

A STUDY ON MEASURING AND IMPROVING TRANSPORTATION PRODUCTIVITY IN CHINA

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INTRODUCTION

Since 1950's, great success has been turned out in transportation industry in China. But it is still unable to meet the demand of the national economic growth. Since 1980's, the reform of economic system has been carrying out in transportation industry. The purpose was to reinforce the capacity for development of enterprises, improve productivity, turn the focal point of the economic development from speed to effectiveness, raise their economic benefits. Therefore, one of the most important problems which economists in China are confronted with is how to measure and improve productivity in all the industrial enterprises, also in transportation firms. Based on the statistics data of input—output in shipping and ports over the years, this paper analysed the growth process of productivity since 1950's. Making use of Delphi technique, we induced the main factors that affecting productivity in transportation. Labor productivity has long been as the important and only target for measuring the productivity in China. But as it is a single input factor, productivity can not represent the result of input—output in enterprises exactly. Here, we used a model with three—factor production function to represent productivity after analysing the various inputs in transportation firms. Each exponent of input factor in the model reflects its elasticity respectively. A case study about port in south of China was given by using this method. The result reported the degree of effect that each input factor gived to the output, also reported the key factors increasing productivity of this port at the present.

Finally, based on the analysis, some suggestions were put forward to accelerate the development of transportation; first, it is very important to create a beneficial external environment for development of the firms. For instants, concessional policies should be ensured in taxation, loan and

etc; the pricing system of shipping, handling rate and other port tariff need to be adjusted; also, more autonomous authorities has to be given to the firms. Second, inside the enterprises, something significant should be done to improve productivity, such as; improving management level, accelerating the replacement of the equipments, promoting technical progress, and further perfecting the system of distribution.

1. PRODUCTIVITY OF TRANSPORTATION MEASURING IN CHINA

The target of transportation productivity statistics used to be point at labor productivity as same as other industries in China, for other input productivity such as fund productivity usually is considered in period of capital recovery. Labor productivity as one of the important economic measurement targets was counted by firms according to the productivity statistic criteria ruled by the government. There are two targets, labor productivity of total members (here after as LPTM), labor productivity of production personnels. The physical target is usually used for output measurement. For shipping and motor transport, the target of LPTM is as following

$$\frac{\text{Conversion ton—kilometers transported this year}}{\text{Average number of total members this year}} \quad (\text{Ton-kilometers per man year})$$

The conversion ton—kilometers means the sum of freight mileage and conversion passengers mileage, each passenger is converted to one ton. As the same, the target of output in port is measured in conversion tons, which is the sum of handled tons of freight and the number of passengers left from the port, so the target of LPTM for ports is conversion tons per man year as following

$$\frac{\text{Conversion tons handled this year}}{\text{Average number of total members this year}} \quad (\text{Tons per man year})$$

As a target of efficiency, labor productivity and equipment efficiency have been played an important role in measuring productivity of the firm, but it is not connection directly with the economic benefit especially in transportation enterprises. With the economic reform is progress in recent years, government and the firms have turned the attention from the amount of output growth speed to the economic benefit, so more and more attention has being paid to obtain the benefit. Now the targets of

other inputs productivity have being counted in the firms such as profit and tax rate per head and profit and tax ratio of capital.

2. ANALYSIS OF LABOR PRODUCTIVITY GROWTH IN WATER TRANSPORTATION

2.1. Data sources

The main transportation industries in China are rail, water transportation and motor, the transportation by pipeline and air is only about three percent of the total mileage. To investigate labor productivity growth process, we used data from Transportation Yearbook of China (1976—1990) and others were collected from ocean shipping companies,

Table 1 Labor productivity annual rate of growth %

	1970—1975	1976—1980	1981—1985	1986—1989	1970—1989
capital ports	2.4	5.5	5.6	0.3	3.5
Shipping	13.4	7.4	3	7.3	7.7
ports in changjiang river *	0.2	6.7	1.7	2.1	2.7

Source: * Changjiang Shipping Administration Bureau Annual Report.

