Analysis of the role of maritime freight transport industry in the Korean national economy

Young Yoon Choi*, Hun-Koo Ha** and Minyoung Park***

Abstract

The maritime freight transportation industry has played an important role in the Korean economy. The Korean maritime freight transportation industry is faced with a period of transforming it competitively and efficiently in this global age. This paper, therefore, aims to identify the impact of the maritime freight transportation industry in the Korean national economy. Hence, this paper provides policy-makers with accessible and reliable information regarding the role of the Korean maritime freight transportation industry. This study employs input-output (I-O) analysis to examine the role of the maritime freight transportation industry in the national economy for the period 1995-2003, with specific application to Korea. This study pays particular attention to the maritime freight transportation industry by taking the industry as exogenous variable and then investigates its economic impacts. We identify inter-industry linkage effects in 20 sectors, production-inducing effects, added value-inducing effects, and supply-shortage effects of the maritime freight transportation industry.

Keywords: Maritime freight transportation industry, Input-output (I-O) analysis, Production-inducing effects, Added value-inducing effects, Supply-shortage effects.

1. Introduction

The maritime freight transportation industry, which takes up the biggest proportion of freight

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*Graduate Student, Inha University, 253 Yonghyun-dong, Nam-Gu Incheon 402-751, Korea.

**Corresponding Author; Professor, Asia Pacific School of Logistics, Inha University, 253 Yonghyun-dong, Nam-Gu Incheon 402-751, Korea. E-mail: hkha@inha.ac.kr

***Assistant Professor, Graduate School of Logistics, Inha University, 253 Yonghyun-dong, Nam-Gu Incheon 402-751, Korea. E-mail: mypark@inha.ac.kr

transportation, is becoming even more important with the advent of globalization. Research on the maritime freight transportation industry is very essential, especially for our country with Busan seaport (one of the main seaports in the world) and Incheon seaport, which is being nurtured by the nation as a part of a strategy to become a hub of Northeast Asia. Moreover, our country has the geopolitical merit of being located in Northeast Asia, alongside the developing economy of China and the second greatest economy in the world, Japan. We also have a basic infrastructure that has a promising potential for development, such as seaports, airports, and railroads. Thus, for our country, the maritime logistics industry is in the limelight as a strategic industry.

However, even though a lot of research in the maritime freight transportation industry area is underway, there are on a few in-depth and precise researches. Also, researches on the ripple effect of the maritime freight transportation industry investment and the pervasive effect of the maritime freight transportation industry on the economy as a whole, are still inadequate.

Moreover, no matter what kind of industry it is, its future tendency is analyzed through the analysis of its trend. But research on the pervasive effect trend of the maritime logistics industry is even more insufficient. Therefore, this research defines and classifies the maritime freight transportation industry in reference to prior research or preexisting documents. This research also uses the survey input-output tables (1995, 2000, 2003) that have been published for ten years and analyzes the pervasive effect of the maritime freight transportation industry on the economy and its trend. When examined in detail, the maritime freight transportation industry's importance to the economy is readily apparent, a big proportion of products are supplied as intermediate products, and the dependent relationship to other industries are definite. According to this importance, the demand-driven model will be used for measurement, and the supply-shortage effects will be measured by use of the supply-driven model. Also, because intermediate logistics is a critical economic component, it directly and indirectly affects the price level of other areas. Other than this, the subject variable of the I-O model will be treated as exogens, and exogenous specification will be used to easily examine the effects of the variable on endogenous economic areas. This will enable more accurate measurement of various pervasive effects. With the results of the research above, the importance of the intermediate maritime freight transportation industry will be described, and policy implications will be made.

2. Literature review

The research on the logistics industry that used the input-output analysis is insufficient, but a lot of researches on the maritime area have been implemented. This appears to be because the maritime area has been the subject of interest as an important transportation method, even before national policies and research on the logistics industry began to receive focus.

First, the research done on the maritime industry (outport maritime, ocean industry, ship building, seaport) by Chang et al. (2006) will be specifically organized mainly by using input-output analysis. And with the input-output tables of 1990, 1995, and 2000, policy proposals are made by measuring and analyzing the industry structure, rate of intermediate input, rate of added-

value, production driven effect, and forward-backward linkage effect, mainly on the outport transportation area and coast, internal upper river area. In the research implemented by Lee et al. (2006)- as a subsequent research to the previous research--the research range was expanded to the transportation area, as well as the pervasive effect of railroad passenger, railroad freight, road passenger, road freight, coast and internal upper river transportation, outport, and air transportation. If we examine other researches related to maritime transportation, Jung (2004) exceeded preexisting researches that used only the demand-driven model, and he used the Leontief price model and measured the pervasive effect of price change of the maritime transportation and seaport service on the economy.

