Deregulation Effects in the Japanese Trucking Industry - Productivity and Welfare Analysis -[1]

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Abstract

The trucking industry in Japan experienced a large economic deregulation in 1990. We try to estimate the effects of deregulation from two viewpoints: that of the trucking carriers' productivity and that of the shippers' and laborers' welfare. We find that only large-scale trucking carriers, which account for less than 2% of all carriers, have improved their productivity after deregulation. Furthermore shippers' welfare has been improved, however some of the shippers' surplus increase is transferred from the decrease of laborers' surplus. Thus, the net increase of social surplus has not been large.

1. Introduction

The trucking industry in Japan experienced a large economic deregulation in 1990. In this article we try to estimate the effects of deregulation from two viewpoints: that of the trucking carriers' productivity and that of the shippers' and laborers' welfare.

There are many studies about the effects of deregulation in the American trucking industry (The Motor Carrier Act of 1980). Ying [1990] and Xu et al. [1994] compared trucking carriers'

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cost structures before and after deregulation. They found the cost advantages of the large-scale carriers became more significant after deregulation and that advantages were attributable to the benefits (longer distances and higher load factors) gained by large-scale carriers in a large-scale network. Therefore, it is suggested that regulations limiting truck routing had made large network use inefficient. Winston et al. [1990] estimated the shippers would gain 48 billion dollars (nominal) surplus in 1977 if deregulation were implemented at that time. Regarding the effects on laborer, Moore [1978] and Kim [1984] said regulation induced excess labor input. Rose [1987] indicated laborer rent had occurred because of regulations and the rent had been large for labor union members (Team star).

There are a few studies about the effects on deregulation in Japan (ex. Yamauchi [1996] and Flath [2001]). However, they could not capture the medium and long-term trends of the effects on deregulation because they did not use long-term data after deregulation. We will revisit the effects of the deregulation of Japan's trucking industry as we can now get over 10 years of data since deregulation was instituted.

This paper consists of the following five sections. Section 2 briefly surveys deregulation policy in the Japanese trucking industry. Section 3 shows the long-term trends of the trucking industry. We estimate the effects of deregulation on the trucking carriers' productivity in section 4 and on shippers' and laborers' welfare in section 5. A Conclusion is drawn in section 6.

2. An overview of deregulation policy in the Japanese trucking industry

The Ministry of Transportation (MOT) established regulations for the Japanese trucking

industry with the Road Transportation Act from 1951 until 1990. It is traditionally asserted that the trucking industry must be regulated to prevent excessive competition of operators from endangering road safety and stable trucking services. However, some studies in the 1980's demonstrated that strict regulations were not needed to maintain stable trucking services in a developed economy where there are enough trucking firms and private trucks, as long as stable services remain of crucial importance for the highly developing economy[2].

The 1990 economy deregulating, Road Fright Transportation Act was implemented with the aim of increasing truck use efficiency and of meeting high quality transportation needs (See table-1.)[3]. On the other hand, safety regulations were made stricter. For example a stricter rule for illegal overloading of goods was implemented.

Firstly, the 1990 act abolished demand-supply balancing for new entries. It is still necessary to acquire a license, the criteria for a new license was simplified to focus on only the applicant's operational ability. Additionally, the minimum number of trucks - a main criterion of operational ability - was decreased. Therefore, it became easier for new trucking companies to entry the field.

With regard to Truck Load (TL) operation, carriers have been able to consolidate plural shippers' consignments after 1990 while only Less than Truck Load (LTL) carriers could consolidate consignments before 1990. Furthermore, since 1990, trucking carriers can freely increase (or decrease) their number of trucks (A prior notice to the MOT is necessary) so that carriers can change their fleet to meet transportation demands more easily. Additions to the 1990 act were also made at later dates. Expanded operation areas were established in 1984 and

[2] For example, Goto and Sugiyama [1983].
[3] Some items were implemented before and some after 1990.

operation areas were finally abolished altogether in 2003[4]. Now any trucking carrier can carry goods in the whole of Japan.

Finally, since 1990, a trucking carrier can change its fares without governmental approval (A prior notice to the MOT had been necessary until 2003, and a post notice to the MOT is necessary since 2003.). But, in truth, trucking carriers had not kept the approved fare before 1990. The 1990 pricing deregulation is really only a confirmation of that state. The trucking market, then, has not been affected by the deregulation of pricing.

In summary, it can be said that deregulation has provided trucking carriers with new business opportunities in a wider area and the possibility of efficient truck operations. On the other hand, the deregulation has made the trucking market competition stiffer.

Table-1 Deregulation in the Japanese trucking industry

	Previous Rule	New Rule (when implemented)
Entry	【New Entry】	
	License	License
	【Demand-supply balancing for a new entry】	
	○	× (1990)
	【Minimum fleet size (a necessary condition for a new entry)】	
	5～15trucks [Depends on the operation area]	5trucks (2001) [Nationwide]
Truck Operation	【Consolidation of plural shippers' consignments by TL trucks】	
	×	○ (1990)
	【Increase (decrease) of trucks】	
	Approval by the government	Notification to the government before changing (1990)
	【Operation Area】	
	Prefecture base	Expanded operation area base (1984) Nationwide base (2003)
Pricing	【Fare change】	
	Approval by the government	Notification to the government *before* changing (1990) Notification to the government within 30 days *after* changing (2003)

[4] A Trucking carrier can only carry goods from, to and inside its licensed operation areas.

3. Trend in the Trucking Industry in Japan

3-1 Number of Trucking Firms, Employees and Vehicles

In this section I will show the long-term trends and indicate how the trends change after deregulation. First of all, we can see the effects of deregulation in the number of trucking firms. The number of trucking firms significantly increased after 1990 (See in figure-1.). Abolishing demand-supply balancing for a new entry was a major factor for this increase. Table-2 shows the change in the number of carriers according to the carrier size (number of trucks in their fleet) and the license category, LTL and TL. TL carriers had been increased by 37% from 1990 to 2000 while LTL carriers slightly decreased. Especially, small TL carriers with less than 20 trucks had been increased by more than ten thousand.