Table 2 Labor productivity annual rate of growth in 4 capital ports 1953—1988 %

	Shanghai	Guangzhou	Qingdao	Qinghuangdao
1953—1957	5.3	11	9.7	20.8
1958—1962	9	-0.2	3.7	-8
1963—1965	-0.3	18	11.9	23.2
1966—1970	-0.6	-4	-3.5	-0.2
1971—1975	2.6	-1.6	10	16.4
1976—1980	8.6	5.3	-2.5	6.9
1981—1985	3.9	3.3	4.7	3.7
1986—1988	1.9	8.5	1.5	2.5
1953—1988	3.9	4	5.2	7.3
1953—1988	4.9*	4.7*	6.7*	8.4*

* :Growth rate of labor productivity of production personnels

Table 3 Contribution quota of labor productivity growth
to output growth in 2 ports

	Labor increase		Labor productivity gains	
	Guangzhou	Qingdao	Guangzhou	Qingdao
1953—1957	0	11	100	89
1958—1962	100	46	0	54
1963—1965	11	0	89	100
1966—1970	100	100	0	0
1971—1975	100	38	0	62
1976—1980	66	100	34	0
1981—1985	65	44	35	56
1986—1988	0	43	100	57

ports, Changjiang Shipping Administration Bureau as noted in the tables. The data listed in tables such as growth rates were calculated by using the original data. The stages of time in tables is divided by each Five Years Development plan in China except the economic adjusted period of 1963—1965.

2. 2. Analysis of the labor productivity growth process

As shown in table 1, 2, 3, it has been seen the characteristics of labor productivity growth process are as following: The labor productivity gained at different growth rate in capital ports, river ports and shipping industry. In capital ports it have been increased about three times and annual growth rate was about 4—5 percent during 1954—1989 and in the period of 1970—1989 it was 3.5 percent. In the same period, It was 2.7 percent in the ports of Changjiang river. Since the ocean shipping industry developed rapidly from 1970's, the growth rate of shipping is higher, it is 7.7 percent of annual growth rate during 1970—1989.

The growth rate of LPTM is varies greatly in different period. In the ports, for example, it gained fast during 1953—1957, as the base number of labor productivity level was very low in the early 50's, the production of ports almost finished by manpower at that time. It was also gained fast since 1976, especially in the period of 1975—1985, with the state economic reform and open door policy set up and capital inputs for ports were in-

creased greatly by the government. Labor productivity was dropped off during 1965—1970 the period of 'Culture Revolution' and the labor productivity level was just kept as in 1950's the output growth was caused by increasing of labor input as shown in table 3.

In all of transportation firms, the growth rate of labor productivity of production personnel is greater than the LPTM. That's caused by the ratio of production personnel of total. The ratio of productive personnel was decreased year by year. For example, it was usually at fifty to sixty percent of the total in early 1950's, but it was twenty—nine to thirty—six percent in 1989 in capital ports.

So the growth speed of labor productivity of ports was not rapid, and the contribution to the output growth is smaller except early 1950's and 1963—1965.

2. 3. Factors affecting productivity growth

Both government and enterprises are concerned with improving productivity in China, but the problem is in which area productivity can be improved. We used two ways to investigate the factors affecting transportation productivity growth. First, we collected opinions from managers, directors in ports and shipping companies, and then based on the survey we used Delphi technique to determine the factors and their important degree on productivity improvement. Table 4 shows the final result

Table 4 Important items affecting productivity

Item	Rank
State economic policy	1
Management level of the firm	2
Equipment efficiency and utilization	3
Distribution system (wages & bonus)	4
Labor utilization & Employees composition	5
Education level and Training	6

obtained from this study. Thirty—eight experts including economists, managers, engineers and professors returned the consultation forms at last turn, about thirty—two percent of them are senior economists. The respondents were asked to indicate on a five point scales how important the

item or subitem is from 5 (extremely important) to 1 (not at all on important consideration). The number of rank in table 4 was the result after calculation of mean importance scores and deviation squared of the items.

