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A Private-Public Comaprison of Bus Service Operators

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A Private-Public Comparison of Bus Service Operators[*]

by

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A Private-Public Comparison of Bus Service Operators

[Abstract] Because bus ridership has been steadily declining, bus companies, especially those operating in the public sector, find themselves in the difficult situation of being unable to provide bus service without government assistance. The main purpose of this study is to determine the key factors causing differences in efficiency between private and public bus operators, especially with regard to the following areas: efficiency in service production, wage, and cost. In our analysis, we use the econometric methods to estimate the cost function of bus services and the wage function. Our analytical results suggest that the total operating cost of public bus operators is 20.2% higher than that of private bus operators, and that the wages of public bus operator employees are 14.5% higher than those of private bus operator employees.

[JEL Classification] H32, L51, L92, R40

[Key Words] private–public comparison, efficiency, operating costs, wage, bus industry

1 Introduction

Due to the steady increase in the use of private autos in Japan, the bus business is facing hard times. In particular, bus services owned by public organizations have been struggling with increases in operating deficits and subsidies, so that recently in many cities there has been a call for restructuring. Publicly and privately owned bus operators co-exist in the Japanese market. Although the financial situation of privately owned bus operators is not completely healthy, they have performed better than their publicly owned counterparts. Moreover, a new transportation policy allowing easier entry into the market will be introduced in February, 2002, presumably increasing competition and further highlighting the difficulties faced by the publicly operated bus companies, with the result that there might be calls for their privatization, in a scenario similar to what happened with the former Japan National Railways.

The main purpose of this study is to find the key factors causing differences in efficiency between private and public bus operators, especially in these areas: efficiency in service production, wage, and costs. In this study, we will make an analysis using observations of both private and public bus operators in the Kansai region in Japan for the five years from FY1997 to 2000. After we explain the current situation of the bus industry in Japan, we examine the performance differences between the two sectors. For our analysis, we use econometric methods to estimate the cost function of bus services and the wage function. Based on these functions, we will evaluate the differences in efficiency between private and public bus operators.

2 An Overview of the Bus Service Industry

Although buses provide an important service in public transportation in Japan, the bus industry is in trouble. There are several problems: 1) a continuous decline in ridership; 2) operating deficits; 3) decreasing financial support from the government to operators; 4) large cost differences between public and private operators; and 5) a difficulty in maintaining bus service in small communities. An overview of Japan's route bus transportation can be seen in Table 1.

The number of passengers transported by route bus declined steadily after 1970, when route bus transported about 10 billion passengers up to 2000, when the number had shrunk to 4.8 billion, 47% of the 1970 figure. More surprisingly, the numbers transported by route bus decreased by about 1 billion passengers, a 17% decrease, over a period of only 5 years, from 1995 to 2000. Average usage of bus transportation was about 96 times per person annually in 1970 but had decreased to only 38 times, a dramatic change compared to the less drastic loss of business of other public transportation modes such as railways.

There were 444 route bus operators in 2000, of which 399 operators, or 85%, were privately owned. Even in 1970, 84.4% of all route bus operators were private, showing that private operators have long played an important role in the bus industry. Despite the decrease in the number of passengers, the number of bus companies has increased since 1985, with most companies entering the market being privately owned.