However, the number of employees and vehicles did not increase as much as the number of firms after 1990 (See in figure-1.). These figures reflect the reality that most of the increase involved carriers of small size.

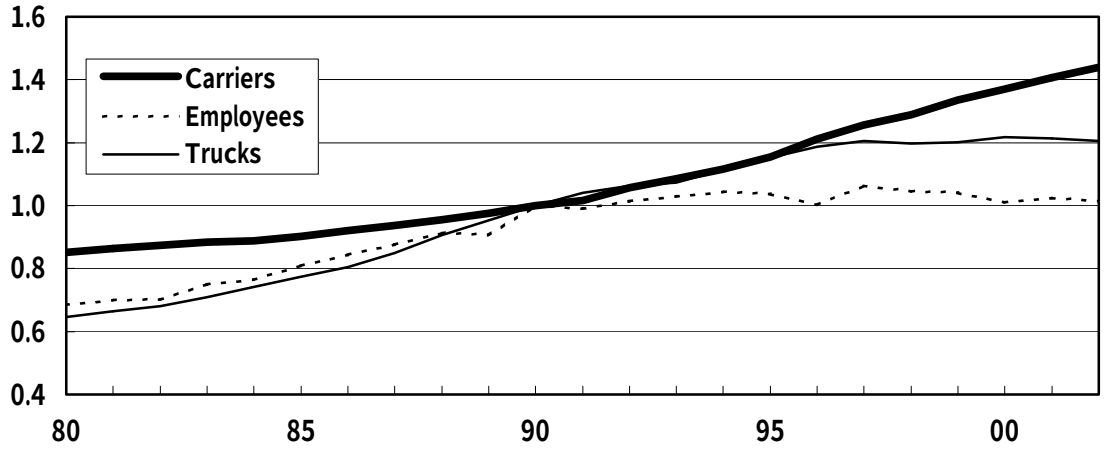

Figure-1 Number of Carriers, Employees and Trucks (1990=1)

Source: *Surface transportation statistics handbook.*

Table-2 Number of Trucking Firms in Detail

	LTL			TL		
Carrier Size	1980	1990	2000	1980	1990	2000
1～20	186	119	58	24,683	24,747	35,987
21～50	68	50	38	5,365	9,080	10,979
51～100	37	51	56	964	2,198	2,668
101～	65	77	120	322	757	767
Total	356	297	272	31,334	36,782	50,401

Source: *Surface transportation statistics handbook*.

3-2 Tonnage, Tons-kilometer and Trucking Attributes

Tonnage and tons-kilometer have been continuously increased for the trucking industry according to the GDP growth (See table-2.). They carried about 3 billion tons and 256 billion tons-km in 2000. This accounts for 46% of all domestic freight tons and 44% of all domestic tons-km. Tons-km has seen a greater increase than tonnage because transportation length has become longer due to an increase in paved roads (especially an increase of expressways). We also recognize that the average length of shipment has been getting longer, as shown in figure-3.

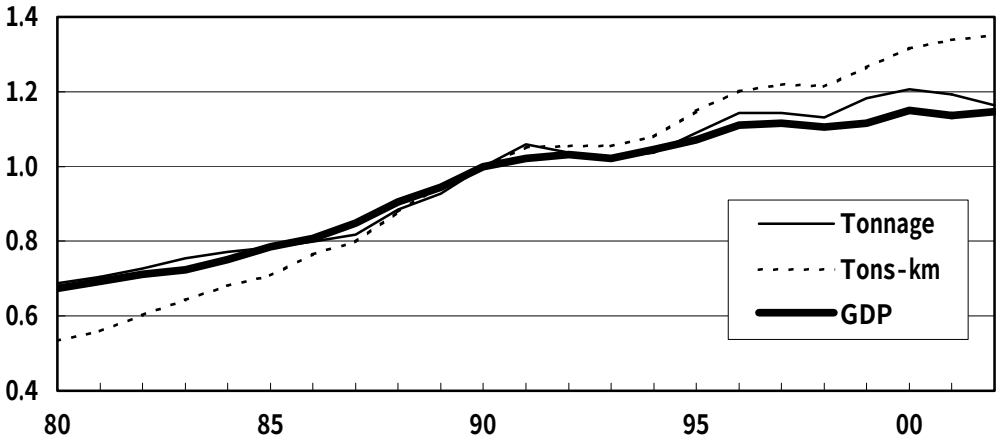

Figure-2 Tonnage and Tons-km (1990=1)

Source) *Domestic transportation statistics handbook*.

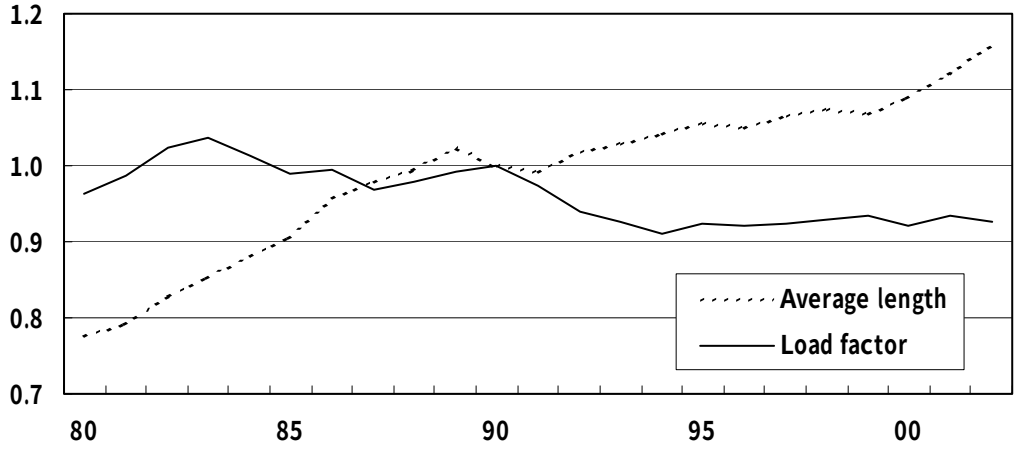

Figure-3 Attributes of Trucking (1990=1)

Source) ***Domestic transportation statistics handbook***.

