10	1.083
APSRTC	13	0.803	15	0.677	14	1.33	1	9.526	2	3.814
MSRTC	14	0.790	17	0.594	7	2.21	2	8.665	1	4.312
KnSRTC	15	0.776	11	0.761	16	0.15	4	5.139	3	3.620
STPJB	16	0.720	8	0.866	20	-1.41	15	0.934	8	1.176
KSRTC	17	0.713	18	0.554	10	1.96	7	1.886	7	1.468
UPSRTC	18	0.629	21	0.51	12	1.62	5	3.036	6	2.032
MPSRTC	19	0.535	19	0.545	17	-0.14	13	0.980	12	0.994
DTC	20	0.509	10	0.771	21	-3.15	9	1.220	5	2.611
BEST	21	0.465	20	0.519	19	-0.84	8	1.478	9	1.126

Estimates of TFP can be compared with more traditional indicators of transport productivity e.g., *revenue pass.-kms per employee*, and *available pass.-kms per employee*. I present these indexes for all 14 years in Table A1 & A2, along with their growth rates. Figure 2B presents distribution of labor productivity index (revenue passenger-kilometers per employee) at firm level data. In Table 3 I present the 1996-97 & 1983-84 rankings of the STUs based on these two (labor) productivity indexes. There is very high positive correlation between TFP indexes and these labor productivity indexes[7]; I find major similarities in rankings drawn from TFP and RPKm/E (revenue pass.-kms per employee) indexes. There are very few similarities in rankings drawn from TFP indexes and APKm/E (available pass.-kms per employee) indexes. As a whole, although there are some similarities among these indexes, there are some major differences. I found that in 1996-97 PATC's TFP exceeded that of MPTC by 5.3% (Table 1). However, PATC's revenue pass.-kms per employee exceeded MPTC's by just 0.48% and MPTC's available pass.-kms per employee exceeded PATC's by 22.8% (Table A1 & A2). In none of the years did revenue pass.-kms per employee and available pass.-km per

[7] Correlation coefficient between TFP & revenue pass.-kms per employee and TFP & available pass.-kms per employee is 0.971 (69.46) and 0.856 (28.35) respectively (T-values in parentheses). Correlation coefficient between these two labor productivity indexes is found to be 0.897 (34.72).

employee produces identical rankings. For example, PATC in 1996-97 ranks 1st on the basis of revenue pass.-kms per employee but 8th on the basis of available pass.-kms per employee.

There are basic problems with input measures used in revenue pass.-kms per employee as well as available pass.-kms per employee index calculation. "*Employees*" provides a very crude measure of total input; in Table A3 I illustrate the firm-by-firm deviation between employees and aggregate input index. I find that the deviations quite often fall in five to fifteen percent range.

Table 3

STUs ranked by Revenue Pass.-Km per Employee and Available Pass.-Km per Employee

	1996-97 RPKm/E		1983-84 RPKm/E		1996-97 APKm/E		1983-84 APKm/E		1983-84 to 1996-97 Average annual growth rate (%)		TFP ranking based on		
											1996-97 Level	1983-84 Level	Sample pd. Growth rate Level
	Rank	Level	Rank	Level	Rank	Level	Rank	Level	RPKm/E	APKm/E	Rank	Rank	Rank
PATC	1	1.669	12	0.768	8	1.655	6	1.185	6.1	2.6	1	12	1
MPTC	2	1.661	3	1.194	1	2.144	3	1.483	2.6	2.9	2	2	8
CRC	3	1.651	4	1.081	2	1.821	2	1.641	3.3	0.8	4	4	5
TPTC	4	1.608	2	1.225	5	1.716	4	1.466	2.1	1.2	3	3	9
JTC	5	1.492	6	1.024	6	1.711	5	1.414	2.9	1.5	5	6	4
ATC	6	1.401	10	0.804	3	1.789	12	1.010	4.4	4.5	8	13	2
CTC	7	1.401	7	1.024	4	1.737	9	1.100	2.4	3.6	6	5	6
PRC	8	1.387	1	1.502	7	1.665	1	2.086	-0.6	-1.7	7	1	18
TTC	9	1.202	8	0.952	13	1.218	10	1.057	1.8	1.1	9	7	15
GSRTC	10	1.051	11	0.780	9	1.490	8	1.115	2.3	2.3	11	9	13
RSRTC	11	1.050	14	0.694	11	1.265	14	0.814	3.2	3.5	12	14	11
PTC	12	1.000	16	0.602	15	1.000	18	0.648	4.0	3.4	10	16	3
KnSRTC	13	0.855	9	0.815	10	1.287	11	1.052	0.4	1.6	15	11	16
MSRTC	14	0.819	17	0.546	12	1.255	13	0.821	3.2	3.3	14	17	7
STPJB	15	0.819	5	1.037	14	1.074	7	1.141	-1.8	-0.5	16	8	20
APSRTC	16	0.796	15	0.603	16	0.994	17	0.680	2.2	3.0	13	15	14
KSRTC	17	0.727	19	0.478	17	0.970	21	0.570	3.3	4.2	17	18	10
UPSRTC	18	0.601	20	0.469	18	0.798	15	0.746	1.9	0.5	18	21	12
MPSRTC	19	0.472	18	0.490	20	0.552	19	0.638	-0.3	-1.1	19	19	17
DTC	20	0.425	13	0.717	21	0.455	16	0.735	-3.9	-3.6	20	10	21
BEST	21	0.406	21	0.436	19	0.586	20	0.571	-0.5	0.2	21	20	19

Table A4 shows different productivity indexes for the passenger road transport industry, along with correlation between them (see also Figure 1).[8] According to first measure of productivity i.e., Caves and Christensen based Total Factor Productivity Index, average growth rate of productivity is found to be 1.333 percent per annum for the sample period in the transport industry. Divisia based TFP index shows that productivity growth in the industry was

[8] I assumed that passenger road transport industry is having only reported 21 firms (which are producing more than 80% of the total production of the industry). This simplification is assumed due to unavailability of industry level data, since many of the STUs do not report required data to the CIRT regularly.

1.325 percent per annum. Productivity growth is 1.414 percent per year when Laspeyres index is used to measure it. Growth is recorded around 1.88 and 1.28 percent per annum for labor productivity and bus productivity respectively for the period 1983-84 to 1996-97. We can see that partial factor productivity indexes are not reliable source to measure the productivity. For passenger road transport industry, relying on labor productivity index is equivalent to overestimation of productivity growth whereas capital (bus) productivity index underestimates growth in productive efficiency.

Analysis of Differences in Productivity

Many factors might account for the substantial differences found in TFP for the State Transport Undertakings. This study is examining the relationships between productivity and two variables- output, and load factor. Before examining the relationship between TFP and output/load factor, I would like to inquire in brief about the performance of STUs operating in Tamil Nadu.

As Table 2 reveals, in recent years, productivity performance of STUs in Tamil Nadu seems to be better than the STUs of the other parts of the country. In 1996-97, top ten most productive STUs were operating in Tamil Nadu. A bivariate regression of TFP on a dummy variable (location of STUs) reveals the same. We divide STUs in two categories – (1) STUs, located in Tamil Nadu, and (2) STUs, located in other parts of the country; and then run a regression as follows:

$TFP_i = f(location) = \beta_0 + \beta_1 TN + u_i;$

Where,

TN = 1 for STUs belonging to Tamil Nadu, and TN = 0 for others.

Bivariate regression coefficient for the dummy variable TN (Tamil Nadu) will express the average TFP for STUs in Tamil Nadu relative to the average TFP of other STUs (located in other state). In other words, β_1 will express the difference between the two group means. Regression results are as follows[9]:

$TFP_i = 0.714 + 0.320TN$; $R^2 = 0.534$, $F_{1,292} = 334.6$

(59.1) (18.3)

The statistically significant positive coefficient for TN indicates that predicted TFP for STUs in Tamil Nadu is 0.320 more than predicted TFP for STUs located in other parts of the

[9] T-values in parentheses.

country. So, we can say that on an average STUs of Tamil Nadu are almost 45% (= (0.320*100/0.714)) more productive than the other STUs. The information of R^2 – that locational differences explain almost 53% of the variation in TFP. The question remains, why Tamil Nadu STUs are more productive?

Most of the states set up the road transport corporations under the Road Transport Corporation Act of 1950. As and when the private corporations were notified and taken over, they were entrusted to these state road transport corporations. Many states have landed up with very large monolithic organizations. But in the state of Tamil Nadu, a conscientious strategic decision was taken to set up a number of state road transport corporations with operations limited to one or two districts. This might have introduced a possibility of yardstick comparison as well as paved the way for more cohesive management. Probably the organizational set up of Tamil Nadu has helped in achieving greater productivity.