Table 1 Overview of Route Bus Transport in Japan								
Year	1965	1970	1975	1980	1985	1990	1995	2000
Number of passengers (millions)	9,862 (0.98)	10,074 (1.00)	9,119 (0.91)	8,097 (0.80)	6,998 (0.69)	6,500 (0.65)	5,756 (0.57)	4,753 (0.47)
Number of users of bus to total population	98.1 (1.02)	96.4 (1.00)	81.3 (0.84)	69.2 (0.72)	58.0 (0.60)	52.8 (0.55)	46.1 (0.48)	38.0 (0.39)
Vehicle kilometer (millions)	2,636 (0.90)	2,935 (1.00)	2,878 (0.98)	2,910 (0.99)	2,880 (0.98)	3,038 (1.04)	2,956 (1.01)	2,897 (0.99)
Average number of passengers per vehicle	67 (0.93)	72 (1.00)	72 (1.00)	74 (1.03)	74 (1.03)	70 (0.97)	69 (0.96)	67 (0.93)
Average trip length per person (km)	5.4 (1.04)	5.2 (1.00)	5.2 (1.00)	5.1 (0.98)	4.8 (0.92)	5.1 (0.98)	5.3 (1.02)	5.6 (1.08)
Number of operators: Total	362 (1.01)	359 (1.00)	364 (1.01)	355 (0.99)	350 (0.97)	377 (1.05)	404 (1.13)	444 (1.24)
Number of operators: Public operators	54 (0.86)	56 (1.00)	59 (1.05)	58 (1.04)	55 (0.98)	50 (0.89)	48 (0.86)	45 (0.80)
Number of operators: Private operators	308 (0.86)	303 (1.00)	305 (1.01)	297 (0.98)	295 (0.97)	327 (1.08)	356 (1.17)	399 (1.32)
Labor productivity (thousands)	11.0 (0.78)	14.1 (1.00)	16.3 (1.16)	18.8 (1.33)	21.5 (1.52)	24.7 (1.75)	26.4 (1.87)	29.9 (2.12)

(Note):
(1) This table was derived by the authors using statistics from the Ministry of Land, Infrastructure and Transport (2002), pp.25-32.
(2) The number in parentheses is the ratio to the number in 1970.

Although the demand for route bus transportation has sharply decreased, the output of route bus transportation changed less drastically. While the number of passengers transported by route bus decreased by the year 2000 to 47% of the 1970 figure, vehicle kilometer remained at 93% of the 1970 level, a fact indicating that the load factor per bus vehicle has sharply declined over the past two decades.

One important characteristic of the bus industry in Japan is that bus operators are generally small. Table 2 shows the size distribution of bus operators from various points of view. By any measure, bus operators are small. If there exist scale economies in the bus industry, these small operators certainly face cost disadvantages.

Table 2 Size Distribution of Bus Operators in Japan in FY2000							
By Vehicle		By Employees		By Capital		By Revenues	
Number of vehicles	Number of operators (%)	Number of employees	Number of operators (%)	Capital (million yen)	Number of operators (%)	Operating revenues (million yen)	Number of operators (%)
- 10	97 (21.8)	- 10	66 (14.9)	- 10*	38 (8.6)	- 50	56 (12.6)
11 - 30	91 (20.5)	11 - 30	75 (16.9)	11 - 30	82 (18.5)	51 – 100	50 (11.3)
31 - 50	51 (11.5)	31 - 50	52 (11.7)	31 - 50	68 (15.3)	101 – 500	103 (23.2)
51 - 100	63 (14.2)	51 - 100	64 (14.4)	51 - 100	65 (14.6)	501 – 1000	46 (10.4)
101 - 200	64 (14.4)	101 - 300	106 (23.8)	101 - 200	37 (8.3)	1001 – 5000	103 (23.2)
201 - 300	29 (6.5)	301 - 500	35 (7.9)	201 - 500	54 (12.2)	5001 - 10000	21 (4.7)
301 - 500	18 (4.1)	501 - 1000	26 (5.9)	501 -	55 (12.4)	10001 -	20 (4.5)
501 -	31 (7.0)	1000 -	20 (4.5)	Public	45 (10.1)	Public	45 (10.1)
Total	444 (100.0)	Total	444 (100)	Total	444 (100.0)	Total	444(100.0)

(Source): Ministry of Land, Infrastructure and Transport (2002), p.26
(Note):
(1) The item “less than 10 million in capital (*)” includes individual ownership companies (2 companies).
(2) Numbers in parentheses are percentages (%).

Both public and private operators have been suffering from financial deficits, as shown in Table 3. A surprising 78.5% of private bus operators have been producing deficits, while almost 100% of public bus operators show deficits. Private bus companies, despite their deficits, are able to survive because of government subsidies from the national government, although these have declined in recent years. For example, subsidies in FY1995 were 8,924 million yen for 161 operators but have decreased to only 7,090 million yen for 164 operators. Due to government budget problems, subsidies have continuously decreased. The main reason why public operators are more deficit-prone is that public operators have higher costs per unit. As Table 4 shows, on average, the costs of public operators are twice as high as those of private operators. Although other factors besides ownership are important, public companies’ costs are certainly higher, especially labor costs.