Table -3 also shows another transportation attribute: decreasing load factor. Load factor has decreased by about 10% after 1990 and its decreasing reflects the stiffer competition among carriers and greater JIT transportation needs. The 2000 MOT report says 51.9% of the trucking shipments have specified delivery times.

3-3 Fare and Wage

Figure-4 shows the transition of the trucking fare per tons-km. It has been dropping sharply after 1994 while it had been stable until 1993. The fare had been dropped by over 20% from 1994 to 2002 and this drop suggests an effect of keener market competition caused by deregulation.

Figure-5 compares the annual income between trucking laborers and all industry laborers. The difference between truckers and other laborers has been expanding since 1990. There was little deference before 1990. Although the wage per hour of truckers was lower than that of other

industry workers, trucking laborers could maintain a similar annual income level until 1990 by working longer. But, they can no longer maintain a similar income because the difference of the hourly wage has expanded by 58% between 1990 and 2002 (from 334yen in 1990 to 528yen in 2002). Among input-factors, pricing fuel and capital are largely set exogenously, but it is easier to set the labor price endogenously. This means that labor input prices are more easily influenced by deregulation.

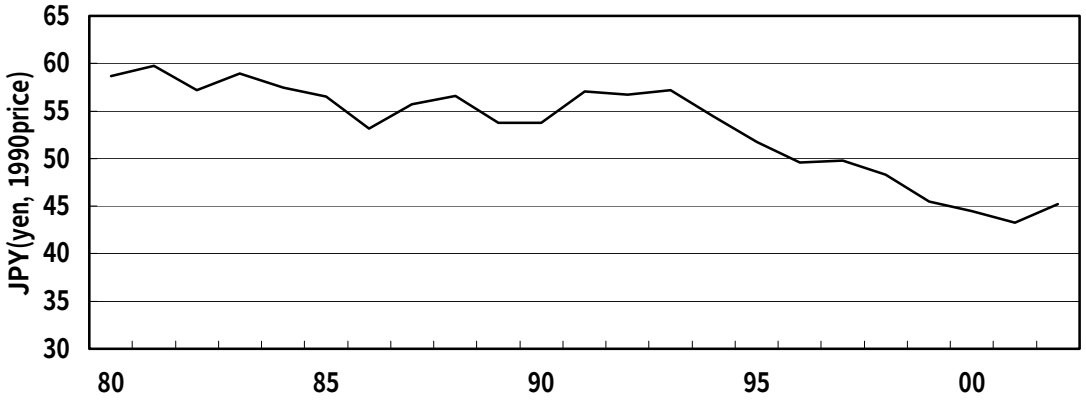

Figure-4 Fares per tons-km

Source: *Domestics transportation statistics handbook*.

Figure-5 Annual Income

Source: *Wage census*.

3-4 Road safety

The number of traffic accidents caused by commercial trucks has been increasing (from 26,097 accidents in 1990 to 37,007 accidents in 2000). While traffic accidents caused by private trucks have been absolutely more, but the overall number has hardly changed (from 154,532 accidents in 1990 to 157,885 accidents in 2000). Figure-6 shows that the growth rate of traffic accidents by commercial trucks obviously exceeds that by private trucks since 1990. While we cannot prove a causal relationship between the increase of traffic accidents and deregulation from these facts only, it is clear that research into the influences of deregulation on road safety is necessary.

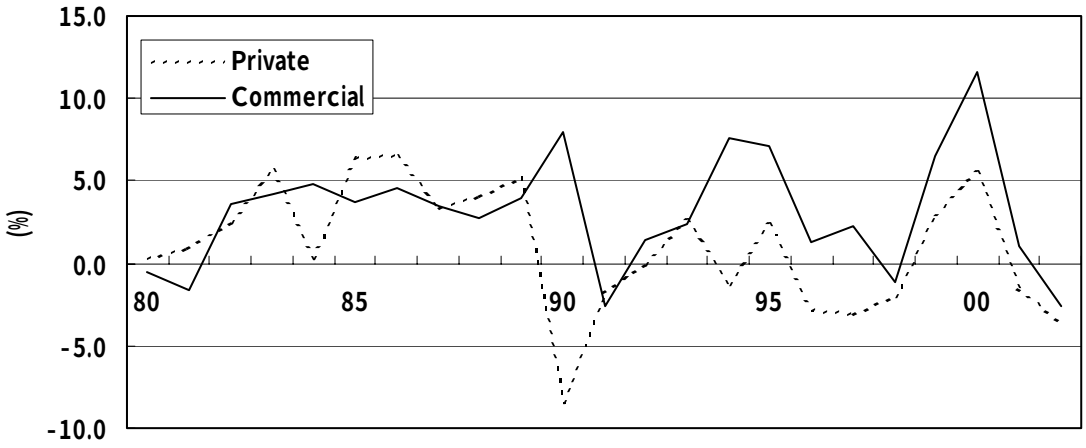

Figure-6 Growth Rate of Traffic Accidents

Source: *Domestic transportation statistics handbook*.

