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Yardstick regulation and the operators' productivity of railway industry in Japan, Research in Transportation Economics (in press)

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ABSTRACT

In Japan, the yardstick regulation was implemented as an incentive only for large private railway companies, in 1997. This study examined the effects of yardstick regulation on productivity of private railway companies by comparing TFP (Total Factor Productivity) of a large private railway group with that of a small private railway group in Kansai metropolitan area. We interpreted a railway's service to conduct the stratified 3T activities; Track, Train and Transport and estimated TFP for individual and total 3T activities. Estimation results showed that both railway groups had increased their TFP of total 3T activities contributed by productivity improvements of track and train activities since 1997. On the other hand, we could not find obvious evidences to show that the yardstick regulation for large railway companies had generated productivity improvements compared with small railway companies to which the traditional rate of return regulation is applied.

1. Introduction

The yardstick regulation with multiple regression analysis was implemented for fifteen large private railway companies, six JRs and ten subways in 1997, while it was not applied to small private railway companies. Mizutani et al. (2009) estimated the variable frontier cost function by using data set of large and small private railway companies. They found that large railways to which the yardstick regulation was applied could have improved cost efficiency by 11.5% between 1995 and 2000. However, statistical significance of the yardstick regulation explained by dummy variable as the evidence of efficiency improvement was observed only at 10% level, therefore its effect might be marginal. Nakayama (2013) compared the productivity trends before and after 1997 by measuring Sequential Malmquist index for fifteen large private railways between 1991 and 2001. He found that average of productivity of fifteen railways had been improved since 1997, while some railway companies had deteriorated. As stated above, it is hard to say that there was a decisive evaluation whether the yardstick regulation had improved operators' productivity or not.

Therefore, we conduct empirical analysis for the effects of yardstick regulation on operating productivity by estimating the activity based TFP (Total Factor Productivity) to compare among large private railways and small private railways in Kansai metropolitan area where includes three large cities, Osaka, Kyoto and Kobe, and has fifteen million people. This article consists of four sections. In section 2, we describe the rail fare regulation scheme in Japan including the yardstick regulation followed by section 3 to estimate TFP and present our conclusion with the research results in section 4.

2. Rail fare regulation scheme in Japan

2.1 Full cost pricing

In Japan, railway fares are regulated by the full cost pricing concept regulation using the following constraint equation:

Revenue requirement = Operating costs + Depreciation + Taxes + Interest + Fair return

The relationship of each factor is drawn in Figure 1. Railway fares for each sector between stations are calculated under the full cost constraint, and the full cost on three-year average is considered when fare is revised. The details of regulation are different in two points among large and small railways. Firstly, it is the difference in definition of fair return. For small private railways, it is defined as the necessary earnings to pay dividend of 10% on equity capital, while it is defined as the rate base multiplied by fair rate of return for large private railways[1]. Secondly, it is the difference in estimation of operating costs. One is the yardstick regulation applicable to large private railways, JRs and subways. The other is the one that sums up total costs applicable to small private railways.

2.2 Yardstick regulation

The current yardstick regulation scheme was implemented in 1997. Since 1970's until 1997, the regulatory authority in Japan, Ministry of Land, Infrastructure, Transport and Tourism (MLIT) had conducted internal calculation of the original productivity index for each large private railway. MLIT had used these indexes when they assessed a proposal of fare tariff revision applied from a large private railway company. In some cases, the applied fare tariff had been discounted after comparing its applicant's productivity with others. Ishii (1996) argued that these indexes could be recognized as a similar kind of yardstick regulation but such indexes might not induce incentive to compete among railway companies. Because the detail of index evaluation procedure was disclosed neither to the public nor to railway companies, therefore railway companies could not find out a way to improve their productivity index.

In 1997 MLIT officially implemented the yardstick regulation with multiple regression analysis to reveal yardstick costs. As shown in Figure 2, if standard cost, which is estimated by the regression analysis, is lower than actual cost, a railway is regarded "inefficient" and standard cost is recognized as the yardstick cost. On the other hand, if standard cost is higher than

[1] For instance, fair rate of return was 5.1% in 1997 and 4.7% in 1998 when some large private railways revised their fares. Rate base regulation entails a possibility of Averch-Johnson effects however, we cannot find a report which concluded these effects had existed in the railway industry in Japan.

actual cost, a railway is regarded "efficient" and actual cost with bonus (half of the difference between actual cost and standard cost) is recognized as the yardstick cost. It means that a railway is allowed to obtain half of its cost-cutting efforts as profit and it should be an incentive to improve operating productivity, since a railway can revise its fare tariff based on its new revenue requirement with bonus.