In this research, the maritime transportation and seaport industry classification was reconstructed, based on the classification indicated in the law (maritime transportation legislation, seaport transportation business law, harbor law, ferry law) and the National Statistical Office data, to upper river transportation, upper river transportation auxiliary service, part of cargo loading or unloading, part of warehousing, part of dummy sectors transportation related service, etc. In this research, the area's pure pervasive effect of price change was measured by using exogenous specification. And in the process of reconstruction, the basic areas were divided in accordance to the research goal, using the total productivity index, so that more precise classification could be implemented. However, there was a limit of not being able to analyze the trend because the analysis was just for one year.

Oh et al. (2003) measured the relationship and pervasive effect of the maritime transportation industry and other related service industries. In this research, due to the classification limits of input-output tables, maritime transportation was defined in the outport transportation area, and categories that are similar to the range of this research, such as railroad, road, air freight transportation, land/air transportation auxiliary service, and cargo loading or unloading, warehousing, and other dummy sectors transportation related service industries were included. However, the classification limit inside the input-output tables could not be overcome, and the analysis area could not be treated as exogenous areas. Thus, there was a limit in accurately measuring the pervasive effects.

Gwak et al. (2005) measured the pure pervasive effect in a different way than the preexisting researches, by using exogenous specification to measure the pervasive effect of Korea's ocean industry on the economy, with the research topic, 'Analyzing the pervasive effect of the ocean industry on the economy using input-output analysis'. Not only the preexisting demand driven model, which measures the pervasive effect derived from the change of demand, used, but so was the supply driven model to measure the pervasive effect driven from the change of supply.

If we look at the methodological traits, for the exogenous specification areas, in the research done by Yu et al. (2004), to overcome the demerit of the difficulty of relative comparison that stems from the fact that exogenous specification provides only the pervasive effect numbers of the research topic, a rational comparison possibility was sought by showing the exogenous specification numbers of other various areas, such as the radio wave industry, power generation industry, transportation industry, and etc.

Based on the previous analysis results of preexisting researches, out of the various methods used as the input-output analysis method, this research measured the production-derived effect and supply-shortage effects of the 1995, 2000, and 2003 input-output tables, which are recent actual

measurement tables published by the Bank of Korea. The economic status of the maritime logistics industry will be understood, and the yearly trend and the pure pervasive effect will be analyzed through exogenous specification. Moreover, the pervasive effect of price change and the added value driven effect will be measured.

3. The methodology

3.1 General framework of the I-O analysis

The I-O model is a linear and inter-sectoral model that shows the relationships among the productive sectors of a given economic system. The basic balance equations of the I-O model consisting of N industry sectors can be expressed as

$$X_i = \sum_{j=1}^n X_{ij} + Y_i = \sum_{j=1}^n a_{ij} X_j + Y_i \quad (1)$$

$$X_j = \sum_{i=1}^n X_{ij} + W_j = \sum_{i=1}^n r_{ij} X_i + W_j \quad (2)$$

where X_i is the total gross output in sector $i = 1, \dots, N$, a_{ij} are direct input or technical coefficients which divide X_{ij} the inter-industry purchases of producing sector i from supply sector j by X_j total gross output in sector j ; r_{ij} are direct output coefficients which divide X_{ij} the inter-industry purchases of producing sector i from supply sector j by X_i total gross input in sector i ; and Y_i the final demand for products in sector i , and W_j final value added by sector j . Thus, Eq. (1) describes the demand-driven model as viewed vertically in the I-O tables, while Eq. (2) expresses the supply-driven model as horizontal manner.

3.2 Demand-driven model

Production-inducing effect

Eq. (1) can be rewritten in an abbreviated matrix form as

$$X = (I - A)^{-1} Y \quad (3)$$

denotes the $N \times N$ identity matrix and $(I - A)^{-1}$ is called the Leontief inverse matrix of which elements $(a_{ij} = \partial X_i / \partial Y_i)$ represent the total direct and indirect outputs in sector i per unit of final demand in sector j . The standard demand-driven model explained above, however, cannot exactly

assess the effects of new production activity in the maritime freight transportation industry on all other sectors of the economy because changes in the final demand come about as a result of forces outside the model (e.g., changes in consumer tastes and government purchases). For this purpose, the maritime freight transportation industry or needs to be handled as exogenous and put into the final demand group. This approach is henceforth referred to as the logistics industry sector-based I-O analysis.