4. Productivity Analysis

4.1 Definition of TFP

TFP (Total Factor Productivity) 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*:

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

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

$$\frac{TFP_{t+1}}{TFP_t} = \frac{\frac{Q_{t+1}}{Q_t}}{\frac{Z_{t+1}}{Z_t}} \qquad (2)$$

Additionally *Q* and *Z* are calculated by using a Tornqvist expression as follows:

$$\frac{Q_{t+1}}{Q_t} = \exp\left[\sum_i \frac{1}{2}\left(r_{i,t} + r_{i,t+1}\right)\ln\left(\frac{q_{i,t+1}}{q_{i,t}}\right)\right] = \prod_i \left(\frac{q_{i,t+1}}{q_{i,t}}\right)^{\frac{1}{2}\left(r_{i,t+1}+r_{i,t}\right)} \qquad (3)$$

$$\frac{Z_{t+1}}{Z_t} = \exp\left[\sum_j \frac{1}{2}\left(s_{j,t} + s_{j,t+1}\right)\ln\left(\frac{z_{j,t+1}}{z_{j,t}}\right)\right] = \prod_j \left(\frac{z_{j,t+1}}{z_{j,t}}\right)^{\frac{1}{2}\left(s_{j,t+1}+s_{j,t}\right)} \qquad (4)$$

where:

Q_t : the aggregated output quantity index at *t*;

Z_t : the aggregated input quantity index at *t*;

q_i : the quantity of *i*th output;

z_j : the quantity of *j*th input;

r_i : the revenue share of *i*th output to total;

s_j : the cost share of *j*th input to total.

4.2 Data

The data used in our research comes the sample data in the 1992 to 2002 *Annual Report on the Trucking Industry* by the Japan Trucking Association. Unfortunately these reports had not been published before deregulation. Thus, we cannot compare TFP from before and after deregulation. However, it is worth analyzing TFP trends after deregulation.

Definitions of the variables are given in table-3. We define the kilometric performance as an output because it is most suitable for estimating TFP as a technical efficiency. Inputs are divided into four factors: labor, fuel, capital and other. Using the perpetual inventory method, capital prices are obtained as follows[5]:

$$p = q\,(r + d) \qquad (5)$$

where:

p : capital price;

q : price of investment goods (deflator for private capital goods investment);

r : interest rate;

d: depreciation rate.

Table-3 Definition of Variables

		Quantity	Price	Cost
Output		kilometric performance	—	—
Input	Labor	Employees	—	Labor Cost
	Fuel	Consumed Fuel	—	Fuel Cost
	Capital	Cost/Price	Calculated by (5)	Depreciation Cost + Interest
	Other	Cost/Price	GDE deflator	Ordinary Cost - (Labor Cost + Fuel Cost + Capital Cost)

Source: Cabinet Office, Government of Japan, *Annual Report on National Accounts*
Japan Trucking Association, *Annual Report on Trucking Industry*

[5] See Jorgenson and Griliches [1967].

4.3 Estimation of TFP

Figure-7 shows that only large carriers with more than 101 trucks have continuously improved their TFP after deregulation, while small and medium carriers have hardly changed their TFP. There are very few carriers with more than 101 trucks (They were less than 2% in 2000, see table-2.).

Table-4 suggests that the output quantities (kilometric performance) have decreased for all carrier scales. Thus, all carriers have decreased their input quantities to cope with the shrink in output. Further, the decreases of labor input are very significant at any scale. However, only large carriers could also largely decrease other input factors. Thus, they could offset output decrease by input decrease, while small and medium carriers could not do so. Figure-8 shows how operating profitability declines at any scale and that this decline resulted in nearly zero or negative profit in 2002.

After all, the trucking industry as a whole has hardly improved their TFP and only a very few large-scale trucking carriers have enjoyed the effects on deregulation of the truck operation. According to the study by the Japan Trucking Association, deregulation of the operation areas and the change in the number of trucks has been very effective for efficient truck use. The large carriers can get more business chances in a wider area and they can also make their truck routing more efficient, as well as merge some business offices into one larger office due to the deregulation of operation areas. Additionally, the large carriers can more easily increase (or decrease) their truck numbers in response to trucking demand changes thanks to the deregulation of fleet change. However, even the large carriers could not have improved their profitability (from 4% in 1992 to 0% in 2002) despite the fact that they have improved their TFP, as the

trucking market has become far more competitive since deregulation than it was before.

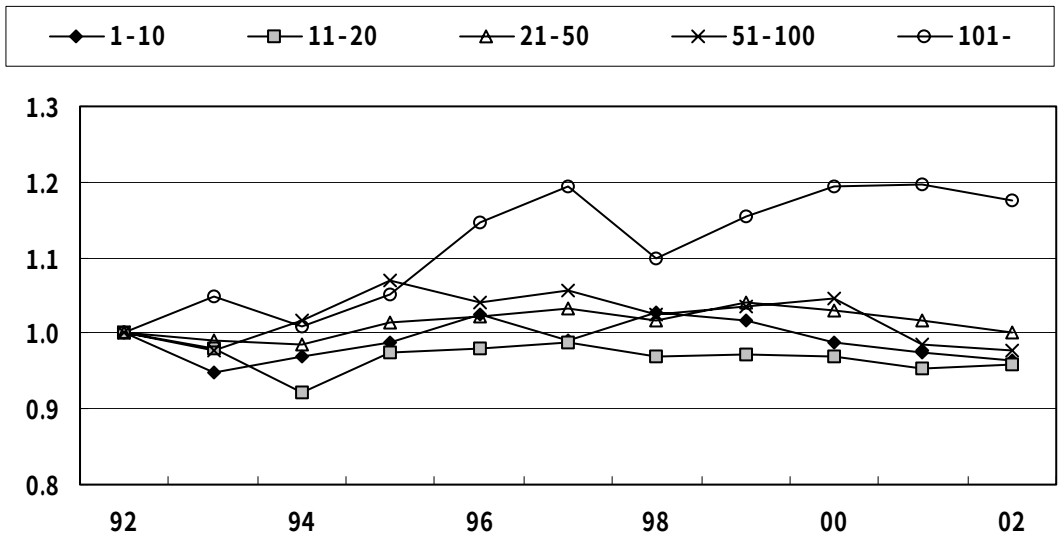

Figure-7 TFP(1992=1)