The regressed parameters, actual and standard costs of each railway are disclosed to maintain transparency of the regulation and to induce railways' motivation for their productivity improvement.

The yardstick cost is estimated as following procedures:

1. We break down the actual operating costs into five cost groups;
   (1) Rail maintenance cost
   (2) Electric line maintenance cost
   (3) Vehicle maintenance cost
   (4) Vehicle operation cost
   (5) Station operation cost
2. We calculate the actual unit cost per facility volume.
3. Multiple regression analysis is applied to specify the relationship between the actual unit cost (y: dependent variable) and explanatory factors to reflect the environment of each railway (x_i: independent variables).
   The linear model ($y=ax_1+bx_2+cx_3+d$ [a,b,c,d:parameters]) is adopted and Table 1 shows the details of definition of variables for large private railways.
4. The standard unit costs for each cost group are derived after substituting the independent variables in Table 1 into the regression model with estimated parameters.
5. The standard costs are calculated by multiplying the standard unit cost and facility volume.
6. The yardstick costs for each cost group are determined by comparing the actual operating costs and the standard operating costs with the yardstick regulation rule as mentioned above.
7. We have total yardstick costs by summing up the yardstick costs of five cost groups.
8. The three-year average of the total yardstick costs are used for a fare tariff revision.

For example, the results of multi regression analysis in 2000 are as follows[2]:

(1) Rail maintenance cost

$$\textit{Rail maintenance cost per rail-km} = 15{,}729.32^{***}\textit{Vehicle density} + 111.05^{*}\textit{Ratio consisted of tunnel and bridge} - 79{,}945.36^{***}$$

$$R^2=0.84$$

(2) Electric line maintenance cost

$$\textit{Electric line maintenance cost per line-km} = 1{,}153.30^{***}\textit{Electric vehicle density} + 714.18^{**}\textit{Ratio consisted of overhead line} + 48.02^{***}\textit{Ratio consisted of tunnel} - 7{,}205.18^{**}$$

$$R^2=0.74$$

(3) Vehicle maintenance cost

$$\textit{Vehicle maintenance cost per vehicle} = 4{,}716.08^{***}\textit{Passenger-km per vehicle} - 474.27^{***}\textit{Number of vehicles per train} - 31{,}961.16^{***}$$

$$R^2=0.56$$

[2] The details of definition of variables are shown in Table 1. The sample size was fifteen for each regression since the sample includes all (fifteen) large private railways. * denotes significance at 10% level, ** at 5% level and *** at 1% level.

(4) Vehicle operation cost

$$\textit{Vehicle operation cost per route-km} = 86.32^{***}\textit{Passengers per train} + 71{,}617.75^{***}\textit{Train density} - 305{,}052.04^{***}$$

R^2=0.94

(5) Station operation cost

$$\textit{Station operation cost per station} = 16.50^{***}\textit{Passengers per station} + 16{,}493.91^{*}\textit{Elevators and escalators per station} + 28{,}891.75^{*}$$

R^2=0.88

The above estimated results were favourable because all parameters are statistically significant with the reasonable sign of number at least 10% level. However, as these regression models have some problems since a few parameters have not shown reasonable signs of number or statistical significance recently, these regression models should be reconsidered.

Table 2 shows the example of yardstick cost calculation of Keihan railway in 2000. Keihan obtained some bonus in four cost groups except for vehicle operation cost. However, their total yardstick cost was less than the total actual cost since the actual cost of vehicle operation was much lower than the standard cost. As the result, the bonus has been completely offset.