Table 3 Financial Situation of Route Bus Operators in FY2000			
	Making profit	Making deficit	Total
Private operator	40 (21.5%)	146 (78.5%)	186 (100.0%)
Public operator	1 (3.1%)	31 (96.9%)	32 (100.0%)
Total	41 (18.8%)	177 (81.2%)	218 (100.0%)
(Source): Ministry of Land, Infrastructure and Transport (2002), p.32 (Note): (1) These numbers are for operators owning more than 30 vehicles.			

Table 4 Average Cost Comparison Between Private and Public Operators in FY2000									
Private operators					Public operators				
Total costs	Operating costs			Non-operating costs	Total costs	Operating costs			Non-operating costs
	Sub total	Labor costs	Other costs			Sub total	Labor costs	Others costs	
359.6 (100.0)	353.1 (98.2)	244.1 (67.9)	109.0 (30.3)	6.5 (1.8)	753.6 (100.0)	731.3 (97.0)	566.3 (75.1)	165.0 (21.9)	22.3 (3.0)
1.00	1.00	1.00	1.00	1.00	2.10	2.07	2.32	1.51	3.43
(Source): Ministry of Land, Infrastructure and Transport (2002), p.34 (Note): (1) Numbers in the first row are average costs in yen per vehicle kilometer. (2) Numbers in parentheses are percentages (%). (3) Numbers in the second row are relative indices when numbers of private operators are one.									

3 Previous Studies

Many studies have been done comparing the private and public sectors in the bus industry in terms of efficiency (costs and/or productivity differences). For example, Anderson (1983) investigates the effect of government ownership and subsidies on performance in the U.S. bus transit industry from 1960 to 1975. Her methodology is to construct regression models while controlling for several factors which affect performance. Although she admits that bureaucratic growth, inefficiency and vote-maximization theories are supportable, she ultimately concludes that inefficiency and bureaucratic growth are associated with passive sponsorship and the large size of a firm, rather than with public ownership. Perry, Babitsky and Gregersen (1988) review 20 studies from three countries (mostly the U.S.) on the relationship between performance of the fixed-route bus and organizational form. They conclude that previous research has not made a persuasive case for the whole-scale privatization of either ownership or management of urban mass transit organizations. As for operating efficiency, they conclude that neither ownership nor management variations appear to have predictable associations with operating efficiency. However, they find that labor costs appear to be positively associated with public ownership.

However, studies showing that private operators are more efficient than public operators are not uncommon (see Table 5). For example, Tittenbrun's summary (1996) suggests that private is more efficient. Hensher (1988) compares private and public urban bus operators' costs by comparing unit costs for those operators in his sample located in Sydney. He finds that both driver costs and total operating costs for the public operators are higher than those for private operators. The major reasons why the private sector's costs are so much lower are the lack of demarcation between jobs, the use of part-time employees, much better driver utilization, the lower number of maintenance staff per bus, and the smaller number of days lost through sickness. Morlok and Viton (1985) compare the cost differences between private and public transit firms. They show that private firms do produce transit service at less cost than public firms and posit the circumstances in which private sector operations would be expected to be less costly.

Although many studies have investigated efficiency differences between private and public bus operators, there have been three main problems with these studies. Many are simply comparisons of performance measures in selected cases. For example, a wage level comparison between private and public operators is common to several studies but most do not control for factors besides the ownership effect. Age distribution and working conditions could be important factors causing differences in wage levels. Studies controlling other factors, such as one by Anderson using the regression technique, are unusual.

However, even if certain studies use regression to control factors, these are not based on economic theory. For example, Anderson (1983) and Perry and Babitsky (1986) use regression techniques to explain factors which affect performance but their studies lack a firm basis in economic theory.