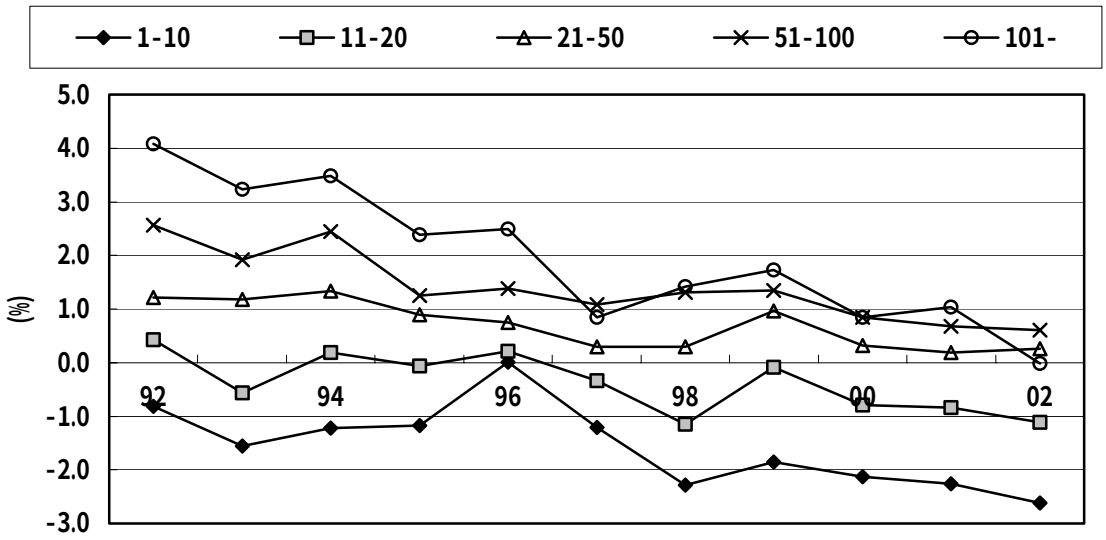

Figure-8 Operating Profitability

Table-4 Annual Average Growth Rate of TFP and Factors (%)

Carrier Size (number of trucks at their fleet)		1～10	11～20	21～50	51～100	101～
Input Quantity	Total	-1.36	-0.77	-0.76	-0.62	-2.44
	Labor	-1.23	-0.89	-0.75	-0.70	-1.20
	Fuel	0.05	0.06	0.05	0.05	0.05
	Capital	0.19	0.20	0.14	0.15	-0.06
	Other	-0.38	-0.13	-0.20	-0.12	-1.25
Output Quantity (kilometric performance)		-1.70	-1.18	-0.74	-0.82	-0.83
TFP		-0.34	-0.41	0.02	-0.21	1.65

5. Welfare Analysis

5.1. Model

In this section we will analyze the structure of the trucking market with time series data and highlight two different effects of deregulation on welfare: that on shippers, and that on trucking laborers. Some previous studies pointed out the biggest effect of deregulation would be an increase in the number of trucking carriers because of the relaxed entry regulations. This study carries the results of this outcome further as expressed in the model of the market structure in figure-9 (Each expression is defined as below. Expected signs are in parentheses and definition of each variable is shown in table-5.).

The system of this model is as follows:

Carrier function (6)

Carriers are influenced by economic activity and the scale of the carrier. A more active economy has a positive effect and a larger carrier scale has a negative on the overall number of carriers. Additionally, as the effect of deregulation most directly occurs in the number of carriers,

we have, therefore, added the deregulation effect as a dummy variable into the carrier function. Thus, the number of the trucking carriers increases and the competition among carriers is keener after deregulation.

Wage function (7)

Wage, which is a labor input price, is set more endogenously than fuel and capital price. Moreover, labor is the biggest input factor and its cost accounts for about 40% of total cost. Keener market competition pressures significantly affect the wages. The wage function includes some explanatory variables, which are length of service, wage levels in overall industry and the number of carriers as a deregulation effect.

Labor supply function (8)

We think the number of laborers in the trucking industry is explained by their wage level and the population of workers in all of Japan. Further, laborers' surplus decreases due to the wage decrease.

Fare function (9)

Fare level is influenced by average load factor, labor cost, other ordinary costs and market competition. The load factor reflects the quality of transportation (lower load factor could be recognized as a result of higher quality JIT transportation). Furthermore, a lower fare will be brought about by keener market competition pressures and lower wages. In this article we call the former (market competition) a direct effect and the latter (wage) an indirect effect. Therefore,

the fare function includes two instrumental variables that explain those effects: number of carriers and hourly wage level.

Transportation demand function (10)

Trucking fare, rail cargo fare, average length of trucking and GDP can explain transportation demand. The measure Tons-km is adopted as a representative transportation quantity. Trucking demand will be negatively affected by trucking fare while positively affected by rail cargo fare, average length and GDP. The average length has become longer as figure-3 shows, and we think this trend is brought about by the construction of roads, especially expressways. Thus, the average shipment length is a variable that reflects road constructions, and shippers' surplus will increase because of the fare decrease.