3. Productivity analysis

3.1 Definition of TFP

TFP is an index, which is calculated as a ratio of the aggregated output quantity index Q to the aggregated input quantity index Z. TFP can be defined as a function of time t:

$$TFP(t) = \frac{Q(t)}{Z(t)} \quad (1)$$

Growth rate of TFP is derived as equation (2) and we define that growth rate of Q and Z are given by Divisia index, $\dot{Q} = \sum_i \dot{q}_i r_i$ and $\dot{Z} = \sum_j \dot{z}_j s_j$:

$$\dot{TFP}(t) = \dot{Q}(t) - \dot{Z}(t) \quad (2)$$

where:

Q : the aggregated output quantity;

Z : the aggregated input quantity;

q_i : the quantity of output i;

z_j : the quantity of input j;

r_i : the revenue share of output i to total;

s_j : the cost share of input j to total.

Equation (2) can be rewritten as (3) if we consider our data is not as continuous but as discrete time series data. And if this ratio is more than 1, productivity should improve.

$$\frac{TFP(t+1)}{TFP(t)} = \frac{Q(t+1)}{Q(t)} \bigg/ \frac{Z(t+1)}{Z(t)} \quad (3)$$

Additionally Q and Z are calculated by using a Törnqvist equation as follows:

$$\frac{Q(t+1)}{Q(t)} = \prod_i \left(\frac{q_i(t+1)}{q_i(t)} \right)^{\frac{1}{2}(r_i(t+1)+r_i(t))}, \quad \frac{Z(t+1)}{Z(t)} = \prod_j \left(\frac{z_j(t+1)}{z_j(t)} \right)^{\frac{1}{2}(s_j(t+1)+s_j(t))}$$

3.2 TFP based on 3T activities

We interpret a railway company's service activity in a stratified form in Figure 3 referencing Nakajima et al. (1996). The activity is divided into the three, track, train and transport activity. We call them 3T activities and define the production function F^k for activity k as follows:

1. Track activity $\quad Q^1(t) = F^1\left(\mathbf{z}^1(t)\right)$ (4)
2. Train activity $\quad Q^2(t) = F^2\left(\mathbf{z}^2(t), Q^1(t)\right)$ (5)
3. Transport activity $\quad Q^3(t) = F^3\left(\mathbf{z}^3(t), Q^2(t)\right)$ (6)

The bottom layer is track activity for construction and maintenance of tracks. The rail-km represents the output of track activity, Q^1. $\mathbf{z}^1$ is a vector of input factors for track activity. The output of train activity, Q^2 is defined as running vehicle-km and the inputs are $\mathbf{z}^2$ and Q^1. Equation (4) is substituted for (5), that is, the output of track activity becomes an input factor of train activity. The top layer is transport activity, output Q^3 of which is measured by passenger-km. Equation (5) is substituted for (6), and therefore, $\mathbf{z}^3$ and Q^2 are input into transport activity. In short, we assume that vertical activity separation is conducted in a railway company.

Growth rate of output of activity k is described as equation (7) with Divisia index:

$$\dot{Q}^k(t) = \frac{d\ln Q^k}{dt} = \left(\sum_j s_j^k(t) \frac{d\ln z_j^k}{dt} + s_{Q^{k-1}}^k(t) \frac{d\ln Q^{k-1}(t)}{dt} \right) + \frac{d\ln TFP^k(t)}{dt}$$
$$\equiv \left(\frac{d\ln \tilde{Z}^k(t)}{dt} + s_{Q^{k-1}}^k(t) \frac{d\ln Q^{k-1}(t)}{dt} \right) + \frac{d\ln TFP^k(t)}{dt} \qquad (7)$$

where s_j^k is the cost share of input j to total cost of activity k and $s_{Q^{k-1}}^k$ is the cost share of Q^{k-1} to total cost of activity k as follows:

$$s_j^k(t) = \frac{w_j^k(t) z_j^k(t)}{\sum_h w_h^k(t) z_h^k(t) + p^{k-1}(t) Q^{k-1}(t)}, \quad s_{Q^{k-1}}^k(t) = \frac{p^{k-1}(t) Q^{k-1}(t)}{\sum_h w_h^k(t) z_h^k(t) + p^{k-1}(t) Q^{k-1}(t)}$$

where:

p^k : price of output of activity k;

w_j^k : price of input j of activity k;

and $s_{Q^0}^1(t) = 0$. Additionally, p^k is unknown because the output Q^1 and Q^2 are dealt within one company. We define p^1 and p^2 as following equations after we assume that these transactions are conducted with zero profit:

$$p^1(t) = \frac{\sum_h w_h^1(t) z_h^1(t)}{Q^1(t)}, \quad p^2(t) = \frac{\sum_h w_h^2(t) z_h^2(t) + p^1(t) Q^1(t)}{Q^2(t)}$$