After the independence, Tamil Nadu like other states in India has followed the policy of progressive nationalization of passenger road transport business. The state pioneered nationalization of road transport services in the country by taking over bus transport system in 1947 in Madras (Chennai) city. Under the transport department, a separate wing was set up to deal with the matters related to the nationalization of the passenger road transport. In view of the importance of road transport in the state, a separate State Transport Department was set up by the government. In 1956, the services already nationalized in Kanyakumari districts came under the control of the department. In 1959, a historic decision was taken which made it obligatory to run express bus services by the State Government for distances exceeding 192 kms. The nationalization of passenger road transport received a shot in the arm in the year 1967-68 when the Government decided to takeover all routes of 120 kms. and above, both ordinary and express services; all routes connecting to Madras city irrespective of length; and all routes connecting to Kanyakumari districts. This resulted in taking over all the vehicles and the other assets of the fleet operators with more than 50 vehicles under the Tamil Nadu Fleet and State Carriage (Acquisition) Act, 1971. The Government of Tamil Nadu at this stage took a strategic decision to entrust the nationalized transport organizations each with a jurisdiction over two districts and normally with less than 500 buses under each State Transport Undertakings. During the period of 18 years from 1972 to 1990, fifteen passenger road transport corporations were set up in Tamil Nadu. The track record of private bus operators from whom the bus transport services were nationalized in Tamil Nadu was very good. They were maintaining a very high standard of customer services. Unlike the other states, the nationalization of passenger road transport services in Tamil Nadu was not prompted by the inefficiency of private operators. The fact that the political party in power had no obligation towards the influential private transport operators who were not political or ideological aligned with them, helped the State Government to undertake speedy nationalization of the passenger road transport services in Tamil Nadu. In this state, nationalization was not justifiable on grounds of inefficiency of operation of the private operators. They were mostly well run private operators with fairly good size and with all infrastructural facilities for maintenance etc., the Government decided to affect minimum alterations in terms of top management and procedures. The methods of recruitment, materials management were built on the existing practices in the private sector and the culture of business which was prevailing in the private sector organization was nurtured.

The passenger road transport activity in the country has been organized in four forms, viz., Public Corporations, Departmental Undertakings, Municipal Undertakings, and Government Companies. It was obvious that a departmental undertaking would not serve the purpose for which nationalization was being adopted. A departmental organization would depend entirely on budgetary support which would not be forthcoming in a manner commensurate with the needs for transport services. The decision-making gets slow down due to bureaucratic procedures. Recruitment of personnel based on technical requirements and mobilization of funds would suffer greatly. Therefore, State Governments had to decide either to have a corporation incorporated under the State Road Transport Act of 1950 or companies incorporated under the Companies Act of 1956. All the STUs in Tamil Nadu have been organized in the form of government companies. One very important reason to organize the passenger road transport activity in the company form was to circumvent the Central Government's interface in the growth and development of such activities. The various STUs in many other states of the Indian Union have been formed under the Road Transport Corporation Act 1950 enacted by the Central Government. Under the provisions of the act, one third of the capital contributions come from the Central Government which are routed through the Department of Railways. This entitles the Central Government to have the representatives on the Board of Directors of the STUs and the Indian Railways to have its say in the decisions taken by these undertakings which may come in conflict with its interests, since it too, is in the business of transport. The Tamil Nadu decided in favor of the company form in view of obtaining the best trade-off between autonomy and control. The company form provided for the operational autonomy to the road transport corporations, on the one hand, and control on strategic matters in the hands of State Government, on the other, by making suitable provisions in the articles of associations of the STUs. The Tamil Nadu Government kept with the powers to create new government companies, appointing the board of directors and recruitment of the managerial personnel including terms and conditions governing their employment.

There was also the problem of having only one corporation to run the entire passenger road transport business for the whole state. To keep the problems connected with the merger of staff and amalgamation of assets under manageable proportions, Tamil Nadu State decided to have different corporations. It was felt that decentralization might provide healthy competition among the corporations; financial and social indicators could be used to make a comparison of relative performance. There could be a sense of pride among different units running services in different districts to think in terms of giving better services and winning greater appreciation for their respective districts. However, it was recognized that there would be certain facilities and services for which there are scale economies. Therefore certain independent organizations were set up to deal with the training and R & D.

The STUs in Tamil Nadu present a vastly different picture of productive efficiency as compared to their counterparts in other states of the country. Such picture might have resulted through organizational innovativeness in the various STUs in Tamil Nadu besides the competition generated through the creation of several state run passenger road transport corporations. Further research to find out “why STUs in Tamil Nadu are more productive compared to their counterparts in other states of the country?” would clearly be desirable.

In 1996-97 the largest State Transport Undertaking, APSRTC, had an output level that was nearly 16 times as great as the smallest STU, MPTC. Furthermore, the rates of growth of output for STUs over 1983-84 to 1996-97 period ranged from -5.7% per year for DTC, to 10.7% per year for JTC. I tried to investigate the extent to which these differences in size are associated with differences in productivity levels. In Table 4 I rank the STUs by their 1996-97 levels of output; in addition I indicate output levels in 1983-84 and growth of output, 1983-84 to 1996-97. In the last three columns of this table I present the rankings of TFP levels in 1996-97, 1983-84, and TFP growth rates from 1983-84 to 1996-97. The largest STUs do not have the highest productivity - the three largest STUs rank 13th, 14th, and 11th according to their TFP levels in 1996-97. Furthermore, the five smallest STUs include three of the five most productive STUs. It seems at first glance that there is inverse relationship between size and productivity of the firm. For example, in 1996-97 a set of nine most productive firms (***P***) and another set of nine biggest firms (***B***) are disjoint set. Most productive firm is 18th and 13th in size in 1996-97 and 1983-84 respectively. In general bigger firms are not more productive than the smaller firms though regression results of Table 6 says that there is a positive relationship between output and TFP for almost every firm except PTC. It indicates that on an average bigger STUs are more inefficient than what it seems from the comparison of TFP indexes. We can draw inference that the problem of principal-agent is more damaging when an organization crosses critical size because cost of managing it might be more than the benefit due to presence of economies of scale.

Table 4

STUs ranked by 1996-97 & 1983-84 level of Output

	1996-97 output		1983-84 output		S.P. growth of OP		1996-97 TFP		1983-84 TFP		S.P. growth of TFP	
	Rank	Level	Rank	Level	Rank	Level (%)	Rank	Level	Rank	Level	Rank	Level (%)
APSRTC	1	9.526	2	3.814	3	7.3	13	0.803	15	0.677	14	1.3
MSRTC	2	8.665	1	4.312	7	5.5	14	0.790	17	0.594	7	2.2
GSRTC	3	5.634	3	3.620	13	3.5	11	0.985	9	0.805	13	1.6
KnSRTC	4	5.139	4	2.989	11	4.3	15	0.776	11	0.761	16	0.2
UPSRTC	5	3.036	6	2.032	14	3.1	18	0.629	21	0.510	12	1.6
RSRTC	6	2.548	10	1.083	6	6.8	12	0.905	14	0.716	11	1.8
KSRTC	7	1.886	7	1.468	16	1.9	17	0.713	18	0.554	10	2.0
BEST	8	1.478	9	1.126	15	2.1	21	0.465	20	0.519	19	-0.8
DTC	9	1.220	5	2.611	21	-5.7	20	0.509	10	0.771	21	-3.1
PRC	10	1.200	13	0.947	17	1.8	7	1.227	1	1.337	18	-0.7
CTC	11	1.131	15	0.570	8	5.4	6	1.228	5	0.915	6	2.3
PTC	12	1.000	11	1.049	19	-0.4	10	1.000	16	0.672	3	3.1
MPSRTC	13	0.980	12	0.994	18	-0.1	19	0.535	19	0.545	17	-0.1
TPTC	14	0.936	17	0.397	5	6.8	3	1.362	3	1.045	9	2.1
STPJB	15	0.934	8	1.176	20	-1.8	16	0.720	8	0.866	20	-1.4
CRC	16	0.929	14	0.584	12	3.6	4	1.350	4	0.977	5	2.5
TTC	17	0.929	16	0.505	10	4.8	9	1.024	7	0.874	15	1.2
PATC	18	0.920	19	0.320	2	8.5	1	1.444	12	0.723	1	5.5
JTC	19	0.874	21	0.234	1	10.7	5	1.284	6	0.902	4	2.8
ATC	20	0.849	18	0.354	4	6.9	8	1.218	13	0.717	2	4.2
MPTC	21	0.582	20	0.297	9	5.3	2	1.368	2	1.047	8	2.1

Average growth rate of output during sample period varies from –5.7% (DTC) to 10.7% (JTC). PATC, which experienced very high growth in output (8.5%), also experienced tremendous growth in productivity (5.5%) during the sample period. In similar fashion, DTC experienced very low growth in output (-5.7%) as well as in productivity (-3.1%).

I also consider the possible relationship between productivity performance and system load factor; which can be taken as an indicator of capacity utilization. The a priori expectation is that higher load factor is associated with higher TFP. In Table 5 I present the STUs load factor in 1996-97 & 1983-84 and their average rates of increase of load factor over this period.

Twelve STUs had 1996-97 load factors within the range 0.71-0.90. The other nine STUs had a little bit lower load factors, within the range of 0.58-0.70. Changes in load factors ranged from -1.34% per year for STPJB to +3.46% per year for PATC. Pattukkottai Azagiri Transport Corporation Limited realizes highest load factor as well as productivity in 1996-97 among all the STUs. It also experienced highest improvement in load factor from 1983-84 to 1996-97, which might have contributed to improve the productivity.