Carrier Function $NC = NC\,(YP, SC, DD)$ (6)
(+) (-) (+)

Wage Function $WT = WT\,(YR, \underline{NC}, WA)$ (7)
(+) (-) (+)

Labor Supply Function $LT = LT\,(\underline{WT}, LP)$ (8)
(+) (+)

Fare Function $PT = PT\,(AT, \underline{WT}, RC, \underline{NC})$ (9)
(-) (+) (+) (-)

Transportation Demand Function $TK = TK\,(\underline{PT}, PR, AL, YP)$ (10)
(-) (+) (+) (+)

5.2. Result of the Estimation

Expressions (6) - (10) were specified as (6') - (10'). We transformed them into logarithmic form and estimated the parameters in two stage least squares with the time series data from 1967 to 2002. The underlined variables are instrumental variables in (6) - (10). The estimated results are (11) - (15) and all signs, t-values and coefficients of determination are good[6].

$$NC_t = \alpha \cdot YP_t^{\beta} \cdot SC_t^{\gamma} \cdot e^{\delta DD} \qquad (6')$$

$$WT_t = \varepsilon \cdot YR_t^{\zeta} \cdot NC_t^{\eta} \cdot WA_t^{\theta} \qquad (7')$$

$$LT_t = o \cdot WT_t^{\rho} \cdot LP_t^{\sigma} \qquad (8')$$

$$PT_t = \iota \cdot AT_t^{\kappa} \cdot WT_t^{\mu} \cdot RC_t^{\nu} \cdot NC_t^{\xi} \qquad (9')$$

$$TK_t = \tau \cdot PT_t^{\phi} \cdot PR_t^{\chi} \cdot AL_t^{\psi} \cdot YP_t^{\omega} \qquad (10')$$

$$\ln NC = \underset{(54.49)}{12.1948} + \underset{(22.86)}{1.3530} \ln YP - \underset{(-11.50)}{1.0539} \ln SC + \underset{(2.84)}{0.0486} DD \qquad (11)$$

$$\bar{R}^2 = 0.986,\ SE = 0.031,\ DW = 0.635,\ n = 36$$

$$\ln WT = \underset{(8.81)}{2.9274} + \underset{(3.76)}{0.2841} \ln YR - \underset{(-3.68)}{0.2858} \ln NC + \underset{(9.62)}{0.9040} \ln WA \qquad (12)$$

$$\bar{R}^2 = 0.984,\ SE = 0.031,\ DW = 0.771,\ n = 36$$

$$\ln LT = \underset{(-4.95)}{-8.9946} + \underset{(4.36)}{0.5431} \ln WT + \underset{(7.34)}{2.1516} \ln LP \qquad (13)$$

$$\bar{R}^2 = 0.937,\ SE = 0.091,\ DW = 0.924,\ n = 36$$

$$\ln PT = \underset{(11.01)}{4.9662} - \underset{(-20.04)}{1.0961} \ln AT + \underset{(10.56)}{0.4433} \ln WT + \underset{(14.21)}{0.7607} \ln RC - \underset{(-13.31)}{0.6062} \ln NC \qquad (14)$$

$$\bar{R}^2 = 0.977,\ SE = 0.019,\ DW = 1.681,\ n = 36$$

[6] In parentheses, are the t-values. $\bar{R}^2$ is the adjusted coefficient of determination: *SE* is standard error: *DW* is the Durbin - Watson ratio and *n* is sample size. We carried out one of the major unit root tests, the Phillips - Perron test (no trend, optimal lags are determined by the AIC2 rule) and the co-integration test before regressions. The results of the tests are shown in table-7 and 8. Then, we recognize we can use our data in level.

$$\ln TK = 8.1818 - 0.3125 \ln PT + 0.1268 \ln PR + 0.7634 \ln AL + 1.2821 \ln YP \qquad (15)$$
$$(19.68) \quad (-6.77) \quad (4.03) \quad (9.78) \quad (28.28)$$

$$\bar{R}^2 = 0.998, \quad SE = 0.022, \quad DW = 1.181, \quad n = 36$$

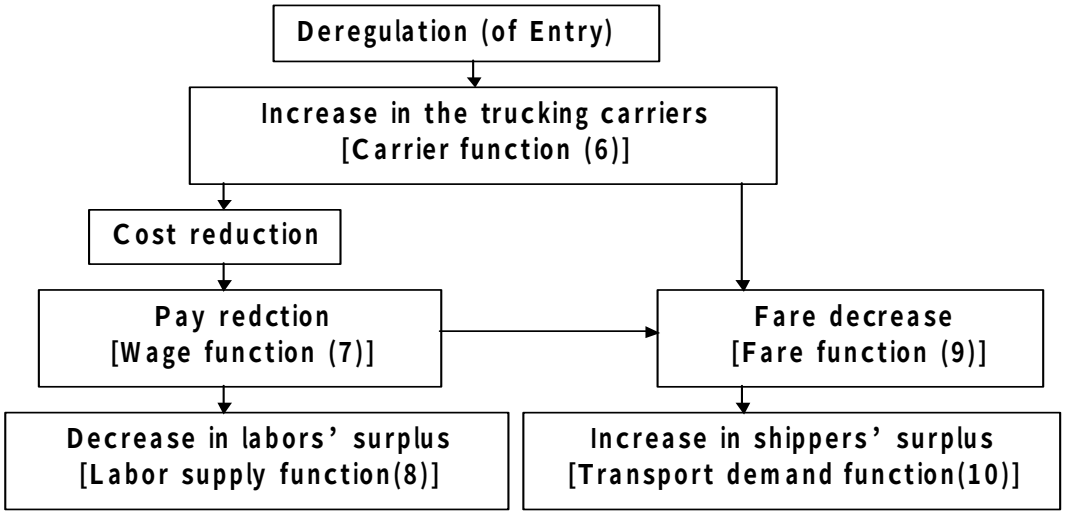

Figure-9 The model

Table-5 Definition of Variables

Variables	Definition
NC	Number of trucking carriers
YP	GDP per capita
SC	Average scale of trucking carrier (= number of trucks / number of carriers)
WT	Average wage per hour in the trucking industry
YR	Average length of service
WA	Average wage per hour in overall industry
PT	Trucking fare per tons-km
AT	Average load factor
RC	Average ordinary cost except for labor cost (= [ordinary cost - labor cost] / kilometric performance)
LT	Employees in the trucking industry
LP	Population of worker
TK	Tons-km by trucking
PR	Rail cargo fare per tons-km
AL	Average length of trucking
DD	Deregulation dummy (until 1990 = 0, after 1991 =1)

Note: Price data are deflated in 1990 price.