Equation (8) is developed after substituting (7) of lower activity for that of upper activity.

$$\frac{d\ln Q^3(t)}{dt} = s^2_{Q^1}(t)s^3_{Q^2}(t)\frac{d\ln \tilde{Z}^1(t)}{dt} + s^3_{Q^2}(t)\frac{d\ln \tilde{Z}^2(t)}{dt} + \frac{d\ln \tilde{Z}^3(t)}{dt}$$
$$+ s^2_{Q^1}(t)s^3_{Q^2}(t)\frac{d\ln TFP^1(t)}{dt} + s^3_{Q^2}(t)\frac{d\ln TFP^2(t)}{dt} + \frac{d\ln TFP^3(t)}{dt} \quad (8)$$

Equation (8) can be rewritten as (9) for discrete time series data with our specification of production function F^k as Transcendental logarithmic form (Diewert (1976)). And this equation allows us to use Törnqvist index for input and output.

$$\ln\frac{TFP(t+1)}{TFP(t)} = \frac{1}{4}\left[s^2_{Q^1}(t+1) + s^2_{Q^1}(t)\right]\left[s^3_{Q^2}(t+1) + s^3_{Q^2}(t)\right]\ln\frac{TFP^1(t+1)}{TFP^1(t)}$$
$$+\frac{1}{2}\left[s^3_{Q^2}(t+1) + s^3_{Q^2}(t)\right]\ln\frac{TFP^2(t+1)}{TFP^2(t)} + \ln\frac{TFP^3(t+1)}{TFP^3(t)} \quad (9)$$

The above equation denotes that TFP growth of activity for providing total railway service (3T activities) (LHS) can be interpreted as the contribution for TFP growth of track activity (the first term of RHS), that of train activity (the second term of RHS) and that of transport activity (the third term of RHS).

3.3 Data

Definitions of the variables are given in Table 3. We can obtain the input factor data of quantity and cost for each activity. At the first stage as track activity, we define rail-km as output, and labour, capital and other factors as inputs. The rail-km is an actual length of a rail track to reflect number of tracks: for instance, the rail-km of double-track is twice the route-km. Quantity of labour input is measured by number of employees for track activity. With reference to the capital input, we followed Nakayama (2013) which adopted the benchmark year method. Then we set the benchmark year 1989 and derive the quantity of capital by equation (10):

$$K_h(t) = I_h(t-1) + \left[1 - d_h(t) - r_h(t)\right]K_h(t-1) \quad (10)$$

where:

K_h : tangible assets of company h;

I_h : gross capital investment of company h;

d_h : depreciation rate of company h;

r_h : asset retirement rate of company h.

We define the price of other input as Corporate Goods Price Index (CGPI) estimated by the Bank of Japan and we have the quantity of other input by dividing the other cost by CGPI. Secondly, train activity lies on the track activity and its output Q^2 is defined as running vehicle-km which shows not only the train frequency but also the number of vehicles per train. Therefore, vehicle-km divided by train-km is the average number of vehicles per train. The input factors, labour, capital and others are defined as same as the inputs of track activity. The quantity of energy is electricity consumption (kwh), and additional-consumed diesel fuel (kl) is converted to the volume of electricity by the energy relationship used in Mizutani et al. (2009)[3].

[3] Fuel 1kl = Electricity 10,526.9kwh

Finally, transport activity lies on the train activity. The output Q^3 is measured by passenger-km and input factors are labour, capital, others and train activity. The data used in our study comes from the data of each railway company shown in the Annual rail statistics (Tetsudo tokei nempo) edited by MLIT for 1990 to 2011. We extracted the data of five large and five small private railways in Kansai metropolitan area. The selected railways and their outputs for each activity in 2011 are shown in Table 4.