Adding subscript 'e' to the new matrices and subscript 'K' to vectors related to the maritime freight transportation industry sector gives $e = (I - A^e)^{-1}(Y^e + A_K \Delta X_K)$. Assuming $\Delta Y^e = 0$ then yields

$$\Delta X^e = (I - A^e)^{-1}(A_K^e \Delta X_K) \quad (4)$$

Eq. (4) can be used to analyze the essential relationship of inter-industries for efficient production with the maritime sector as an infrastructure and to evaluate the impact of a change in logistics supply investments of the maritime freight transportation industry sectors on the output of all other sectors, that is, the production-inducing effect.

Added value-driven effect

The added value driven effect shows the pervasive effect of a unit change of the final demand of that area, on the added value area.

$$W = \hat{A}_v X = (I - A)^{-1} Y \quad (5)$$

Here, $\hat{A}_v$ is the added value coefficient matrix, and it is the added value coefficient that is converted into a diagonal matrix. Here, the added value coefficient is defined as $a_v = W_j / X_j$, and this shows the change of added value, according to a unit change of the output. $\hat{A}_v$ is made of each diagonal element of the added value coefficient matrix ($1 \times n$). Equation (5) becomes equation (6), when it is used to find out the added value driven effect.

$$W = \hat{A}_v \Delta X = \hat{A}_v (I - A)^{-1} \Delta Y \quad (6)$$

Here, $\hat{A}_v (I - A)^{-1}$ is the added value driven coefficient matrix, and this shows the change of added value according to a unit change of the final demand of a certain industry. To examine the added value driven effect of the increase in output of area K on other industries, under the premise that there is no change in the final demand, equation (6) become equation (7), as area K goes under exogenous specification.

$$\Delta W^e = \hat{A}_v^e (I - A^e)^{-1} (A_K^e \Delta X_K) \quad (7)$$

$\hat{A}_v^e$ is the matrix that is left after excluding the row and column of area K added value coefficient matrix. The added value driven effect from the output increase of area K can be calculated through equation (7).

Inter-industry linkage effect analysis

The linkage effect analysis to quantify the strength of causation among industries was based on the assumption that the economy in related industries can be boosted through linking input and output activities. In general, the linkage effect is classified into the backward linkage effect and the forward linkage effect. The backward linkage effect is represented as the power of dispersion, which is the average of n elements in column of j the Leontief inverse matrix divided by average of all n^2 elements. Similarly, the forward linkage effect is expressed as the sensitivity of dispersion, which is the average of n elements in row i of the Leontief inverse matrix divided by all n^2 elements. If some industries have both power of dispersion and sensitivity of dispersion values greater than one for both forward and backward linkage effects, these industries play important roles in economic development in supporting other industries (forward linkage effect) as well as boosting other industries (backward linkage effect). Focusing on the maritime freight transportation industry, the backward linkage effect indicates that production activities of the individual sector may induce greater use of other sectors as an input for maritime logistics production. On the other hand, the forward linkage effect means that maritime production may be used as an input to other sectors for their own production. The high amount of intermediate inputs means the nature of logistics sector involving the assembly of many different products purchased from a large number of industries. The Forward and backward linkage effects are useful in assessing the impact of the maritime freight transportation industry sector on the national economy as a whole.

$$FL_i = \frac{\frac{1}{n} \sum_{j=1}^n a_{ij}}{\frac{1}{n^2} \sum_{i=1}^n \sum_{j=1}^n a_{ij}} \quad (8)$$

$$BL_j = \frac{\frac{1}{n} \sum_{i=1}^n a_{ij}}{\frac{1}{n^2} \sum_{i=1}^n \sum_{j=1}^n a_{ij}} \quad (9)$$

3.3 Supply driven model

The conventional I-O model, which depends on the assumption of fixed input coefficients and a perfectly elastic supply of inputs, concentrates on analyzing the impacts stemming from the final

demand, or backward linkage, and output orientation of activities. However, the conventional I-O model may not be appropriate for dealing with the impact of primary supply, or forward linkage, and the input orientation of activities. Therefore, the supply driven I-O model has been developed to deal with the direct and indirect impacts of supply restrictions. Eq. (2) can be rewritten in an abbreviated matrix form as $'=W(I-R)^{-1}$. A prime (') denotes the transpose of the given matrix and R is the output coefficient matrix.