Table-6 Annual average of surplus change (billion yen, 1990price)

	Shippers' surplus			Laborers' surplus	Social surplus change (= Shippers' surplus + Laborers' surplus)
	Direct effect	Indirect effect	Total Effect	Total Effect	
Case I	345	72	418	-177	241
Case II	347	73	419	-75	344

Table-7 Result of the Unit Root Test

Phillips-Perron test			
Variables	Test statistics	Number of lags	P-values
ΔlnNC	-41.8708	3	0.0000
ΔlnYP	-11.4966	2	0.0942
ΔlnSC	-29.2474	4	0.0012
ΔlnWT	-20.7374	2	0.0097
ΔlnYR	-40.7039	2	0.0001
ΔlnWA	-19.6898	2	0.0126
ΔlnPT	-37.8706	2	0.0001
ΔlnAT	-12.2784	6	0.0778
ΔlnRC	-37.9043	2	0.0001
ΔlnLT	-33.8245	9	0.0004
ΔlnLP	-18.3170	2	0.0177
ΔlnTK	-12.2892	2	0.0776
ΔlnPR	-22.0637	10	0.0070
ΔlnAL	-17.7063	10	0.0206

Table-8 Result of the Co-integration Test

Phillips-Perron test			
Variables	Test statistics	Number of lags	P-values
EC	-23.5928	2	0.0048
EW	-14.1099	3	0.0498
EP	-28.5317	2	0.0014
EL	-30.3578	10	0.0009
ET	-19.3597	2	0.0136

To summarize: the number of carriers (*NC*) increases according to GDP (*YP*) growth while it decreases due to the enlargement of carriers scale (*SC*) (11). In particular, GDP has a large

elasticity (The parameter is 1.3530.) and the deregulation dummy (*DD*) variable affects the increase of carriers significantly. Secondly, in expression (12) the longer length of service (*YR*) and the higher wage level in overall industry (*WA*) contribute to higher wages in trucking (*WT*), although more carriers (*NC*) have a negative effect. The labor supply function (13) shows that changes in wage levels in trucking (*WT*) and the population of workers (*LP*) have had positive effects on the number of trucking employees (*LT*). From expression (14) we can see a lower load factor (*AT*), which reflects a higher quality of transportation, a higher average cost - with the exception of labor costs - (*RC*) and a higher wage (*WT*) bring higher fares, while more carriers (*NC*) bring lower fares. Finally, from the transportation demand function (15), the parameter of trucking fares (*PT*) shows that higher fares make less trucking demands (*TK*) but that trucking demand is not elastically adjusted by their own fares (The parameter is -0.3125.). This value corresponds to the existing studies (For example it is -0.18 in Yamauchi [1996] and -0.47 in Flath [2001].). We can recognize that there is a substitute relationship between trucking demand and rail cargo demand because the parameter of rail cargo fares is significantly positive. Average length (*AL*), which is a proxy variable for road construction, and GDP (*YP*) growth have positive effects. Thus, these estimated results could be reasonable.

5.3 Change of the Surplus Distribution

We analyzed the change in welfare caused by deregulation in figure-10 and estimated the results, given in expressions (11) - (15). We think it would be possible to draw the surplus distribution change by the deregulation as the following mechanism.

The first quadrant in figure-10 shows a relationship between the number of carriers (*NC*) and trucking fares (*PT*) in (14). There is a negative relationship between these elements as known by the parameter of *NC* (-0.6062). In the same way, trucking wages (*WT*) and the number of carriers (*NC*) are extracted from (12) in the second quadrant. There is also a negative relationship in this comparison. The third quadrant shows a positive relationship between employees (*LT*) and wage (*WT*) in (13). A negative relationship between trucking demand (*TK*) and fares (*PT*) in (15) are drawn in the fourth quadrant.

The number of carriers resulting from deregulation is *L* in the figure-10. The estimated number of carriers would be *K* without deregulation [*DD* = 0 in (11)]. Our model thinks the number of carriers could be pushed up from *K* to *L* by deregulation. Therefore as the equilibrium shifts from *M* to *N*, then fare goes down from *E* to *F* in the first quadrant, and as the equilibrium transfers from *P* to *Q* then wages drop from *A* to *D* in the second quadrant. In the third quadrant, the equilibrium shifts from *B* to *C* because of the wage dropping. The trapezoid *ABCD* is recognized as a declined laborers' surplus (*LS*) as a result of deregulation. Finally, the equilibrium moves from *H* to *I* because of the fare dropping and we define the trapezoid *EFIH* as directly increased shippers' surplus due to deregulation (direct effect), which is directly brought by keener market competition. Additionally, the trucking fare could be lower through wage dropping as shown in the second quadrant, then fares transfer from *F* to *G*. We define the trapezoid *FGJI* as an indirectly increased shippers' surplus due to deregulation (indirect effect). As a result the total effect for shippers (*SS*) is the trapezoid *EGJH*.