Table 5 A summary of previous private–public comparisons of efficiency

Study	Country	More efficient sector			Source
		private	No difference	public	
Nelson (1972)	U.S.			X	(a)
Foster (1973)	U.S.			X	(a)
OECD (1975)	U. S. (New York City)	X			(b)
Oelert (1976)	West Germany	X			(b)
King and Erlbaum (1977)	U.S.		X		(a)
Holthoff and Knighton (1977)	U.S.	X			(a)
Pozdena (1977)	U.S.			X	(a)
Wallis (1979)	Australia	X			(b)
Wallis (1980)	Australia	X			(c)
Tunbridge and Jackson (1980)	U.K.	X			(c)
Feibel and Walters (1980)	Developing countries	X			(b)
Barbour and Zerillo (1982)	U.S. (New York)	X			(a)
Pucher (1982)	U.S.	X			(a)
So. California Association of Governments (1982)	U.S. (Los Angels)	X			(c)
Cox (1983)	U.S. (Cleveland)	X			(c)
Anderson (1983)	U.S.		X		(d)
Pucher and Markstedt (1983)	U.S.	X			(e)
Morlok and Viton (1985)	U.S. (New York City Suburbs)	X			(c)
Perry and Babitsky (1986)	U.S.	X			(f)
Thriez (1986)	Turky (Istanbul) and India (Calcutta)	X			(b)
Hensher (1988)	Australia (Sydney)	X			(g)
De Rus and Nombela (1997)	Spain	X			(h)

(Note):
(a) Perry, J. L., T. Babitsky, H. Gregersen (1988), (b) Tittenbrun (1996), (c) Morlok and Viton (1985), (d) Anderson (1983), (e) Pucher and Markstedt (1983), (f) Perry and Babitsky (1986), (g) Hensher (1988), (h) De Rus and Nombela (1997)

Third, although some studies are based on economic theory, their results are not reliable. For example, Hensher (1988) and de Rus and Nombela (1997) analyze cost structure by using econometric methods, but portions of their results do not satisfy sufficient conditions. For example, the first-order term of input factor price in Hensher's study shows a negative sign and de Rus and Nombela's study does not satisfy the homogeneity condition in input factor prices. It is important to investigate whether or not the ownership effect is relevant to efficiency. We have to control especially such factors as output size, service quality as related to load factor and peak ratio, network conditions such as bus stop spacing, network size, and demand conditions.

4 Model

4.1 Cost Model

Since Viton (1981), who was most likely the first to do so, estimated the translog function for the urban bus system in the early 80's, many cost studies have been undertaken for a wide variety of reasons. For instance, studies have evaluated scale economies, deregulation effects, and the effects of subsidies on cost structure. But the most common model of cost function is the translog function, for example, Williams and Hall (1981), Tauchen, Fravel and Gilbert (1983), Obeng (1984, 1985), Berechman and Gilliano (1984), Andrikopoulos, Loizidis and Prodromidis (1992) and Fazioli, Fillippini and Prioni (1993). Although more recently other methods have appeared in the literature--for example, the stochastic cost frontier model (Jorgensen, Pedersen and Volden, 1997) and the Data Envelopment Analysis (Cowie and Asenova, 1999) have been applied to bus industry—the translog model is still well used, as in de Rus and Nombela (1997) and Matas and Raymond (1998).

In this study, we followed the general structure of the cost model for bus firms, a model which has already been developed in previous studies. That is, we assumed the cost function as a function of output (Q), input factor prices ($\boldsymbol{w}$) and output conditions ($\boldsymbol{H}$). In this study, we specify the output measure as a single output. But there might be a possibility of aggregation bias on output because output conditions such as service characteristics and network conditions could be different among bus operators. Therefore, we include in the cost function output conditions (***H***), which represents output characteristics and network characteristics. In this study, the quantity of output is measured in annual vehicle kilometers. Variables of output conditions are bus stop spacing, peak ratio, and the average load of bus service. Furthermore, we include the ownership dummy variable (***D***) as a fixed effect in the cost function, because our main purpose is to evaluate how the ownership difference affects the cost structure of the route bus operation. The cost function is generally expressed as follows:

$$C = C(Q, \boldsymbol{H}, \boldsymbol{w}, D), \quad (1)$$

where C: total cost

Q: quantity of output

$\boldsymbol{H}$: output condition

$\boldsymbol{w}$: input factor prices

D: ownership dummy variables.