Table 5

STUs ranked by passenger load factor[10]

	passenger Load factor				L.F. growth for S.P.		TFP rankings based on		
	1996-97		1983-84				1996-97	1983-84	S.P.G.R.
	Rank	Level	Rank	Level	Rank	G.R.(%)	Level	Level	Level
PATC	1	89.90	20	57.79	1	3.46	1	12	1
PTC	2	89.15	3	82.80	9	0.57	10	16	3
TTC	3	87.96	5	80.30	8	0.70	9	7	15
TPTC	4	83.54	9	74.50	6	0.88	3	3	9
DTC	5	83.25	1	87.00	15	-0.34	20	10	21
CRC	6	80.85	19	58.71	2	2.49	4	4	5
JTC	7	77.73	15	64.60	3	1.43	5	6	4
MPSRTC	8	76.13	13	68.50	7	0.82	19	19	17
PRC	9	74.24	16	64.20	5	1.12	7	1	18
RSRTC	10	74.00	7	76.00	13	-0.20	12	14	11
CTC	11	71.90	2	83.00	19	-1.10	6	5	6
APSRTC	12	71.40	6	79.00	17	-0.78	13	15	14
ATC	13	69.85	11	71.00	11	-0.13	8	13	2
MPTC	14	69.05	10	71.80	14	-0.30	2	2	8
STPJB	15	67.97	4	81.00	21	-1.34	16	8	20
UPSRTC	16	67.17	21	56.00	4	1.41	18	21	12
KSRTC	17	66.81	8	74.80	18	-0.87	17	18	10
GSRTC	18	62.87	17	62.30	10	0.07	11	9	13
BEST	19	61.77	14	68.00	16	-0.74	21	20	19
KnSRTC	20	59.22	12	69.10	20	-1.18	15	11	16
MSRTC	21	58.21	18	59.30	12	-0.14	14	17	7

[10] L.F., S.P., and S.P.G.R. stands for load factor, sample period, and average growth rate during sample period respectively.

Table 6

Bivariate Regressions of TFP on Output, and Multiple Regressions of TFP on Output & Load Factor for each STUs[11]

	MODEL 1[12]				MODEL 2[13]					
	Constant	Output	R^2	Adj. R^2	Constant	Output	Load factor	R^2	Adj. R^2	$F_{1,11}$
MSRTC	-3.849	0.325	0.801	0.784	-6.326	0.367	0.492	0.887	0.867	8.37
	(7.62)	(6.94)			(6.73)	(9.28)	(2.91)			
APSRTC	-2.242	0.185	0.799	0.783	-5.139	0.223	0.575	0.835	0.806	2.40
	(7.77)	(6.93)			(2.71)	(6.31)	(1.54)			
KnSRTC	-2.522	0.223	0.547	0.509	-4.256	0.170	0.539	0.927	0.913	57.26
	(4.15)	(3.80)			(12.38)	(6.64)	(7.55)			
GSRTC	-4.583	0.426	0.403	0.354	-6.431	0.358	0.634	0.922	0.908	73.19
	(2.96)	(2.85)			(10.33)	(6.28)	(8.55)			
UPSRTC	-5.459	0.496	0.894	0.885	-5.362	0.367	0.285	0.931	0.919	5.90
	(11.14)	(10.06)			(12.97)	(5.45)	(2.45)			
KSRTC	-8.864	0.894	0.972	0.969	-8.457	0.899	-0.105	0.979	0.975	3.67
	(21.45)	(20.49)			(19.53)	(22.64)	(1.88)			
RSRTC	-3.398	0.334	0.839	0.826	-3.561	0.335	0.037	0.839	0.810	0.00
	(8.56)	(7.92)			(2.29)	(7.54)	(0.11)			
MPSRTC	-6.756	0.689	0.928	0.922	-6.722	0.557	0.268	0.965	0.959	11.63
	(13.61)	(12.46)			(18.56)	(9.97)	(3.39)			
STPJB	-8.147	0.883	0.849	0.836	-7.694	0.725	0.223	0.912	0.896	7.88
	(8.43)	(8.20)			(9.79)	(7.09)	(2.82)			
CTC	-3.988	0.452	0.519	0.479	-5.533	0.465	0.342	0.754	0.709	10.51
	(3.62)	(3.59)			(5.82)	(4.95)	(3.24)			
PRC	-2.375	0.281	0.517	0.477	-1.604	0.331	-0.286	0.554	0.472	0.91
	(3.49)	(3.58)			(1.51)	(3.49)	(0.95)			
TTC	-0.296	0.025	0.001	-0.082	5.431	0.215	-1.675	0.149	-0.006	1.91
	(0.164)	(0.12)			(1.21)	(0.89)	(1.38)			
TPTC	-1.396	0.182	0.425	0.378	-5.326	0.189	0.897	0.929	0.917	78.08
	(2.67)	(2.98)			(11.02)	(8.44)	(8.86)			
JTC	-2.370	0.291	0.848	0.835	-3.187	0.222	0.335	0.951	0.942	23.12
	(8.08)	(8.17)			(13.14)	(8.77)	(4.82)			
ATC	-5.490	0.653	0.818	0.803	-6.394	0.517	0.493	0.908	0.891	10.76
	(7.41)	(7.35)			(10.37)	(6.61)	(3.27)			
CRC	-3.795	0.457	0.763	0.743	-3.828	0.418	0.086	0.770	0.728	0.33
	(6.12)	(6.22)			(5.97)	(4.13)	(0.58)			
PATC	-3.910	0.474	0.736	0.714	-6.049	0.291	0.857	0.894	0.874	16.40
	(5.60)	(5.78)			(8.61)	(4.11)	(4.04)			
MPTC	-2.768	0.351	0.590	0.555	-5.287	0.199	0.889	0.795	0.758	11.00
	(3.97)	(4.15)			(5.77)	(2.58)	(3.32)			
DTC	-6.035	0.588	0.945	0.941	-6.163	0.578	0.049	0.946	0.936	0.20
	(15.19)	(14.41)			(11.53)	(11.80)	(0.38)			
BEST	-2.112	0.164	0.016	-0.067	-5.156	-0.029	1.132	0.977	0.973	459.61
	(0.61)	(0.44)			(9.05)	(0.49)	(21.57)			
PTC	2.218	-0.269	0.155	0.084	-1.408	-0.306	0.887	0.243	0.105	1.28
	(1.35)	(1.48)			(0.39)	(1.68)	(1.13)			

[11] T-values in parentheses; all values are in natural log. Number of observations for each regression is 14.

[12] Model 1 is highly significant (according to Model F-statistic) for almost every STUs except TTC, BEST, and PTC. Model F-statistic is not reported in the Table due to space limitation (Critical $F_{1,12;0.05} = 4.75$).

[13] Model 2 is strongly significant (according to Model F-statistic) for virtually every firm except TTC and PTC. Model F-statistic is not reported in the Table because of space limitation (Critical $F_{2,11;0.05} = 3.98$). Table report F-statistic ($F_{1,11}$) to verify whether marginal contribution of added variable (Load factor) is statistically significant or not (Critical $F_{1,11;0.05} = 4.84$). F-test shows that marginal contribution of load factor is statistically insignificant in case of APSRTC, KSRTC, RSRTC, PRC, TTC, CRC, DTC, and PTC.

Table 6 (Continued)