Table-6 shows the estimated annual average of the increased shippers' surplus and decreased laborers' surplus in the 12 years since deregulation (1991-2002). To calculate each

surplus change we use the actual measurement as data under deregulation in case Ⅰ and the reproduction measurement by regression results (11) - (15) in case Ⅱ. Data without deregulation are estimated by (11) - (15) in both cases [*DD* = 0 in (11) as mentioned above]. The effects for shippers' surplus are estimated as about the same in both cases: an annual average increase of 420 billion yen. The direct effect is estimated at about 350 billion yen, which accounts for 0.07% of GDP and the indirect effect is estimated at 70 billion yen and accounts for 0.02% of GDP (in 1990 prices). On the other hand, the effects for laborers' surplus are estimated at -180 billion yen (in case Ⅰ) and -75 billion yen (in case Ⅱ), while net increases of social surplus, which are offset by the surplus transfers from laborers to shippers are calculated at about 240 billion yen (in case Ⅰ) and 340 billion yen (in case Ⅱ). Case Ⅱ especially suggests that the decreased laborers' surplus would be mostly an indirect effect of the shippers' surplus. Therefore, deregulation has brought a certain increase of shippers' surplus, but about 20 - 40% of the increase would be transferred from the decrease of laborers' surplus. Moreover, average operating profitability has dropped by 2% since deregulation [average profitability before deregulation (1980-90) is 3.2%, it is 1.2%, after deregulation (1991-2002)]. The profit change from these profitability changes, is estimated at an annual average of -230 billion yen. If we assume this decrease of profit transferred to the shippers' surplus, the social net surplus would hardly increase in case Ⅰ and would increase only 100 billion yen in case Ⅱ.

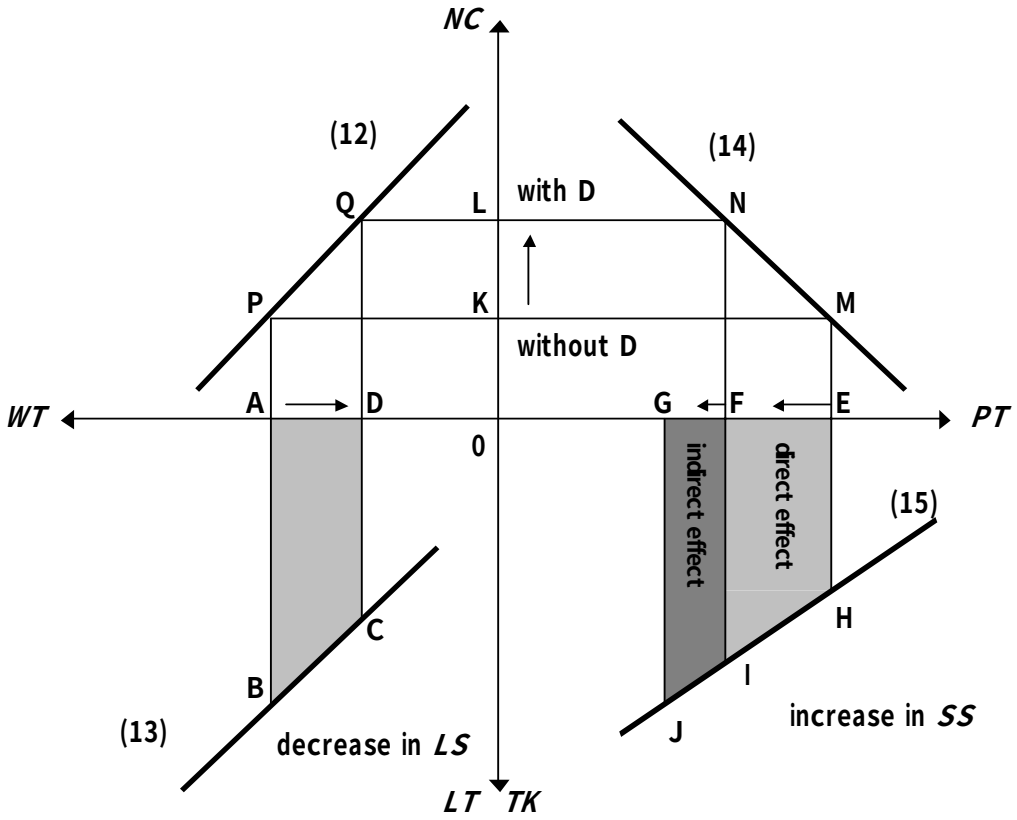

Figure-10 Surplus distribution changes

6. Conclusion

After all deregulation in the Japanese trucking industry has made the trucking market competition keener through promoting new entries. The increase of the trucking carriers would be the biggest effect by deregulation. TL carriers had been increased by 37%, absolutely by over ten thousand from 1990 to 2000. Moreover, higher quality of transportation would be provided by more JIT transportations. We could say the deregulation policy has brought a positive effect because shippers' welfare has been obviously improved (over 400 billion yen annually which corresponds to 0.09% of GDP) without large trucking market confusion. However, this study

finds that some of the shippers' surplus increase is transferred from the decrease of laborers' surplus by wage dropping, and from the decrease of producers' surplus by profitability dropping. Thus, the net increase of social surplus has not been large.

Additionally, this finding corresponds to the fact that only large-scale trucking carriers with more than 101 trucks have improved their TFP after deregulation while small and medium scale carriers, which account for more than 98% of all carriers, have not done so. Therefore, the effect of a social surplus increase through improvement in carriers' productivity, which is one of the major objectives of deregulation, has been small.

Further, though the absolute wage level of trucking employees has not dropped, the difference of wage between trucking and industry overall has been expanding since deregulation. Then the wage of trucking is lower than that of industry overall by 10% on hourly wage base and by 25% on annual income base in 2002. The profitability of the trucking carriers at any scale has also dropped and recently it is nearly zero or negative. Generally, the probability of illegal trucking operations, for example over loading and overwork driving, has likely risen to secure a certain income and profit. And actually, traffic accidents caused by the commercial trucks have increased, with a higher growth rate than that caused by private trucks since deregulation, as mentioned above 3-4. It is important that we verify the effects of deregulation on the road safety in the near future.

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