3.4 Estimation results

We summarise the estimation results on the average for the large and small railway groups. Table 5 gives us input cost share for each activity and it is similar for both groups. TFP index of each activity is shown in Figure 4, 5, 6 and 7 with setting the benchmark year 1997 when the yardstick regulation scheme was implemented. In addition, annual growth rate of TFP is broken down into output and input factors in Table 6 and 7 for the respective groups.
Figure 4 shows that TFP of 3T activities (total railway service) for both railway groups had almost same trend, which had decreased until 2001 and increased since 2002. However, when we broke down 3T activities into three elements, we found the productivity trends in each activity had been different between both groups. Firstly, Figure 5 showed that both groups have upward trend for track activity since 1997 and TFP of small railway had improved more than that of large railway. As shown in Table 6 and 7, decreases of input factors had contributed to the track TFP improvement for large railways (-1.65%) and small railways (-1.93%), while their output for both had been stable. TFP of train activity have continuously upward trends during our research period for both and that of small railway had steeper inclination in Figure 6. From Table 6 and 7, train outputs were largely increased until 1997 (large railway: 1.27%, small railway: 2.99%) and increased outputs were considered as main drivers to improve their train TFP. On the other hand, both of their train outputs have been decreased slightly and larger-reduced input factors have brought their TFP improvement since 1997. Transport productivity for both groups had been decreased and that of small railways decreased larger (Figure 7). Therefore, the improved TFP in track and train activity had been partially offset by the worse TFP in transport activity. On the other hand, the decreased transport TFP would reflect mitigation of congestion in the vehicle. Actually, average load factor in the morning peak hour of large railways had been decreased from 168% in 1990 to 125% in 2011 and that of small railways from 157% to 99%. It means quality of transportation had been improved.
Additionally, TFP with Törnqvist index which our study defines is a hybrid of productivity and economies of scale. Therefore, large railways had advantages in scale, but small railways nevertheless improved their productivity more than large railways. As above, we could not find obvious evidences to show that the productivity of large railways with yardstick regulation had been enhanced higher than that of the small railways without yardstick regulation.

4. Conclusion

This study analysed effects of the yardstick regulation for operating productivity of large and small railways in Kansai metropolitan area by estimating TFP in the stratified 3T activity form, that is Track, Train and Transport activity. TFP of total 3T activities have similar upward trends for large private railways with the yardstick regulation and small private railways without the yardstick regulation. We could not find out obvious evidence to show that the yardstick regulation for large private railways had contributed to productivity improvement compared with the traditional full cost pricing regulation for the small private railways. With reference to TFP trends of each broken down activity, we found that TFP improvement of track activity and train activity contributed to the improvement of TFP of total 3T activities.

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Table 1 Definitions of variables in regression model for yardstick regulation (large private railway)

Cost	Dependent variable (unit cost)	Independent variable		
	y	x_1	x_2	x_3
(1) Rail maintenance cost	Rail maintenance cost per rail-km	Vehicle density = ln (vehicle-km / rail-km)	Ratio consisted of tunnel and bridge = (tunnel-km + bridge-km) / rail-km	
(2) Electric line maintenance cost	Electric line maintenance cost per line-km	Electric vehicle density = ln (electric vehicle-km / electrified rail-km)	Ratio consisted of overhead line = ln (overhead line -km / electric line-km)	Ratio consisted of tunnel = length of tunnel / rail-km
(3) Vehicle maintenance cost	Vehicle maintenance cost per vehicle	Passenger-km per vehicle = ln (passenger-km / number of vehicle)	Number of vehicles per train = vehicle-km / train-km	
(4) Vehicle operation cost	Vehicle operation cost per route-km	Passengers per train = passenger-km / train-km	Train density = ln (train-km / route-km)	
(5) Station operation cost	Station operation cost per station	Passengers per station = number of passengers / number of stations	Elevators and escalators per station = (number of elevators + number of escalators) / number of stations	

Note: electric line-km = overhead line-km + feeder line-km

Table 2 Example of the yardstick cost calculation in 2000 (Keihan railway)