Multiple Regressions of TFP on Output, Load Factor, and Time-trend for each STUs

Model 3[14]									
	Constant	Output	Load factor	Time	R^2	Adj. R^2	$F_{3,10}$	$F_{2,10}$	$F_{1,10}$
MSRTC	-5.913	0.171	0.886	0.012	0.898	0.867	29.18	4.75	1.08
	(5.76)	(0.86)	(2.07)	(1.00)					
APSRTC	-5.563	0.295	0.502	-0.006	0.849	0.803	18.71	1.66	0.93
	(2.84)	(3.48)	(1.31)	(0.94)					
KnSRTC	-3.516	0.074	0.591	0.005	0.935	0.916	47.93	29.85	1.23
	(4.78)	(0.84)	(7.04)	(1.13)					
GSRTC	-10.718	0.947	0.222	-0.020	0.954	0.940	68.73	59.89	6.96
	(6.26)	(4.12)	(1.31)	(2.62)					
UPSRTC	-4.282	0.224	0.355	0.006	0.947	0.931	59.75	5.00	3.02
	(5.86)	(2.17)	(3.10)	(1.73)					
KSRTC	-7.415	0.743	-0.013	0.005	0.982	0.977	185.16	2.78	1.67
	(8.57)	(6.17)	(0.14)	(1.37)					
RSRTC	-8.933	0.725	0.481	-0.028	0.917	0.892	36.80	4.70	9.40
	(4.23)	(5.49)	(1.65)	(3.05)					
MPSRTC	-6.845	0.518	0.385	-0.003	0.974	0.966	123.91	8.85	3.46
	(20.40)	(9.37)	(4.01)	(1.83)					
STPJB	-7.379	0.716	0.172	-0.001	0.913	0.887	34.91	3.68	0.11
	(5.46)	(6.42)	(0.88)	(0.29)					
CTC	1.107	-0.333	0.345	0.043	0.882	0.846	24.84	15.38	10.85
	(0.52)	(1.32)	(4.49)	(3.29)					
PRC	-3.053	0.421	-0.109	-0.011	0.664	0.564	6.59	2.19	3.27
	(2.44)	(4.23)	(0.37)	(1.81)					
TTC	10.588	-0.023	-2.419	0.028	0.286	0.072	1.34	2.00	1.92
	(1.86)	(0.08)	(1.88)	(1.39)					
TPTC	-4.724	0.145	0.837	0.003	0.938	0.919	50.28	41.37	1.45
	(6.73)	(3.37)	(7.49)	(1.17)					
JTC	-1.488	0.039	0.247	0.022	0.974	0.966	123.13	24.23	8.85
	(2.44)	(0.61)	(4.03)	(2.93)					
ATC	-7.678	0.665	0.525	-0.011	0.909	0.882	33.23	5.00	0.11
	(2.10)	(1.58)	(2.91)	(0.36)					
CRC	-2.982	0.333	0.044	0.006	0.792	0.730	12.72	0.70	1.06
	(2.87)	(2.56)	(0.28)	(1.03)					
PATC	-4.210	0.127	0.722	0.018	0.972	0.963	113.75	42.14	27.86
	(8.12)	(2.57)	(6.13)	(5.23)					
MPTC	-2.153	-0.213	0.889	0.036	0.946	0.930	58.38	32.96	27.96
	(2.79)	(2.41)	(6.17)	(5.28)					
DTC	-6.814	0.654	0.019	0.007	0.951	0.937	65.27	0.61	1.02
	(8.33)	(7.52)	(0.14)	(1.05)					
BEST	-4.895	-0.093	1.202	0.003	0.978	0.972	151.24	218.64	0.45
	(7.18)	(0.88)	(11.01)	(0.73)					
PTC	1.413	-0.169	-0.067	0.026	0.954	0.937	68.44	86.85	154.57
	(1.47)	(3.47)	(0.31)	(12.37)					

[14] T-values in parentheses; all variables are in natural log except Time-trend. Number of observations for each regression is 14. Model 3 is statistically significant for almost every STUs except TTC at 5% level of significance. $F_{1,10}$ statistic in the Table signifies statistical significance of marginal contribution of added variable i.e., time-trend. F-test shows that marginal contribution of time-trend is statistically significant only for seven firms (GSRTC, RSRTC, CTC, JTC, PATC, MPTC, and PTC) at 5% level of significance. $F_{2,10}$ statistic reveals the statistical significance of marginal contribution of both load factor & time-trend jointly. F-test shows that 'incremental' contribution of explanatory variables, load factor & time-trend is statistically significant for most of the STUs. It is statistically insignificant for seven STUs (APSRTC, KSRTC, STPJB, PRC, TTC, CRC, and DTC) only.

Critical $F_{3,10;0.05} = 3.71$, $F_{1,10;0.05} = 4.96$, and $F_{2,10;0.05} = 4.10$.

This study summarizes the relationships between productivity and these two variables (i.e., output, and load factor) by reporting bivariate/multivariate regression analysis presented in Table 6, 7, and 8.[15] Model 1 of Table 6 presents a bivariate regression of TFP on Output for individual STUs. This model is statistically significant for almost every STUs except TTC, BEST, and PTC i.e., variation in 'Output' is not able to explain the variation in TFP for TTC, BEST, and PTC. The Model 1 regressions show positive and statistically significant relationship between TFP and Output for all STUs except three STUs mentioned above.[16] Model 2 of Table 6 presents a multiple regression of TFP on Output and load factor for individual STUs. This model is statistically significant for almost all the STUs except TTC and PTC i.e., variation in 'Output and Load factor' is not able to explain the variation in TFP for TTC and PTC. Sign of coefficient of Output is unchanged for every STUs except BEST, though coefficient of output is statistically insignificant in case of BEST. F-test shows that marginal contribution of load factor is statistically insignificant in case of APSRTC, KSRTC, RSRTC, PRC, TTC, CRC, DTC, and PTC. Moreover, wherever coefficient of load factor is statistically significant in this model, it's sign is positive which implies that productivity will increase if we increase the load factor at a given level of output.

Model 3 of Table 6 includes Time-trend as another explanatory variable besides Output and Load factor. Like to Model 1 & Model 2 this model is run for every STUs. Time-trend is included to see whether there is presence of autonomous growth in TFP or not. Coefficient of time-trend is found to be statistically significant for GSRTC, RSRTC, CTC, JTC, PATC, MPTC, and PTC though sign of coefficient is negative in case of GSRTC, and RSRTC. Regression results of Model 3 imply that if there is no change in produced output and load factor of Gujarat State Road Transport Corporation, and Rajasthan State Road Corporation then it is most likely that these two will experience decline in productivity in forthcoming years. This Model is statistically significant for almost all the STUs except one (TTC) only, i.e., variation in 'independent variables' is unable to explain the variation in TFP for only one firm. Coefficient and 'incremental' contribution of Time-trend is statistically significant for GSRTC, RSRTC, CTC, JTC, PATC, MPTC, and PTC. F-test shows that marginal contribution of load factor and time-trend (together) is statistically significant for most of the STUs. It is statistically insignificant in case of APSRTC, KSRTC, STPJB, PRC, TTC, CRC, and DTC.

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[15] All regressions are based on ordinary least squares (OLS) estimates.

[16] The bivariate regression of TFP on output can be derived from a specification in which total operating cost is a function of output and factor prices. A positive coefficient on output corresponds to positive scale economies.

In case of Thiruvalluvar Transport, variation in productivity over time is not (significantly) explained by variation in output and load factor, though it experienced average productivity growth of 1.22 percent per annum during 1983-84 to 1996-97. Variation in TFP over time is very well explained by variation in output, or variation in output and load factor, or variation in output and load factor with autonomous time-trend, for every STUs except Thiruvalluvar Transport. Perhaps network structure is playing very important role with other exogenous variables in explaining the variation of productivity over time for Thiruvalluvar Transport.

Table 7

Cross-sectional regression results for every year from 1983-84 to 1996-97[17]

		1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97
Model 1	Constt.	0.844	0.845	0.887	0.601	0.737	1.050	0.845	1.196	1.207	1.226	1.699	1.323	1.146	1.300
		(1.63)	(1.71)	(1.81)	(1.30)	(1.68)	(2.53)	(1.86)	(1.97)	(2.31)	(1.99)	(2.90)	(1.86)	(1.40)	(1.50)
	Output	-0.125	-0.122	-0.124	-0.091	-0.103	-0.133	-0.108	-0.150	-0.147	-0.148	-0.196	-0.156	-0.130	-0.148
		(2.16)	(2.22)	(2.29)	(1.77)	(2.16)	(2.97)	(2.23)	(2.31)	(2.63)	(2.26)	(3.14)	(2.05)	(1.50)	(1.61)
	R^2	0.197	0.205	0.216	0.141	0.197	0.318	0.207	0.219	0.267	0.212	0.342	0.182	0.106	0.120
	$F_{1,19}$	4.65	4.91	5.24	3.12	4.66	8.87	4.97	5.34	6.93	5.10	9.86	4.22	2.25	2.60
Model 2	Constt.	-0.180	-1.478	-0.070	0.150	0.448	2.125	1.133	4.370	1.968	0.731	1.880	1.064	-2.549	-2.633
		(0.10)	(1.15)	(0.06)	(0.18)	(0.46)	(1.83)	(0.95)	(2.53)	(1.21)	(0.35)	(1.00)	(0.40)	(0.80)	(0.68)
	Output	-0.126	-0.126	-0.134	-0.105	-0.108	-0.128	-0.106	-0.172	-0.149	-0.145	-0.199	-0.152	-0.086	-0.075
		(2.12)	(2.45)	(2.42)	(1.84)	(2.11)	(2.84)	(2.10)	(2.79)	(2.61)	(2.13)	(2.92)	(1.74)	(0.92)	(0.65)
	Load Factor	0.241	0.553	0.247	0.141	0.079	-0.265	-0.072	-0.689	-0.174	0.110	-0.037	0.052	0.763	0.758
		(0.60)	(1.94)	(0.93)	(0.63)	(0.33)	(0.99)	(0.26)	(1.94)	(0.50)	(0.25)	(0.10)	(0.10)	(1.20)	(1.04)
	R^2	0.212	0.343	0.252	0.159	0.202	0.354	0.210	0.355	0.277	0.214	0.342	0.182	0.172	0.170
	$F_{2,18}$	2.43	4.70	3.04	1.71	2.28	4.92	2.40	4.95	3.45	2.45	4.68	2.00	1.87	1.84
	$F_{1,18}$	0.34	3.78	0.87	0.39	0.11	1.00	0.07	3.80	0.25	0.05	0.00	0.00	1.43	1.08

Table 7 reports cross-section regression results for each year from 1983-84 to 1996-97. Model 1 of this Table represents a regression of TFP on Output for each year. Coefficient of Output is negative with varying degree of significance for every year. Model 2 is similar model with Load factor as another explanatory variable. It can be noticed from Table 7 that coefficient of load factor is statistically insignificant for every year. Marginal contribution of load factor is also statistically insignificant for every year. Therefore, it can be said that across firm, Load factor is not an important variable to explain the variation in TFP. F-test shows that Model 2 is not statistically superior to Model 1. So, we can use Model 1 to analyze the

[17] T-values are reported in parentheses. All variables are in natural log. Critical $F_{1,19;0.05} = 4.38$, $F_{1,18;0.05} = 4.41$, and $F_{2,18;0.05} = 3.55$.

variation of TFP across cross-section for every year. This Model is statistically insignificant for the year 1986-87, 1995-96, and 1996-97. The information of R^2 reveals that only few percentage of variation in TFP can be explained by the variation in output. It indicates that there is presence of firm specific effects.