Furthermore, in this study, we employ a translog cost function, as other cost studies have done. Among previous studies, our cost model is very similar to Mizutani (1994) and de Rus and Nombela (1997). The specific translog cost model used here is shown as follows:

$$\ln C = \alpha_0 + \alpha_Q \ln Q + \Sigma_i \beta_i \ln w_i + \Sigma_m \mu_m \ln H_m + (1/2)\, \alpha_{QQ} (\ln Q)^2 + (1/2)\, \Sigma_j \Sigma_i \beta_{ij} (\ln w_i)(\ln w_j) + \\ + (1/2)\, \Sigma_n \Sigma_m \mu_{mn} (\ln H_m)(\ln H_n) + \Sigma_i \gamma_{Qi} (\ln Q)(\ln w_i) + \Sigma_m \gamma_{Qm} (\ln Q)(\ln H_m) + \\ \Sigma_m \Sigma_i \gamma_{im} (\ln w_i)(\ln H_m) + \delta D, \quad (2)$$

where C: total operating cost

Q: output measure

w_i: input factor price (i (or j) = *L1* (driver), *L2* (non-driver), *E* (energy), *K* (material and capital), *S* (other service))

H_m: operating condition (m (or n) = *BS* (bus stop spacing), *PK* (peak ratio), *LD* (average load))

D: ownership dummy (public =1, private = 0).

In this model, we impose the restriction on input factor prices such that $\Sigma_i\beta_i = 1$, $\Sigma_i\gamma_{Qi} = 0$, $\Sigma_m\gamma_{imi} = 0$. Other restrictions are as follows: $\beta_{ij} = \beta_{ji}$, $\mu_{mn} = \mu_{nm}$. Furthermore, we apply Shephard's Lemma on the total cost function. Then we can obtain the input share equations as follows:

$$s_i = \beta_i + \Sigma_j\beta_{ij}(\ln w_j) + \gamma_{Qi}(\ln Q) + \Sigma_m\gamma_{im}(\ln H_m), \quad (3)$$

where s_i : input i's share of total operating cost.

As for the estimation technique, we apply the SUR (Seemingly Unrelated Regression) by Zellner (1962) for the total cost function and the input share equations. Furthermore, it is worth noting that we normalize the observation on each variable by dividing by its sample mean, before making the natural logarithmic transformation. In the actual estimation, we drop the price of other factor price (w_S) from equations (2) and (3) by using the condition, $\beta_S = 1 - \beta_{L1} - \beta_{L2} - \beta_E - \beta_K$.

4.2 Wage Function

In this section, we employ the wage function to evaluate the wage difference between private and public bus operators. As for the attributes of wage of bus operators, we chose four variables: average employed years (*T*), working conditions (*R*), job type dummy (*X*) and ownership dummy (*D*). In the literature of labor economics, other factors such as education and training history are also used to explain the wage, but we could not include these variables because of the unavailability of data. Furthermore, the average age of each organization could also be important but we excluded it because this variable seems to be correlated to the average employed years in our data set. As for the functional form, we employed the simple log-linear function.

$$W = W(T, R, X, D), \tag{4}$$

Where W: average monthly salary per employee

T: average employed year

R: working condition

X: job type dummy (driver =1, non-driver = 0)

D: ownership dummy (public = 1, private =0).

$$\ln W = \alpha_0 + \alpha_T \ln T + \beta_R \ln R + \theta X + \delta D, \tag{5}$$

Where W: average monthly salary per employee

T: average employed year

R: working condition

X: job type dummy (driver =1, non-driver = 0)

D: ownership dummy (public = 1, private = 0).

5 Empirical Analysis

5.1 Sample Selection

In this section, we will analyze Japanese bus operators by using econometric methods. Based on previous studies, we carefully selected our observations. Table 6 shows a list of the bus companies taken as examples for this analysis.

First, in order to create relatively similar demand and competition (i.e. with private auto) conditions, we selected observations from the same region. The selected observations are seventeen organizations, both publicly and privately owned companies, from the Kansai Region. Publicly owned bus operators are all municipal (city) governments' operators while private bus operators are joint stock companies. We gathered data for these organizations from the fiscal years 1997 through 2000, giving us a total of 68 observations. Our data was derived from several sources but the cost data in particular were obtained from Kobe city, and are statistics originally collected by the Japan Bus Association.