		JPY(thousand)
(1) Rail Maintenance cost	Actual Cost	3,342,479
	Standard Cost	4,092,161
	Bonus	374,841
	Yardstick Cost	3,717,320
(2) Electric line maintenance cost	Actual Cost	3,062,428
	Standard Cost	3,262,707
	Bonus	100,140
	Yardstick Cost	3,162,568
(3) Vehicle maintenance cost	Actual Cost	4,439,997
	Standard Cost	4,537,710
	Bonus	48,857
	Yardstick Cost	4,488,854
(4) Vehicle operation cost	Actual Cost	8,570,197
	Standard Cost	7,583,507
	Bonus	0
	Yardstick Cost	7,583,507
(5) Station operation cost	Actual Cost	10,067,580
	Standard Cost	10,929,191
	Bonus	430,806
	Yardstick Cost	10,498,386
Total	Actual Cost	30,137,573
	Yardstick Cost	29,450,636

Note: Bonus = (Standard cost – Actual cost) / 2 if Standard cost > Actual cost
= 0 if Standard cost < Actual cost
Yardstick cost = Actual cost + Bonus

Table 3 Definitions of the variables for TFP estimation

Activity	Output	Input		
	Quantity	Factor	Quantity	Cost
3. Transport	Passenger-km	Labour	Number of employees	Labour cost + Fringe benefit cost
		Capital	By equation(10)	Depreciation cost
		Train	Vehicle-km	Train activity cost
		Other	Cost/CGPI	Maintenance cost + Other cost+ Advertising cost
2. Train	Vehicle-km	Labour	Number of employees	Labour cost + Fringe benefit cost
		Capital	By equation(10)	Depreciation cost
		Energy	Electricity consumption	Energy cost
		Track	Rail-km	Track activity cost
		Other	Cost/CGPI	Maintenance cost + Other cost
1. Track	Rail-km	Labour	Number of employees	Labour cost + Fringe benefit cost
		Capital	By equation(10)	Depreciation cost
		Other	Cost/CGPI	Maintenance cost + Other cost

Table 4 Summary of sample selection and outputs in 2011

Group	Company	Output			Passenger Density
		Rail-km (km)	Vehicle-km (thousand)	Passenger-km (thousand)	(daily PAX / route-km)
Large	Kintetsu	1,051.1	298,506	10,802,141	58,467
	Nankai	307.5	94,843	3,628,775	64,381
	Keihan	204.3	90,600	3,956,986	123,278
	Hankyu	291.3	170,249	8,491,290	161,562
	Hanshin	85.2	44,302	2,058,733	115,030
Small	Kitakyu	12.0	6,649	247,354	114,548
	Senboku	28.5	10,574	447,759	85,551
	Kobe	101.2	18,010	474,106	18,612
	Sanyo	118.1	32,036	780,310	33,734
	Nose	28.4	4,798	145,226	26,810

Table 5 Input cost share on average between 1990 and 2011

Input factor	Large railway				Small railway			
	Activity				Activity			
	Track	Train	Transport	3T activities	Track	Train	Transport	3T activities
Labour	0.31	0.32	0.13	0.45	0.28	0.31	0.11	0.43
Energy		0.09		0.06		0.09		0.07
Capital	0.39	0.07	0.02	0.19	0.44	0.09	0.03	0.24
Other	0.30	0.09	0.13	0.29	0.28	0.09	0.10	0.26
Track		0.43				0.42		
Train			0.71				0.76	

Table 6 Annual average growth rate of TFP and factors (Large railway) (%)

Period	Activity	Output	Input							TFP	
			Labour	Energy	Capital	Other	Track	Train	Total		Contribution
1990-1997	Track	0.69	-0.32		-0.23	0.50			-0.04	0.74	0.18
	Train	1.27	0.10	0.05	0.12	0.25	0.29		0.82	0.44	0.32
	Transport	-1.41	-0.05		0.16	0.49		0.94	1.54	-2.91	-2.91
	3T activities	-1.41	-0.09	0.04	0.22	0.83			1.00	-2.40	
1997-2011	Track	-0.01	-1.32		0.42	-0.75			-1.65	1.67	0.53
	Train	-0.13	-0.64	-0.05	0.11	0.03	-0.00		-0.55	0.42	0.30
	Transport	-1.18	-0.77		0.03	-0.04		-0.10	-0.87	-0.31	-0.31
	3T activities	-1.18	-1.29	-0.03	0.17	-0.27			-1.42	0.24	