In Model 1, 2, and 3 of Table 6, it is assumed that coefficients are constant over time. But, when estimating a time series equation for a single cross-sectional unit we may find that a regression coefficient changes over time. Similarly, when estimating a regression equation for cross-sectional (Model 1, and 2 of Table 7) data it is often assumed that the equation is valid for each individual in the sample, which may not be very realistic assumption. When we analyze the data pertaining to a number of individuals, the use of pooled data allows us the possibility of modeling these differences. In fact, a pooled data base blends characteristics of both cross-sectional and time series data. Like cross-sectional data, it describes each of a number of individuals. Like time series data, it describes each single individual through time. Pooled data analyses are important because they reveal the information necessary to deal with both the inter-temporal dynamics and the individuality of the entities being investigated.

Regressions reported in Table 8 I pool observations across firms and years. The first regression TFP0 (bivariate regression of TFP on load factor) shows positive but statistically insignificant relationship between natural logarithms of TFP and load factor. The second regression TFP1 shows negative and statistically significant relationship between natural logarithms of TFP and output. These results might be misleading since we have assumed that the relationship between load factor and TFP, & output and TFP is the same for all firms and time points. TFP0 and TFP1 is very simple model, which might make it elegant, but the adjustments are very often *ad hoc*, lacking in theoretical depth. Thus, it is not a simple matter to test hypotheses of interest from such a restrictive model. TFP2 is similar to TFP1 with Load factor as an additional explanatory variable. These models are restrictive in the sense that they ignore variables reflecting managerial and technical differences between firms and/or variables that reflect general conditions affecting the productivity of all firms but that are fluctuating over time. Ideally, such firm- and time-effects variables should be explicitly introduced into these models. Econometricians have recognized that it is important in the analysis of panel data (cross sections of time series) to allow for effects related to each time period and to each cross-section unit. Here these effects represent differences in TFP associated with firms and with time that are not accounted for by differences in output, and load factor. Such effects can be captured by using either fixed or random effects model. This study specify a fixed-effects model (analysis of covariance):

$\ln TFP_{it} = \alpha + \sum_i \mu_i + \sum_t \lambda_t + \beta_{OP} \ln OP_{it} + \beta_{LF} \ln LF_{it}$ **(5)**

where i = 1, 2, .., 20; t = 1983-84, 1984-85, .., 1995-96.

λ_t are the effects associated with years prior to 1996-97, and the μ_i are the effects associated with firms other than PTC (Pallavan Transport). Hence, α represents the intercept for PTC in 1996-97. The level regression of **(5)** is obtained by appending a classical additive disturbance term. The result of this regression is presented in TFP5 of Table 8. TFP5 shows positive coefficients of both output and load factor with individual statistical significance. TFP3 is a fixed effects model with only output as an explanatory variable, and is nested in TFP5. LR test shows that TFP3 is statistically dominated by TFP5.

Three alternative TFP regression models (TFP2, 4, & 5) which are reported in Table 8, include two basic variables (output, and load factor). The difference between models lies in the way in which year and firm dummy variables are incorporated. TFP2 has the simplest model specification, doesn't include any dummy. TFP4 includes year dummies only, where as TFP5 includes both year dummies and firm dummies. TFP5 has accounted for the effects of those omitted variables that are specific to individual cross-sectional units but stay constant over time, and the effects that are specific to each time period but are the same for all cross-sectional units. Statistical tests shows that TFP5 model is the best model to analyze the differences in productivity among the STUs.[18]

[18] TFP0 is nested in TFP2, TFP4, and TFP5, and is obviously statistically dominated by each of them. TFP1 is nested in TFP2, the log likelihood ratio test between TFP1 and TFP2 yields a test statistic of 3.04. The critical value of χ^2 distribution with 1 degree of freedom at 5% level of significance is 3.84, which implies that TFP2 is not statistically superior to TFP1. TFP3 is nested in TFP5, and is statistically dominated by TFP5. LR test yields a test statistic of 83.06, which is significantly larger than 3.84 – the critical value of χ^2 distribution with 1 degree of freedom at 5% level of significance. TFP2 is nested in TFP4, and is statistically dominated by TFP4. Similarly, TFP4 is nested in TFP5, and is statistically dominated by TFP5. The log likelihood ratio test between TFP2 and TFP4 yields a test statistic of 28.12 (=2* (20.66-6.60)), which is significantly larger than 22.36 – the critical value of χ^2 distribution with 13 degrees of freedom at 5% level of significance. The LR test between TFP4 and TFP5 yields a test statistic of 640.54, which is significantly larger than 31.41 – the critical value χ^2 distribution with 20 degrees of freedom at 5% level of significance. Therefore, TFP5 is statistically preferred over the other two models.

Table 8. TFP regression results based on panel data analysis[19]

Parameter	TFP0	TFP1	TFP2	TFP3	TFP4	TFP5
Constant	-0.860	0.903	0.231	-3.589	0.614	-4.838
	(2.06)	(5.90)	(0.56)	(12.67)	(1.46)	(17.03)
Output		-0.117	-0.117	0.375	-0.133	0.281
		(7.07)	(7.09)	(12.28)	(8.09)	(9.87)
Load factor	0.160		0.157		0.126	0.473
	(1.64)		(1.74)		(1.40)	(9.04)
1983-84				-0.003	-0.242	-0.031
				(0.08)	(3.36)	(1.10)
1984-85				-0.002	-0.208	-0.031
				(0.05)	(2.89)	(1.13)
1985-86				-0.016	-0.184	-0.025
				(0.53)	(2.56)	(0.94)
1986-87				-0.022	-0.153	-0.015
				(0.75)	(2.13)	(0.57)
1987-88				-0.036	-0.138	-0.021
				(1.22)	(1.92)	(0.80)
1988-89				-0.035	-0.106	-0.029
				(1.22)	(1.47)	(1.16)
1989-90				-0.042	-0.083	-0.045
				(1.47)	(1.16)	(1.77)
1990-91				-0.084	-0.126	-0.101
				(2.90)	(1.77)	(4.02)
1991-92				-0.060	-0.082	-0.061
				(2.08)	(1.14)	(2.44)
1992-93				-0.058	-0.072	0.052
				(2.02)	(1.00)	(2.07)
1993-94				-0.041	-0.429	-0.019
				(1.43)	(0.59)	(0.74)
1994-95				-0.031	-0.043	-0.022
				(1.06)	(0.61)	(0.88)
1995-96				-0.002	0.012	0.00003
				(0.06)	(0.17)	(0.001)
				+ FDs		+ FDs
No. of obs.	294	294	294	294	294	294
No. of parameters	2	2	3	35	16	36
R-square	0.009	0.146	0.155	0.885	0.232	0.912
Adj. R-square	0.006	0.143	0.149	.870	0.191	0.899
Log-Likelihood	-16.83	5.08	6.60	299.40	20.66	340.93

Comparison of TFP2 and TFP4 shows the statistical significance of time-specific effects. Also, while comparing TFP4 and TFP5, it can be noticed that there is statistically significant presence of firm specific effects. Coefficient of output in every model of Table 8 is statistically significant. It's sign is positive in the Models which include time as well as firm specific effects. If we account for the effects of those omitted variables that are specific to

[19] T-values in parentheses; all variable except dummies are in natural log. PTC (1996-97) is taken as reference. FDs stands for firm dummies. The parameters estimates for the firm dummies are not reported here due to space limitation.

individual State Transport Undertakings but stay constant over time, and the effects that are specific to each time period but are same for all the STUs, then productivity seems to be positively related with output and load factor. TFP5 regression result shows that if other things are same then it is most likely to experience the growth in productivity if output and/or load factor is increased. Regression results of Table 6, 7, and 8 indicate that there is strong relationship between TFP and output in Passenger Road Transport Industry in India. Perhaps because of economies resulting from the filling of excess capacity and economies resulting from larger firm size – often referred to as short-run and long-run scale economies, respectively. This study is not aware of any prior evidence of economies due to firm size in the industry. Positive coefficient on load factor suggests that filling of excess capacity is at least a partial explanation for the growth of TFP in the 1983-84 to 1996-97 period. However, load factor does not provide a complete picture of capacity utilization, since it only indicates the utilization of available seats.