Table 6 List of bus operators used for this study

No	Name of company	Type	No	Name of company	Type
1	Hankyu Bus	Private	10	Shinki Bus	Private
2	Keihan Bus	Private	11	Osaka City	Public
3	Nankai Bus	Private	12	Kyoto City	Public
4	Kintetsu Bus	Private	13	Kobe City	Public
5	Hanshin Bus	Private	14	Takatsuki City	Public
6	Sanyo Bus	Private	15	Amagasaki City	Public
7	Kyoto Bus	Private	16	Itami City	Public
8	Keihan Uji Kotsu	Private	17	Akashi City	Public
9	Kongo Jidosya	Private			

5.2 A Performance Comparison Between Private and Public Operators

Before we apply econometric methods, we will compare the performance difference of these organizations. A comparison of major performance measures of the selected organizations is summarized in Table 7. This table shows that the operating revenue cost ratios of private and public bus operators are similar, with both creating operating deficits. The fact that both the average operating revenues and the average operating costs of public operators are larger than those of private operators might imply that the size and fare of public operators are larger than those of private operators, in addition to the ownership being different.

Wage level also differs greatly between the two sectors, with that of public operators about 61% higher than that of private operators. However, this wage differential between these sectors might be the result of carrier differences in addition to difference in ownership. Furthermore, operating conditions are different between the two sectors. Public operators have more passengers per operator, shorter average route length, and shorter bus stop spacing. These results show that we must control operating conditions.

Table 7 A private-public comparison of performance in selected organization				
Measure	Definition	Unit	Public	Private
Operating revenue cost ratio	Operating revenues / operating costs	-	0.811	0.882
Average operating revenue	Operating revenues / vehicle kilometer	Yen / vehicle-km	760	458
Average operating cost	Operating costs / vehicle kilometer	Yen / vehicle-km	882	438
Labor productivity	Vehicle kilometer / employees	Vehicle-km / person	17,701	22,111
Average monthly wage	Total salary expenditure per month / number of persons paid	Yen / person	981,133	601,865
Passenger density	Number of passengers / number of routes	Person / route	39,300	33,343
Number of passengers per operator	Number of passengers	1000 Person	60,456	29,447
Bus density	Vehicle kilometer / route kilometer	-	21,021	6,751
Average route length	Route kilometer / route	km	6.5	11.2
Daily bus operation	Number of bus operations per day	Number of operation / day	3,496	2,298
Average bus stop spacing	Route kilometer / number of bus stops	km	1.000	2.698

5.3 Definition of Variables for Econometric Analysis

The variables used for the estimation of total operating cost function are defined as follows and shown in Table 8. First, total operating costs (C) are the sum of labor, energy, material and capital costs for the operating division. The costs of the non-operating division, which are the general administrative costs of the administrative division of the headquarters, are not included because these are not reported publicly.

As for output measures, we use annual vehicle kilometer (Q). In this study, the cost model is a single-output model with a variable of output characteristic. However, the costs of bus operation are affected by operating conditions. Certainly, previous studies on cost estimation in the bus industry include many kinds of variables related to operating conditions. Therefore, in order to avoid estimation bias based on different kinds of operating conditions, we also include three kinds of variables describing operating conditions: bus stop spacing (H_{BS}), peak ratio (H_{PK}), and average load (H_{LD}). Bus stop spacing is defined as the average length between bus stops. The peak ratio is defined as the ratio of the total number of pass users to the total number of passengers, because most pass users are commuters. Finally, average load is defined as the number of passengers per vehicle per kilometer.

We define five kinds of input factor prices. First, as for labor price, we choose two kinds of price: the labor price of the bus operator (w_{L1}) and the labor price of other workers (w_{L2}). These prices both are defined as the average monthly salary per employee. Therefore, we obtained these by dividing monthly labor costs in each category by the total number of employees. Energy price (w_E) is obtained by dividing energy expenditures by diesel consumption. Capital and material price (w_K) is obtained here by dividing depreciation expenditures by the total number of vehicles held by the organization. Finally, the price of other service costs (w_S), such as highway charges, insurance, and tax payments is the consumer price index.