Table 7 Annual average growth rate of TFP and factors (Small railway) (%)

Period	Activity	Output	Input							TFP	
			Labour	Energy	Capital	Other	Track	Train	Total		Contribution
1990-1997	Track	0.69	0.35		0.76	0.80			1.91	-1.20	-0.39
	Train	2.99	0.56	0.20	0.38	0.26	0.27		1.67	1.29	0.90
	Transport	0.07	-0.14		0.22	0.58		2.30	2.96	-2.81	-2.81
	3T activities	0.07	0.32	0.15	0.69	1.14			2.31	-2.18	
1997-2011	Track	0.00	1.18		-0.19	-0.57			-1.93	1.97	0.67
	Train	0.07	-0.70	-0.01	-0.27	-0.03	-0.00		-1.01	1.08	0.84
	Transport	-1.77	-0.20		-0.10	-0.46		0.04	-0.72	-1.06	-1.06
	3T activities	-1.77	-0.95	-0.01	-0.53	-0.65			-2.12	0.36	

Full cost	Revenue requirement
Fair return [Small private railways] defined as the necessary earnings to pay dividend of 10% on equity capital [Large private railways / JRs / Subways] defined as the rate base multiplied by fair rate of return	Increased revenue under the revised tariff
Interest Taxes Depreciation Operating costs [Small private railways] defined as the total sum of the actual cost [Large private railways / JRs / Subways] defined as the total yardstick cost	Revenue under the present tariff

Figure 1 Relationship among full cost pricing factors

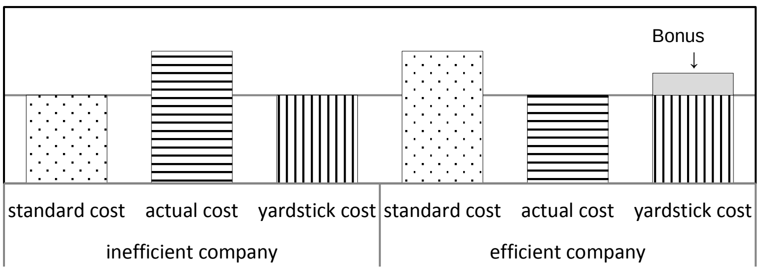

Figure 2 Estimation of yardstick cost

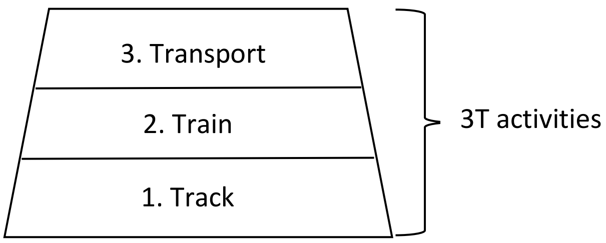

Figure 3 Activity Stratum

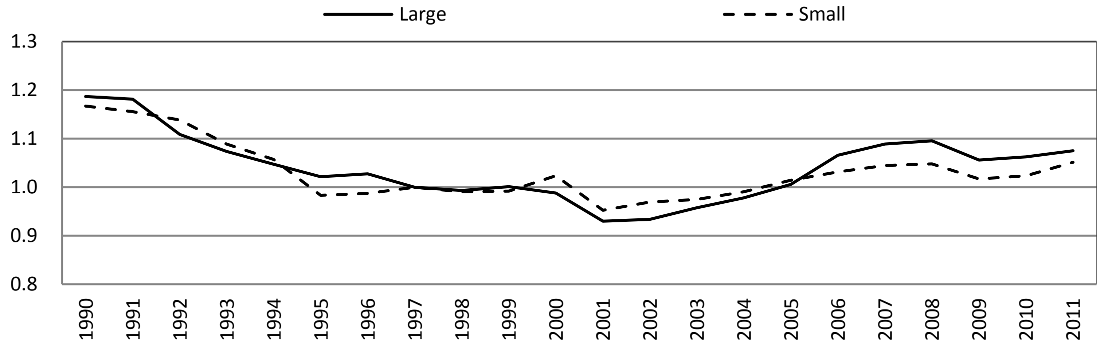

Figure 4 TFP(3T activities) (1997=1)