Productivity varies due to differences in production technology, differences in the efficiency of the production process, and differences in the environment in which production takes place. Econometric approach to decompose the productivity change is basically based on cost function estimation. Further research into the possibility of cost function estimation, and cost function based TFP measures would clearly be desirable.

Summary and Concluding Remarks

Twenty one State Road Transport Undertakings are compared on the basis of levels and rates of growth of output, load factor, labor productivity, and total factor productivity. Annual estimates have been presented for the years 1983-84 to 1996-97. I have found wide variations among the STUs for all of these measures. The largest STU, APSRTC, had an output index in 1996-97 that was nearly sixteen times as large as that of the smallest STU, MPTC. The most productive and least productive STUs in 1996-97 were PATC and BEST respectively. These STUs were dissimilar in size, having the 18^{th} and 8^{th} rank in output production, but PATC's TFP index was 210% higher than the BEST's. The average annual growth of productivity ranged from a low of –3.15% for DTC to a high of 5.46% for PATC. I have investigated whether the large differences in TFP levels are associated with differences in total output, and system load factor. I have found, however, that TFP is positively related to output and load factor (TFP5 of Table 8). One interpretation of my results could be that the differences in the levels of TFP reflect differences in managerial efficiency because firm specific effects are playing major role in explaining the differences in TFP.

Table A4 shows productivity indexes for passenger road transport industry. One of the most general TFP index (proposed by Caves and Christensen) shows that average growth of productivity in this industry was around 1.33 percent per annum for the sample period 1983-84 to 1996-97. Industry experienced decline in productivity for three years – 1989-90 to1990-91, 1992-93 to 1993-94, and 1995-96 to 1996-97.

It is clear that modeling the determinants of total factor productivity and estimating the contributions of various factors that affect TFP growth are affected by quality of data used. It is important to recognize that the passenger-kms are not homogeneous. This study ignores the differences in quality of output. I also assume that the quality of machinery and equipment, and the utilization of labor force is same for all STUs. Impact of public infrastructure (e.g., quality of road), and network structure on the productivity of STUs is also ignored for this study due to unavailability required data set. It is felt that there should be continuous and increased effort to improve the quality of data to achieve more realistic picture. As data become available, I intend to update my estimates and to study further the relationships among TFP, network configuration, individual firm characteristics, and the degree of regulation.

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Appendix

Table A1

Ratio of Revenue Pass.-Kms to Employees for STUs, 1983-84 to 1996-97, Indexes

	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97
MSRTC	0.546	0.581	0.670	0.684	0.694	0.730	0.724	0.668	0.683	0.694	0.697	0.741	0.806	0.819
APSRTC	0.603	0.640	0.699	0.720	0.743	0.767	0.793	0.714	0.743	0.791	0.788	0.848	0.849	0.796
KnSRTC	0.815	0.865	0.840	0.755	0.819	0.868	0.870	0.863	0.897	0.901	0.860	0.950	1.044	0.855
GSRTC	0.780	0.823	0.820	0.917	0.855	0.870	0.911	0.849	0.843	0.879	0.722	0.780	0.983	1.051
UPSRTC	0.469	0.431	0.491	0.553	0.525	0.561	0.580	0.570	0.620	0.585	0.618	0.581	0.638	0.601
KSRTC	0.478	0.517	0.474	0.531	0.605	0.641	0.655	0.639	0.684	0.708	0.760	0.788	0.783	0.727
RSRTC	0.694	0.726	0.679	0.679	0.747	0.708	0.714	0.607	0.738	0.876	0.898	1.000	1.045	1.050
MPSRTC	0.490	0.492	0.435	0.451	0.522	0.571	0.592	0.594	0.547	0.506	0.539	0.501	0.468	0.472
STPJB	1.037	0.941	0.990	0.913	0.954	0.951	1.036	0.851	0.900	0.903	0.889	0.895	0.938	0.819
CTC	1.024	1.018	1.028	0.909	0.924	0.954	0.976	1.018	1.057	1.093	1.428	1.245	1.324	1.401
PRC	1.502	1.118	1.125	1.043	1.048	1.136	1.068	1.159	1.034	1.079	1.128	1.253	1.286	1.387
TTC	0.952	1.087	0.953	1.178	1.071	1.159	1.211	1.234	1.110	1.251	1.265	1.058	1.249	1.202
TPTC	1.225	1.314	1.374	1.442	1.308	1.328	1.288	1.347	1.296	1.297	1.346	1.413	1.575	1.608
JTC	1.024	0.982	0.986	1.009	0.991	1.136	1.140	1.224	1.170	1.281	1.397	1.423	1.478	1.492
ATC	0.804	0.741	0.829	0.799	1.116	1.136	1.093	1.148	1.145	1.168	1.246	1.250	1.341	1.401
CRC	1.081	1.128	1.173	1.090	0.991	1.123	1.106	1.135	1.167	1.249	1.157	1.328	1.569	1.651
PATC	0.768	1.149	1.167	1.192	1.230	1.218	1.323	1.307	1.277	1.361	1.453	1.574	1.569	1.669
MPTC	1.194	1.111	1.184	1.060	1.058	1.102	1.126	1.222	1.275	1.354	1.337	1.691	1.799	1.661
DTC	0.717	0.817	0.746	0.843	0.923	0.656	0.722	0.676	0.679	0.567	0.707	0.476	0.433	0.425
BEST	0.436	0.479	0.596	0.644	0.503	0.543	0.419	0.446	0.421	0.387	0.415	0.429	0.434	0.406
PTC	0.602	0.654	0.651	0.689	0.672	0.758	0.710	0.730	0.738	0.780	0.770	0.910	1.022	1.000

Ratio of Revenue Pass.-Kms to Employees for STUs, 1983-84 to 1996-97, Growth rates (%)[20]

	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1984-97
MSRTC	6.4	15.4	2.1	1.4	5.2	-0.8	-7.7	2.2	1.6	0.5	6.3	8.7	1.6	3.2
APSRTC	6.2	9.2	3.1	3.2	3.2	3.3	-10.0	4.1	6.5	-0.4	7.6	0.1	-6.2	2.2
KnSRTC	6.1	-2.9	-10.1	8.4	6.0	0.3	-0.8	3.9	0.5	-4.6	10.6	9.8	-18.1	0.4
GSRTC	5.6	-0.4	11.9	-6.8	1.8	4.8	-6.8	-0.7	4.2	-17.8	8.0	26.1	6.9	2.3
UPSRTC	-8.0	13.9	12.7	-5.1	6.8	3.4	-1.8	8.8	-5.7	5.7	-6.0	9.8	-5.8	1.9
KSRTC	8.1	-8.3	12.2	14.0	5.9	2.2	-2.5	7.0	3.5	7.4	3.7	-0.7	-7.1	3.3
RSRTC	4.6	-6.4	-0.1	10.1	-5.2	0.9	-15.1	21.7	18.7	2.5	11.3	4.6	0.5	3.2
MPSRTC	0.4	-11.6	3.7	15.8	9.4	3.6	0.4	-7.9	-7.4	6.4	-7.0	-6.5	0.7	-0.3
STPJB	-9.3	5.2	-7.7	4.4	-0.3	9.0	-17.8	5.7	0.4	-1.6	0.6	4.8	-12.7	-1.8
CTC	-0.6	1.0	-11.6	1.7	3.3	2.3	4.3	3.9	3.4	30.6	-12.8	6.3	5.8	2.4
PRC	-25.5	0.6	-7.2	0.4	8.4	-6.0	8.5	-10.8	4.4	4.6	11.1	2.6	7.8	-0.6
TTC	14.2	-12.4	23.6	-9.1	8.2	4.5	1.9	-10.1	12.7	1.1	-16.4	18.0	-3.8	1.8
TPTC	7.2	4.6	5.0	-9.3	1.6	-3.0	4.6	-3.8	0.1	3.8	5.0	11.5	2.1	2.1
JTC	-4.1	0.3	2.3	-1.8	14.7	0.3	7.4	-4.4	9.5	9.1	1.9	3.8	1.0	2.9
ATC	-7.9	11.9	-3.6	39.7	1.8	-3.8	5.0	-0.2	2.0	6.7	0.4	7.2	4.5	4.4
CRC	4.4	4.0	-7.1	-9.1	13.3	-1.5	2.6	2.8	7.1	-7.3	14.7	18.2	5.2	3.3
PATC	49.5	1.6	2.2	3.2	-1.0	8.6	-1.2	-2.3	6.5	6.8	8.3	-0.3	6.4	6.1
MPTC	-7.0	6.6	-10.4	-0.2	4.1	2.2	8.5	4.3	6.2	-1.2	26.4	6.4	-7.7	2.6
DTC	14.0	-8.8	13.1	9.5	-29.0	10.2	-6.5	0.4	-16.5	24.7	-32.7	-8.9	-2.0	-3.9
BEST	10.0	24.4	8.0	-22.0	8.1	-22.9	6.5	-5.6	-7.9	7.1	3.3	1.4	-6.6	-0.5
PTC	8.7	-0.5	5.9	-2.5	12.8	-6.4	2.8	1.1	5.8	-1.4	18.3	12.3	-2.2	4.0

[20] 1984-85 signifies 1983-84 to 1984-85 and so on; whereas 1984-97 signifies 1983-84 to 1996-97.