As for the ownership dummy variable (D), this variable is defined as the difference in ownership, in which public ownership is equal to one and private ownership is equal to zero. All public bus operators used here are those of municipal governments.

As for variables for wage function, the wage per employee (w) is defined as average monthly salary per employee. The average employed year (T) of the firm is used here. This measure is defined as how many years an employee has worked for the firm on average. Finally, vehicle-km per employee (R) is obtained by dividing vehicle kilometer by the total number of employees.

Table 8　Definition and statistics on variables used for the estimation of total cost function

Variable	Definition	Unit	Mean	Standard Deviation	Minimum	Maximum
C (Total operating cost)	Sum of labor, energy, material, depreciation costs and other service costs	million yen	8,695	8,601	517	28,525
Q (Output)	Annual vehicle kilometer	thousand vehicle-km	12,736	10,683	1,310	32,674
w_{L1} (Wage of driver)	Average monthly salary per driver	yen / driver	785,708	146,759	573,035	1,092,380
w_{L2} (Wage of non-driver)	Average monthly salary per non-driver	yen / non-driver	816,609	196,152	297,890	1,102,960
w_E (Energy price)	Energy expenditure per diesel consumption	yen / litter	58.8	3.5	53.0	64.0
w_K (Capital price)	Depreciation costs per vehicle	thousand yen / vehicle	1,167	496	150	2,272
w_S (Service price)	Consumer price index	-	96.4	0.9	95.6	97.9
H_{BS} (Bus stop spacing)	Kilometers between bus stops	km	2.1	1.7	0.2	6.0
H_{PK} (Peak ratio)	Pass users per total passengers	-	0.338	0.132	0.113	0.629
H_{LD} (Average load)	Number of passenger per vehicle per km	passenger/ vehicle/km	5.4	3.9	0.6	15.8
w (Wage per empoyee)	Average monthly salary per employee	yen / employee	636,867	118,498	228,905	835,695
T (average employed years)	Average employed years	year	18	6	3	32
R (Vehicle-km per employee)	Vehicle-km per employee	vehicle-km / person	20,185	5,363	12,306	39,628

5.4 Estimation Results

The estimation results of both cost and wage functions are shown in Table 9. Estimation methods are the SUR (Seemingly Unrelated Regressions) for the cost model with input share equations and the OLS (Ordinary Least Squares) regression for the wage function. The goodness-of-fit in these regressions is acceptably high for these models. The estimated cost model meets almost all of the required properties. First, symmetry and homogeneity in input factor prices are satisfied because restrictions in input factor prices are imposed. The monotonicity and the concavity conditions in the cost model are satisfied at least locally. The first-order coefficients in the cost model show the correct sign. As for the wage function, the coefficients show almost the correct sign. Therefore, we decided to evaluate the ownership difference according to total operating cost and wage. Furthermore, it is worth noting that in this analysis, we use pooled data, which might lead to serial correlation and heteroskedasticity. However, test results show there is neither serial correlation nor heteroskedasticity.

Table 9 Estimation Results of Total Operating Cost Function and Wage Function

Cost Function (First order term only)		Wage Function	
α_0 (constant)	11.270 (0.023)	α_0 (constant)	5.938 (0.430)
α_Q (output)	0. (0.017)	α_T (employed year)	0. 405 (0.026)
β_{L1} (wage of driver)	0. (0.005)	β_R (working condition)	0.079 (0.044)
β_{L2} (wage of non-driver)	0. (0.006)	θ (driver dummy)	0. 140 (0.018)
β_E (energy price)	0. (0.001)	δ (ownership dummy)	0. 139 (0.024)
β_K (capital price)	0. (0.002)		
μ_{BS} (bus stop spacing)	-0.128 (0.031)		
μ_{PK} (peak ratio)	0. (0.072)		
μ_{LD} (average load)	-0.168 (0.025)		
δ (ownership dummy)	0. (0.031)		

R-squared	0.996	R-squared	0.782
(Note): The full estimation result in the cost model is shown in Appendix-1.			