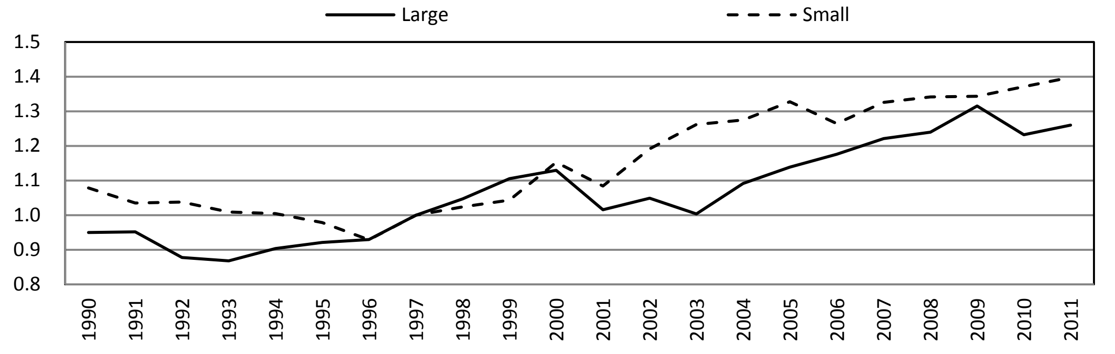

Figure 5 TFP(Track activity) (1997=1)

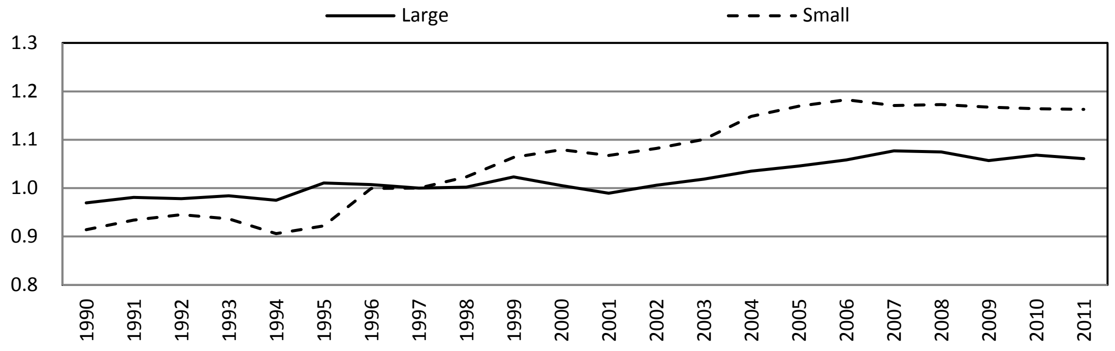

Figure 6 TFP(Train activity) (1997=1)

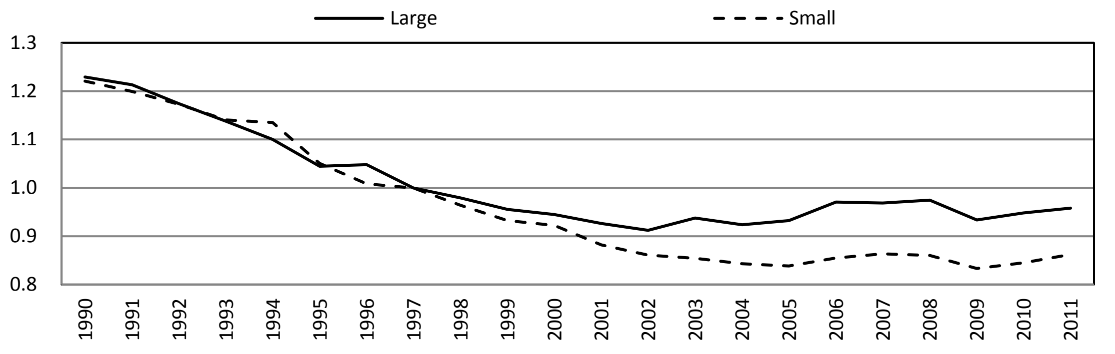

Figure 7 TFP(Transport activity) (1997=1)