3. THE MODEL FOR EXAMINE PRODUCTIVITY

3. 1. The model

On consideration of the situation in transportation industry, we use a three factors production function to evaluate the productivity. The productivity of transportation industry can be expressed as the ratio of real output to real input as follow

$$P = Y/M \quad (1)$$

Here P is the total productivity, Y is the total output and M means the total input.

As mentioned above the total output is used to be expressed by the physical target, such as freight volume or freight mileage. The total input includes labor, equipment, capital, materials etc., in which the raw materials, energy consumption, part stores and consumable supplies are classed with intermediate input. So the total input M can be classed as follow: 1) labor input = average number of employees each year; 2) capital input = depreciation of productive fixed assets + interest expense caused by productive fixed assets + fund for major overhaul and technological improvement; 3) intermediate input = average occupied amount of normed current fund each year.

The model can be written as

$$Y = P \cdot M = P \cdot A^\alpha \cdot B^\beta \cdot C^\gamma \quad (2)$$

Here A —Labor input; B —intermediate input; C —capital input; α, β, γ —elasticity of labor, intermediate and capital input.

Considering national situation in China, big and medium size firms are usually owned the dormitories, hospitals schools for employees etc, which is impossible to affect the output directly. Eventhough they are taken into account of fixed assets, the depreciation of this part should not be considered into the model. As the same the depreciation of basic construction of ports, such as berths, docks is not taken into account. The interests expense caused by productive fixed assets are either interest expense of loan or profit and tax rate of capital of the firm.

Based on the data of inputs and output of the homogeneous firms, the

total productivity of firms can be calculated according to (2). The data of inputs and output is expressed in absolute numbers, the total productivity only reflects absolute production of the firm in a certain period. It is called the static productivity of firms. The productivity levels of different firms, in the same period, can be compared with by using the result calculated by this formula. In calculation, the sample should have a number of input and output data collected from homogeneous firms in the same period. Using the regression theory, the expected values $(\hat{P}, \hat{\alpha}, \hat{\beta}, \hat{\gamma})$ of $(P, \alpha, \beta, \gamma)$ can be obtained and \hat{P} represents the average productivity level in a certain period. Assume P_i is the productivity of the firm i , it can be obtained from following

$$P_i = Y_i/M_i = Y_i/(\hat{A}_i^\alpha \cdot \hat{B}_i^\beta \cdot \hat{C}_i^\gamma)$$

Y_i, A_i, B_i, C_i —output and input data of the firm i .

So the relative productivity can be expressed as P_i/\hat{P} .

Based on the formula (1), the dynamic total productivity can be reckoned by using input and output index targets as

$$p = (y/m) \cdot 100\% \tag{3}$$

Here p, y, m are the index of total productivity, total output and total input respectively. The result can reflect the productivity level in different periods. In order to get the real relative productivity, the constant price system should be used.

Beside the absolute and relative productivity, the formula of partial input productivity also can be developed so the relationship between input factor and productivity can be shown as three part targets:

$$\text{Labor productivity} = \frac{\text{total output}}{\text{labor input}}$$

$$\text{Capital productivity} = \frac{\text{total output}}{\text{capital input}}$$

$$\text{Intermediate input productivity} = \frac{\text{total output}}{\text{intermediate input}}$$

By using these total and partial productivity targets, the influence of each input factor to output can be evaluated and find out the main input factors which are related to the total productivity growth. Further more we can organize various inputs reasonably for getting the maximum economic benefit.