$(I-R)^{-1}$ is named as the output inverse matrix of which elements ($r_{ij}=\partial X_j/\partial W_i$) represent the total direct and indirect requirements in sector j per unit of final value added in sector i . As is the case with the demand-driven I-O model, treating the maritime freight transportation industry sector as exogenous and assuming that there is no change in value-added in all other sectors.

$$\Delta X^{e'} = R_k^e \Delta X_K (I - R^e)^{-1} \quad (10)$$

Eq. (10) can enable evaluation of the impacts of a unit shortage in the maritime freight transportation industry sector on the output of all other sectors and be used as a basis to define shortage or failure costs of maritime logistics production.

4. Results

4.1 Reconstructed I-O table

Table 1 is the restructured input-output tables. It was restructured into a total of 20 sectors, focusing on the maritime freight transportation industry and logistics sectors. The reconstructed input-output table is like Table 1. It is reconstructed to a total of 20 areas, and the logistics industry was divided into 6 sections. Because the logistics industry is a synthetic one, which made up of different areas of various characteristics (such as transportation, warehousing, and service), dividing it into different modes was deemed more realistic and precise, than analyzing it as one area. This is why it was divided into 6 sections. Especially, in reference to the definition, the dummy sectors in transportation service were renamed into logistics service. Other than this, the agriculture, forestry, and fishing; mining and quarrying; electricity, gas, water supply were reconstructed as the synthetic big group. Manufacturing includes light and heavy industry. Also, the wholesale and retail trade area (which was renamed because it was the wholesale and retail trade of road, railroad facilities related to logistics, and the extracted maritime/air passenger area) was added to the preexisting railroad/road passenger area, forming a passenger area.

Table 1
Reconstruct I-O table

Number	Sector	404 sector (I-O table)	Rate			Remarks
			1995	2000	2003	
1	Agriculture, Forestry, and Fishing	1~30	1	1	1	
2	Mining and Quarrying	31~45	1	1	1	
3	Manufacturing	46~304	1	1	1	
4	Electricity, Gas, Water supply	305~311	1	1	1	
5	Road construction	317	1	1	1	
6	Railroad construction	318	1	1	1	
7	Subway construction	319	1	1	1	
8	Break water, Pier, and Harbor construction	320	1	1	1	
9	Airport construction	321	1	1	1	
10	Construction	312~316, 322~328	1	1	1	
11	Service	331~332, 340~342, 346~401, 345 (travel service)	1+0.37(travel service)	1+0.26(travel service)	1+0.23(travel service)	
12	Dummy sectors	402~404	1	1	1	
13	Passenger transportation	333, 335, 337~339 (passenger)	1+0.01 (maritime passenger) +0.73(air passenger)	1+0.02 (maritime passenger) +0.66(air passenger)	1+0.02 (maritime passenger) +0.67(air passenger)	
14	Wholesale and Retail trade	329~330	1	1	1	
15	Railroad freight transportation	334	1	1	1	logistics industry
16	Road freight transportation	336	1	1	1	
17	maritime freight transportation	337~338	0.99	0.98	0.98	
18	Air freight transportation	339	0.27	0.33	0.33	
19	Warehousing and Cargo loading or unloading operations	343~344	1	1	1	
20	Logistics service	345	0.63	0.74	0.77	

4. 2 Demand driven model analysis

The previously presented equations were used, and applied to the realigned input-output tables.

By using the demand driven model that measures the pervasive figures resulting from changes in the final demand, the production derived effect, added value driven effect, forward linkage effect, and the backward linkage effect were examined.

The production driven effect

By applying the equation previously stated in the research method clause, the production driven coefficients were deduced, as stated in Table 2. The production-driven coefficient is the output amount that needs to be produced, according to a unit change in the final demand (investment, etc.) of an industry product.