Table A2

Ratio of Available Pass.-Km to Employees for STUs, 1983-84 to 1996-97, Indexes

	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97
MSRTC	0.821	0.838	0.945	0.949	0.986	1.014	1.013	0.967	1.019	1.055	1.120	1.174	1.228	1.255
APSRTC	0.680	0.721	0.819	0.839	0.894	0.898	0.929	0.871	0.887	0.935	0.978	0.987	1.015	0.994
KnSRTC	1.052	1.088	1.109	1.053	1.102	1.131	1.091	1.083	1.110	1.169	1.168	1.216	1.108	1.287
GSRTC	1.115	1.217	1.253	1.331	1.411	1.392	1.408	1.353	1.401	1.404	1.454	1.448	1.461	1.490
UPSRTC	0.746	0.744	0.781	0.649	0.743	0.781	0.780	0.733	0.764	0.764	0.799	0.799	0.881	0.798
KSRTC	0.570	0.586	0.525	0.571	0.637	0.678	0.690	0.651	0.689	0.739	0.790	0.931	1.006	0.970
RSRTC	0.814	0.846	0.859	0.857	0.928	0.876	0.834	0.679	0.880	0.994	1.111	1.212	1.296	1.265
MPSRTC	0.638	0.624	0.625	0.634	0.675	0.698	0.681	0.645	0.696	0.638	0.599	0.568	0.582	0.552
STPJB	1.141	1.006	1.084	1.035	1.128	1.100	1.184	1.063	1.105	1.102	1.161	1.201	1.331	1.074
CTC	1.100	1.034	1.146	1.688	1.742	1.744	1.353	1.315	1.408	1.502	1.829	1.660	1.709	1.737
PRC	2.086	1.492	1.543	1.472	1.531	1.605	1.504	1.444	1.274	1.220	1.586	1.637	1.628	1.665
TTC	1.057	1.224	1.110	1.311	1.230	1.265	1.299	1.219	1.263	1.267	1.411	1.107	1.275	1.218
TPTC	1.466	1.455	1.593	1.706	1.631	1.624	1.659	1.641	1.584	1.663	1.621	1.646	1.723	1.716
JTC	1.414	1.462	1.812	2.043	1.879	1.547	1.629	1.583	1.632	1.776	1.910	1.900	1.853	1.711
ATC	1.010	1.320	1.543	1.516	1.531	1.583	1.501	1.634	1.516	1.499	1.662	1.635	1.729	1.789
CRC	1.641	1.485	1.585	1.906	1.444	1.534	1.442	1.137	1.469	1.597	1.499	1.666	1.796	1.821
PATC	1.185	1.290	1.369	1.427	1.567	1.558	1.556	1.514	1.545	1.720	1.756	1.818	1.680	1.655
MPTC	1.483	1.432	1.616	1.537	1.490	1.502	1.638	1.602	1.603	1.727	1.700	1.817	1.877	2.144
DTC	0.735	0.870	0.771	0.775	0.771	0.657	0.551	0.614	0.606	0.608	0.890	0.516	0.470	0.455
BEST	0.571	0.568	0.584	0.604	0.600	0.598	0.532	0.543	0.552	0.582	0.589	0.588	0.592	0.586
PTC	0.648	0.666	0.662	0.690	0.728	0.845	0.766	0.738	0.735	0.774	0.754	0.933	1.088	1.000

Ratio of Available Pass.-Km to Employees for STUs, 1983-84 to 1996-97, Growth rates (%)[21]

	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1984-97
MSRTC	2.1	12.8	0.4	4.0	2.8	-0.1	-4.5	5.4	3.5	6.2	4.8	4.6	2.2	3.3
APSRTC	6.0	13.6	2.4	6.5	0.4	3.4	-6.2	1.8	5.4	4.6	0.9	2.9	-2.1	3.0
KnSRTC	3.4	2.0	-5.1	4.7	2.6	-3.5	-0.8	2.5	5.3	-0.1	4.2	-8.9	16.2	1.6
GSRTC	9.1	3.0	6.2	6.0	-1.3	1.1	-3.9	3.5	0.2	3.6	-0.4	0.9	2.0	2.3
UPSRTC	-0.2	5.0	-16.9	14.5	5.2	-0.2	-6.0	4.2	0.0	4.5	0.0	10.3	-9.4	0.5
KSRTC	2.9	-10.4	8.6	11.7	6.4	1.8	-5.7	5.8	7.3	6.9	17.8	8.1	-3.6	4.2
RSRTC	4.0	1.5	-0.3	8.3	-5.6	-4.7	-18.6	29.6	12.9	11.8	9.1	6.9	-2.4	3.5
MPSRTC	-2.2	0.2	1.4	6.4	3.4	-2.3	-5.3	7.8	-8.3	-6.1	-5.2	2.5	-5.1	-1.1
STPJB	-11.9	7.8	-4.6	9.0	-2.5	7.7	-10.2	3.9	-0.3	5.3	3.5	10.8	-19.3	-0.5
CTC	-6.0	10.7	47.3	3.2	0.1	-22.4	-2.8	7.1	6.7	21.7	-9.2	2.9	1.6	3.6
PRC	-28.5	3.4	-4.6	4.0	4.8	-6.3	-4.0	-11.8	-4.3	30.0	3.2	-0.6	2.3	-1.7
TTC	15.7	-9.3	18.0	-6.2	2.8	2.8	-6.2	3.7	0.3	11.4	-21.5	15.1	-4.5	1.1
TPTC	-0.7	9.5	7.1	-4.4	-0.4	2.1	-1.1	-3.5	4.9	-2.5	1.6	4.7	-0.4	1.2
JTC	3.4	23.9	12.8	-8.0	-17.7	5.3	-2.8	3.1	8.8	7.5	-0.5	-2.5	-7.6	1.5
ATC	30.7	16.9	-1.8	1.0	3.4	-5.2	8.8	-7.2	-1.1	10.9	-1.6	5.8	3.4	4.5
CRC	-9.5	6.7	20.3	-24.2	6.2	-6.0	-21.1	29.2	8.7	-6.1	11.1	7.8	1.4	0.8
PATC	8.8	6.1	4.3	9.8	-0.6	-0.1	-2.7	2.0	11.3	2.1	3.5	-7.6	-1.5	2.6
MPTC	-3.4	12.8	-4.9	-3.1	0.8	9.1	-2.2	0.0	7.7	-1.6	6.9	3.3	14.2	2.9
DTC	18.4	-11.3	0.5	-0.6	-14.8	-16.1	11.4	-1.3	0.4	46.3	-42.0	-9.0	-3.3	-3.6
BEST	-0.5	2.8	3.5	-0.8	-0.2	-11.2	2.2	1.5	5.4	1.2	-0.2	0.8	-1.1	0.2
PTC	2.7	-0.5	4.1	5.6	16.0	-9.3	-3.8	-0.3	5.3	-2.6	23.7	16.5	-8.1	3.4

[21] 1984-85 signifies 1983-84 to 1984-85 and so on; whereas 1984-97 signifies 1983-84 to 1996-97.