First, as for the cost function, the coefficient of the ownership dummy shows 0.184 and is statistically significant at 1%, indicating that public ownership pushes total operating costs upward. If other conditions such as outputs, input factor prices, and operating conditions hold the same between private and public bus operators, then total operating costs for the public bus operators is 20.2% higher than that for the private bus operators. In spite of the fact that we control several factors which affect cost difference, the ownership effect is still significant for total operating costs. As for the wage function, the coefficient of the ownership dummy is statistically significant at 0.139, which is slightly lower than the case for total operating cost. This result means that the wage level of public bus operators is about 14.5% higher than that of private bus operators. These results indicate that public ownership certainly involves higher costs and a higher wage level than private bus operators.

6 Concluding Remarks

The bus industry has suffered a decline in bus ridership due to the increase in use of the private auto and apparently can no longer continue to provide service without government assistance. Furthermore, the deregulation of land transport introduced quite recently will create more competition, with privately owned bus operators becoming more free to enter a market where public bus companies have dominated. With this imminent change in mind, we have focused on performance differences between private and public bus operators. Our main question is whether or not public bus operators are less efficient than private operators, even if we control other factors. Most previous studies reporting that private bus operators are more efficient have failed to hold other factors constant.

In our analysis, we estimate the cost function of bus services and the wage function with econometric methods. Based on our analytical results, we conclude that private bus operators are more efficient than their public counterparts, with the total operating cost of public bus operators being 20.2% higher than that of private bus operators and the wage of public bus operators 14.5% higher than that of private bus operators. This result suggests that if factors besides ownership had been controlled for, the efficiency difference found by previous researchers might have been smaller. In other words, compared with private bus operators, public bus operators seem still to have room to improve their performance. One reason why private is still more productive is due to the pressure imposed by competition. Because private operators do not receive many subsidies and are required to be self-sufficient through the collection of fare revenues, they are careful to maintain good management to avoid bankruptcy. However, public operators still qualify for government subsidies and their wages are higher in order to be consistent with those of other divisions of city government, so that they are less likely to react vigorously to stem decreases in their business. Under these circumstances, public operators are less efficient than their private counterparts.

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Appendix-1 Estimation Results of Translog Cost Function

Table A-1 Estimation Results of Total Operating Cost Function

	Estimate	Standard Error		Estimate	Standard Error		Estimate	Standard Error
α_0	11.267	0.023	β_{EE}	0.042	0.009	γ_{ELD}	0.001	0.001
α_Q	0.959	0.017	β_{EK}	0.000	0.001	γ_{KBS}	0.004	0.002
β_{L1}	0.621	0.005	β_{KK}	0.032	0.004	γ_{KPK}	0.001	0.004
β_{L2}	0.114	0.005	γ_{QL1}	-0.034	0.004	γ_{KLD}	0.004	0.003
β_E	0.046	0.001	γ_{QL2}	-0.002	0.005	μ_{BSBS}	-0.208	0.051
β_K	0.054	0.002	γ_{QE}	-0.001	0.001	μ_{BSPK}	0.006	0.078
μ_{BS}	-0.122	0.031	γ_{QK}	0.000	0.002	μ_{BSLD}	-0.190	0.046
μ_{PK}	0.121	0.073	γ_{QBS}	-0.093	0.022	μ_{PKPK}	0.335	0.136
μ_{LD}	-0.149	0.022	γ_{QPK}	-0.096	0.047	μ_{PKLD}	-0.090	0.075
δ	0.184	0.031	γ_{QLD}	-0.080	0.028	μ_{LDLD}	-0.332	0.113
α_{QQ}	0.172	0.050	γ_{L1BS}	-0.001	0.005			
β_{L1L1}	0.172	0.040	γ_{L1PK}	0.014	0.011			
β_{L1L2}	-0.008	0.026	γ_{L1LD}	0.003	0.007			
β_{L1E}	-0.017	0.006	γ_{L2BS}	-0.009	0.006			
β_{L1K}	-0.036	0.008	γ_{L2PK}	-0.034	0.012			
β_{L2L2}	0.045	0.027	γ_{L2LD}	-0.007	0.009	R-squared		0.996

β_{L2E}	-0.025	0.004	γ_{EBS}	0.003	0.001	Log likelihood	967.822
β_{L2K}	-0.005	0.007	γ_{EPK}	0.002	0.002	Observations	68

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