Through the partial derivative of formula (2), the following formulae are obtained

$$\alpha = \frac{A}{Y} \cdot \frac{\partial Y}{\partial A} \quad \beta = \frac{B}{Y} \cdot \frac{\partial Y}{\partial B} \quad \gamma = \frac{C}{Y} \cdot \frac{\partial Y}{\partial C}$$

$\frac{\partial Y}{\partial A}$ expresses the increment rate of output by vertical expansion of labor input when other input factors are constant. $\alpha = \frac{A}{Y} \cdot \frac{\partial Y}{\partial A}$ expresses the relative quota of labor input for output. Similarly β and γ respectively express the relative quota of the capital input and the intermediate input for output.

For getting the elasticities of input factors, formula (2) is firstly taken logarithm and changed nonlinear function into linear function.

$$\text{Log}Y = \text{Log}P + \alpha \cdot \text{Log}A + \beta \cdot \text{Log}B + \gamma \cdot \text{Log}C \quad (4)$$

Then the regression model can be as following

$$\begin{cases} \text{Log}Y = \text{Log}P + \alpha \cdot \text{Log}A + \beta \cdot \text{Log}B + \gamma \cdot \text{Log}C + \epsilon \\ \epsilon \sim N(0, \sigma^2) \end{cases}$$

The equation of above could be dealt with the statistical software package and productivity function of the sample copy, expressed by mathematical expectation, can be obtained.

$$\text{Log}P = \text{Log}Y - \alpha \cdot \text{Log}A - \beta \cdot \text{Log}B - \gamma \cdot \text{Log}C \quad (5)$$

For using formula (5), the significance tests must be taken after being created, such as T and F tests.

3. 2. Case study

For examine the model developed above, we have dealt with a couple of examples in water transportation industry. Here is a case study of port in south of China. Table 5 is the index data of input—output over the period 1952—1987 based on the calculation result by using the original input and output data of this port. These intermediate input data and capital input data are dealt with the constant price system.

Using the data of table 5, the productivity formula can be obtained by the statistical software package.

$$\text{Log}P = \text{Log}Y - 0.136\text{Log}A - 0.377\text{Log}B - 0.352\text{Log}C \quad (6)$$

Table 5 Input—output data of index

year	Labor input index	intermediate input index	capital input index	output index	year	Labor input index	intermediate input index	capital input index	output index
52	100	100	100	100	70	534.63	9417.65	806.85	1220.33
53	229.28	917.65	345.21	172.76	71	570.95	9879.41	861.64	1245.52
54	401.53	2102.94	574.34	211.06	72	603.59	9882.35	1001.37	1242.00
55	396.33	2164.71	867.12	299.23	73	606.88	12285.29	1143.84	1324.78
56	262.23	1628.41	726.03	442.89	74	598.32	15176.47	1241.10	1295.89
57	227.52	2064.71	586.30	399.26	75	642.58	15917.65	1502.74	1345.68
58	267.35	2332.35	700.00	562.95	76	735.17	18055.88	1801.37	1378.93
59	345.95	1708.82	597.26	716.10	77	850.76	20676.47	2191.78	1611.65
60	334.48	2947.06	805.48	779.71	78	938.61	26252.94	3241.10	2167.32
61	519.11	3841.18	924.66	622.35	79	948.78	32814.71	4241.10	2432.74
62	319.42	4855.88	1001.37	539.06	80	968.77	29682.35	4828.77	2487.46
63	321.94	3308.82	913.7	644.52	81	1024.62	2868.35	5076.71	2673.98
64	327.14	3355.88	934.25	798.79	82	1065.60	27141.18	3053.42	3095.93
65	347.48	4288.24	1108.22	988.67	83	1061.09	27835.29	3201.37	3304.47
66	423.70	4238.24	1338.36	1125.90	84	1175.31	26244.12	3338.36	3405.01
67	448.62	5905.88	1610.96	1076.64	85	1202.14	27232.35	4057.53	3606.11
68	498.01	6355.88	1828.77	1153.09	86	1287.77	31200.00	4756.16	3849.88
69	502.22	7091.18	1880.82	1156.65	87	1290.1	41129	6887.2	4461.3