Table 2
The production driven effect

Sector	1995		2000		2003	
	value	rank	value	rank	value	rank
Agriculture, Forestry, and Fishing	1.8102	16	1.9468	15	2.0079	15
Mining and Quarrying	1.7253	18	1.8559	16	1.8450	16
Manufacturing	2.6860	5	2.8879	4	2.8467	3
Electricity, Gas, Water supply	2.1265	11	2.1937	14	2.1779	14
Road construction	2.3438	9	2.3147	11	2.3759	9
Railroad construction	2.8616	2	2.8595	5	2.7841	5
Subway construction	2.7777	3	2.9590	3	2.8541	2
Break water, Pier, and Harbor construction	2.3012	10	2.3564	10	2.2485	12
Airport construction	2.6971	4	2.4211	9	2.3439	10
Construction	2.4094	8	2.4428	8	2.4005	8
Service	1.7298	17	1.8218	17	1.8159	18
Dummy sectors	3.2464	1	2.9954	2	3.0859	1
Passenger transportation	2.0441	12	2.2533	13	2.2739	11
Wholesale and Retail trade	1.7072	19	1.7734	18	1.8230	17
Railroad freight transportation	1.8371	15	2.7747	6	2.6697	7
Road freight transportation	1.9501	13	2.2621	12	2.2473	13
maritime freight transportation	2.5477	7	3.0228	1	2.8299	4
Air freight transportation	2.5725	6	2.6956	7	2.7373	6
Warehousing and Cargo loading or unloading operations	1.7034	20	1.7009	20	1.7938	19
Logistics service	1.9135	14	1.7538	19	1.7495	20
Total average	2.2495		2.3646		2.3455	

First of all, to compare the maritime freight transportation industry with other industries, the basic method was used for analysis. In comparison to the averages of all the fields, which are 2.2495, 2.3646, and 2.3455, the average production-driven effect of the maritime freight transportation industry was high, with a 2.5477, 3.0228, and 2.8299. This means that when one final demand is generated, its effect on the economy as a whole was 2.5477, 3.0228, and 2.8299 in the years 1995, 2000, and 2003. The maritime freight transportation industry is considerably more influential on the economy as a whole.

Figure 1 shows the trend of the production driven effects of all the industries. They are showing an increasing trend. Figure 2 shows the trend of the production driven effect of the logistics industry. The general average of the logistics industry did not show any significant shifts. However, the maritime freight transportation industry showed a rapidly increasing trend in the year 2000, and a decreasing one in 2003.

Figure 1. The trend of the production-driven effects of all the industries

Figure 2. The trend of the production-driven effect of the logistics industry

Table 3 shows the yearly exogenous specification of the maritime freight transportation industry. In other words, it shows the production driven effect and pure pervasive effect.

The result of the 1995 exogenous specification of the logistics industry was high in the area of maritime and air freight transportation, and it was low in the warehousing, loading and unloading, and logistics service areas. The result of the 2000 exogenous specification of the logistics industry was also high in the area of maritime and air freight transportation, and it was low in the warehousing, loading and unloading, and logistics service areas. All the areas of the logistics industry except for the logistics service area increased in production driven effect, compared to that of 1995. Railroad freight transportation especially significantly increased. The result of the 2003 exogenous specification of the logistics industry was also high in the area of maritime and air freight transportation, and it was low in the warehousing, loading and unloading, and logistics service areas. Most of the areas of the logistics industry stimulate the most driven production in the manufacturing and service industries, which have massive outputs.

The results of the exogenous specification of the maritime freight transportation industry also show a similar trend, increasing in 2000, and decreasing in 2003. The production driven effect is especially high on the main national industries, such as the manufacturing and service industry.

Table 3

The production driven effects of the maritime freight transportation industry in 1995~2003 (exogenous specification)

Sector	1995		2000		2003	
	maritime freight transportation	rank	maritime freight transportation	rank	maritime freight transportation	rank
Agriculture, Forestry, and Fishing	0.0300	7	0.0370	10	0.0286	8
Mining and Quarrying	0.0210	11	0.0512	8	0.0377	5
Manufacturing	0.5288	2	0.8016	1	0.6910	2
Electricity, Gas, Water supply	0.0231	10	0.0348	11	0.0297	7
Road construction	0.0000	15	0.0000	15	0.0000	15
Railroad construction	0.0000	15	0.0000	15	0.0000	15
Subway construction	0.0000	15	0.0000	15	0.0000	15
Break water, Pier, and Harbor construction	0.0000	15	0.0000	15	0.0000	15
Airport construction	0.0000	15	0.0000	15	0.0000	15
Construction	0.0194	12	0.0113	12	0.0135	11
Service	0.6209	1	0.4834	2	0.7152	1
Dummy sectors	0.0504	5	0.0542	7	0.0541	4
Passenger transportation	0.0123	13	0.0109	13	0.0109	12
Wholesale and Retail trade	0.0246	9	0.0393	9	0.0330	6
Railroad freight transportation	0.0249	8	0.0730	5	0.0023	13
Road freight transportation	0.0622	4	0.0699	6	0.0162	10
maritime freight transportation	-	-	-	-	-	-
Air freight transportation	0.0014	14	0.0017	14	0.0017	14
Warehousing and Cargo loading or unloading operations	0.0847	3	0.1440	3	0.0212	9
Logistics service	0.0352	6	0.1218	4	0.1702	3
Total average	1.5388		1.9344		1.8252	