Table A3

Number of employees index/aggregate input index

	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97
MSRTC	1.088	1.083	1.036	1.042	1.044	1.021	1.022	1.033	1.028	1.022	1.002	0.989	0.971	0.964
APSRTC	1.123	1.103	1.075	1.070	1.060	1.044	1.038	1.062	1.047	1.032	1.021	1.014	1.004	1.009
KnSRTC	0.933	0.923	0.937	0.960	0.943	0.939	0.949	0.950	0.946	0.935	0.935	0.913	0.906	0.908
GSRTC	1.033	0.997	0.991	0.976	0.964	0.976	0.977	0.989	0.984	0.977	0.967	0.949	0.942	0.937
UPSRTC	1.088	1.081	1.084	1.081	1.057	1.040	1.041	1.050	1.042	1.041	1.035	1.027	1.012	1.046
KSRTC	1.159	1.150	1.176	1.137	1.093	1.058	1.045	1.061	1.048	1.030	1.003	0.973	0.956	0.981
RSRTC	1.032	1.024	1.027	1.033	1.001	1.024	1.031	1.096	1.014	0.970	0.924	0.915	0.857	0.862
MPSRTC	1.112	1.120	1.111	1.109	1.076	1.056	1.068	1.086	1.090	1.110	1.121	1.144	1.131	1.134
STPJB	0.835	0.877	0.861	0.880	0.856	0.871	0.852	0.865	0.854	0.855	0.842	0.837	0.852	0.879
CTC	0.893	0.914	0.903	0.900	0.886	0.892	0.895	0.894	0.898	0.887	0.819	0.891	0.892	0.877
PRC	0.890	0.900	0.905	0.941	0.920	0.912	0.942	0.950	0.972	0.943	0.916	0.891	0.906	0.885
TTC	0.918	0.858	0.909	0.841	0.876	0.874	0.867	0.403	0.886	0.874	0.809	0.839	0.786	0.852
TPTC	0.853	0.864	0.833	0.831	0.863	0.870	0.862	0.872	0.898	0.880	0.868	0.862	0.861	0.847
JTC	0.881	0.848	0.898	0.856	0.899	0.890	0.871	0.878	0.890	0.858	0.829	0.832	0.841	0.861
ATC	0.891	0.933	0.886	0.896	0.891	0.884	0.910	0.965	0.913	0.905	0.883	0.887	0.879	0.869
CRC	0.904	0.902	0.877	0.912	0.932	0.895	0.902	0.931	0.925	0.890	0.894	0.835	0.823	0.818
PATC	0.941	0.891	0.896	0.876	0.858	0.868	0.887	0.899	0.905	0.857	0.852	0.831	0.866	0.865
MPTC	0.877	0.915	0.873	0.909	0.926	0.893	0.876	0.889	0.898	0.875	1.022	0.832	0.826	0.824
DTC	1.075	1.067	1.045	1.070	1.042	1.115	1.199	1.123	1.129	1.129	1.116	1.154	1.191	1.199
BEST	1.192	1.190	1.178	1.217	1.160	1.147	1.357	1.279	1.182	1.172	1.147	1.141	1.142	1.146
PTC	1.116	1.107	1.108	1.089	1.083	1.039	1.093	1.066	1.076	1.061	1.082	1.015	0.966	1.000

Table A4

Comparisons of Productivity Indexes (Industry Level Data)[22]

	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97
TFP(CC)	0.8419	0.8734	0.8935	0.9254	0.9323	0.9466	0.9713	0.8784	0.9478	0.9527	0.9452	0.9687	1.0269	1.0000
TFP(D)	0.8427	0.8735	0.8940	0.9266	0.9325	0.9459	0.9693	0.8784	0.9469	0.9522	0.9451	0.9694	1.0273	1.0000
TFP(L)	0.8332	0.8668	0.8891	0.9209	0.9296	0.9443	0.9679	0.8761	0.9445	0.9507	0.9445	0.9692	1.0273	1.0000
LP	0.7849	0.8209	0.8513	0.8835	0.8978	0.9169	0.9299	0.8885	0.9089	0.9240	0.9291	0.9640	1.0336	1.0000
BP	0.8478	0.8716	0.8993	0.9361	0.9444	0.9685	0.9970	0.9472	0.9681	0.9691	0.9585	0.9761	1.0295	1.0000

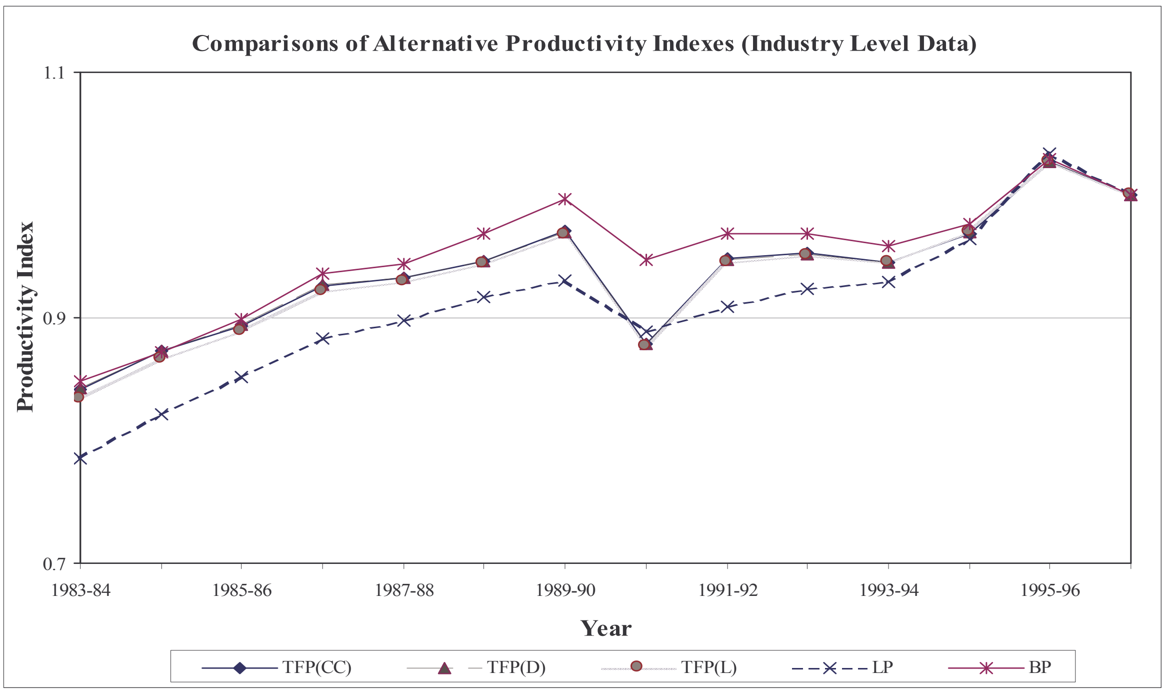
[22] For this study, road transport industry consists 21 STUs. All calculation is done on the basis of selected firms. TFP(CC), TFP(D), and TFP(L) signify Total Factor Productivity (Caves and Christensen) Index, Total Factor Productivity (Divisia) Index, and Total Factor Productivity (Laspeyres) Index respectively. LP and BP denote Partial Productivity Index for Labor and Partial Productivity Index for Bus (Capital) respectively. This study takes 1996-97 as a base year for calculation of these indexes. Growth rates (in %) of TFP(CC) for the periods of 1983-84 to 1984-85, 1984-85 to 1985-86, …., 1995-96 to 1996-97, and 1983-84 to 1996-97 are as follows: 3.74, 2.30, 3.57, 0.75, 1.53, 2.61, -9.56, 7.90, 0.52, -0.79, 2.49, 6.01, -2.62, and 1.33.

Table A4 contd.

Correlation among different indexes (Industry Level Data)[23]

	TFP(CC)	TFP(D)	TFP(L)	LP	BP
TFP(CC)	1.0000	0.9999 (226.22)	0.9996 (126.97)	0.9603 (11.92)	0.9391 (9.47)

Figure 1



[23] T-values in parentheses. Tabulated "t" statistic- 2.179 at 12 degrees of freedom.

Figure 2A

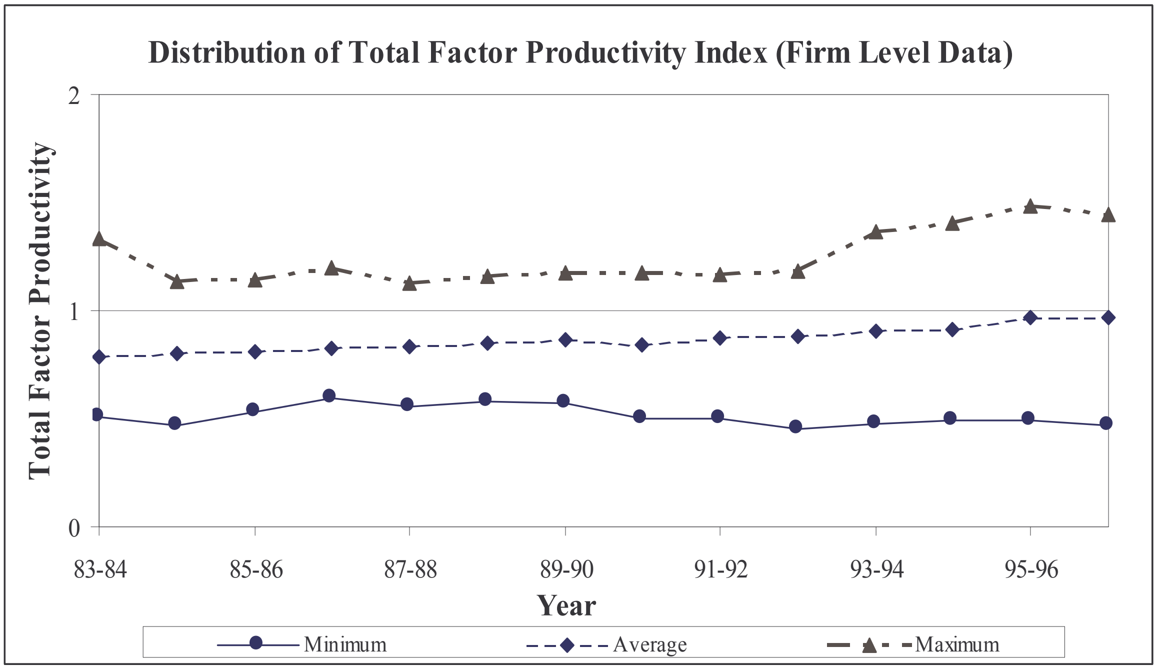


Figure 2B