Table 6 Productivity data of index

year	Labor productivity index	intermediate productivity index	capital productivity index	total productivity index	year	Labor productivity index	intermediate productivity index	capital productivity index	total productivity index
53	100	100	100	100	70	303	69	302	194
54	69	53	73	69	71	290	67	289	189
55	100	73	69	84	72	273	67	248	177
56	224	144	122	156	73	290	57	231	166
57	232	103	136	141	74	287	45	209	146
58	279	128	161	175	75	278	45	179	137
59	275	223	240	256	76	249	41	153	134
60	309	141	193	205	77	251	41	147	125
61	159	86	134	133	78	306	44	134	133
62	224	59	108	110	79	340	39	115	125
63	266	103	141	156	80	335	45	103	126
64	324	126	171	190	81	346	50	105	134
65	378	122	178	201	82	386	61	203	188
66	353	141	168	209	83	413	63	206	190
67	319	97	134	164	84	384	69	204	201
68	307	96	126	161	85	398	70	178	195
69	306	87	123	151	86	397	65	162	185

The average productivity P of this port every year is determined from

the formula (6) . Table 6 is the results of productivity index of this port.

Table 6 shows that although the labor productivity has been increased nearly 3 times during 1953 to 1986, the capital productivity only gained 62% and the intermediate input productivity is reduced obviously. The total average productivity is gained 85%. The result shows that the substitution between the input factors is obviously possible.

CONCLUSION

Being an important productivity target, labor productivity reflects labor efficiency. It's valuable to search out the factors which affect the development of labor productivity and point out the channel of improving labor productivity based on the analysis. But a problem has to be mention that in recent years, in some enterprises, although labor productivity maintained a good growth momentum basically , the business met series of difficulty year after year, so there is no direct contact between the growth of labor productivity and economic benefit of the firm. Of course the reasons were very complicated. With the deepening of the economic reform, especially when they faced with tightness of money, more and more firms realized gradually that a good economic benefit can be obtained only when the productivity has been raised. Consequently ,it's essential to develop a target system which can be used to measure the total productivity level in transportation. This paper had done a bash at this point. On the other hand, as installations of transportation is a part of the basic installation of the whole society. The obscure relationship between the government authority and enterprises ,and the socialization of the enterprises made it more difficult to analyse the input factors. Therefore, more research work should be done in the field of the transportation productivity.

After all these analysis above ,in order to improving transportation productivity, we suggest that ,first, a good external environment should be created for enterprises, For example, so far as economic policy of the country is concerned, we should like to put forward the following proposals: (1) In order to ensure the effectiveness and capacity for extending reproduction of the enterprises, the pricing of shipping, handling rate and other port tarriff should be rectified the part of pricing that isn't in keeping with law of value should be cleared up. (2) Concessional policies

should be provided for enterprises in taxation ,loan and etc. ,so as to give full play to differential rate. (3)More autonomous authorities should be guarantee for the enterprises in system of personnel,wage and salary ,operation of capital ,and etc. (4)In conditon of tightness of money at present ,we should encourage enterprises to excavate their potential capacity, uphold and give concessional policy for their renewe and reformation of technique . (5)Further perfect managerial system in transportation industry ,restrict the behaviour of the enterprises and the markets with law or regulation.

Considering the enterprises,some ideas to improve productivity are stated as following:(1)Further improve the basic quality of the directing staffs and employees,promote managerial modernization. (2)Perfect the contracted managerial responsibility system for enterprises, reform and improve distribution system(wage & bonus). Arouse the activity of employees. (3)Carry out and excellent the system of personal responsibility of post . Reduce the ratio of unproductive personnel. (4)Adopt advanced scientific technology. Speed up the renewal of the equipment,raise the depreciation rate. (5)Strengthen the link of training employees. Heighten their cultural level and technological skill level.

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