Table 4

The added value driven effects of the maritime freight transportation industry in 1995~2003 (exogenous specification)

Sector	1995		2000		2003	
	maritime freight transportation	rank	maritime freight transportation	rank	maritime freight transportation	rank
Agriculture, Forestry, and Fishing	0.0135	8	0.0136	11	0.0119	9
Mining and Quarrying	0.0096	12	0.0185	8	0.0151	6
Manufacturing	0.2312	2	0.2801	1	0.2634	2
Electricity, Gas, Water supply	0.0128	9	0.0149	10	0.0147	7
Road construction	0.0000	15	0.0000	15	0.0000	15
Railroad construction	0.0000	15	0.0000	15	0.0000	15
Subway construction	0.0000	15	0.0000	15	0.0000	15
Break water, Pier, and Harbor construction	0.0000	15	0.0000	15	0.0000	15
Airport construction	0.0000	15	0.0000	15	0.0000	15
Construction	0.0124	11	0.0059	12	0.0079	10
Service	0.4018	1	0.2705	2	0.4312	1
Dummy sectors	0.0256	5	0.0228	6	0.0245	4
Passenger transportation	0.0071	13	0.0055	13	0.0059	12
Wholesale and Retail trade	0.0127	10	0.0171	9	0.0159	5
Railroad freight transportation	0.0159	7	0.0212	7	0.0007	14
Road freight transportation	0.0367	4	0.0340	5	0.0072	11
maritime freight transportation	-	-	-	-	-	-
Air freight transportation	0.0007	14	0.0008	14	0.0008	13
Warehousing and Cargo loading or unloading operations	0.0558	3	0.0970	3	0.0128	8
Logistics service	0.0196	6	0.0764	4	0.1086	3
Total average	0.8553		0.8784		0.9206	

The added-value-driven effects

The yearly added value driven effects of the maritime freight transportation industry is as stated in Table 4. In the input output tables from 1995 to 2003, the added value is generated most in the same industries (as in the case of production driven effect, the manufacturing and service industries) due to the output increase of the maritime logistics industry. This is because the added-value-driven effect originates from the production-driven amount.¹ The maritime freight transportation industry was found to generate high added-value in warehousing, loading and unloading. Thus, it is analyzed that a great deal of added-value is generated at warehousing facilities, and in the process of loading and unloading at seaports.

4. 3 The inter-industry linkage effects

The backward linkage effect

If we examine the impact factor of the maritime freight transportation industry, the standard point of the average is far higher than 1, and the maritime freight transportation industry was found to be influential. This means that the maritime freight transportation industry influences all the other industries through purchase.

The forward linkage effect

If we examine the index of the sensitivity of dispersion of the maritime freight transportation industry, the standard point is far lower than 1, thus forward linkage effect is low. The impact factor of the maritime freight transportation industry shows a relatively strong influencing power. Seeing that the index of the sensitivity of dispersion is far lower than the total average 1, it is analyzed as a industry of weak forward linkage effect. This means that it is weakly influenced by industrial growth. Analysis demonstrates that the maritime logistics industry is a final demand manufacturing industry.²

¹Yoo Seung-hun and two other people(2004), Analysis of the industrial pervasive effect of the radio broadcasting industry : using input output analysis

²According to the Input Output Theory(p251) of Kang(2000), there is the method of classifying the industry types by comparing the industry's rate of intermediate input and rate of intermediate demand with the rate of intermediate input and rate of intermediate demand of the computation business: intermediate demand manufacturing industry with a high forward and backward linkage effect, intermediate demand primary industry with a high forward linkage effect but a low backward linkage effect, and final demand manufacturing industry with a high backward linkage effect, but a low forward linkage effect. Final demand primary industry with a low forward and backward linkage effect,

Table 5
The backward linkage effect

The impact factor	1995	rank	2000	rank	2003	rank
Agriculture, Forestry, and Fishing	0.8047	16	0.8233	15	0.8561	15
Mining and Quarrying	0.7669	18	0.7849	16	0.7866	16
Manufacturing	1.1940	5	1.2213	4	1.2137	3
Electricity, Gas, Water supply	0.9453	11	0.9277	14	0.9285	14
Road construction	1.0419	9	0.9789	11	1.0129	9
Railroad construction	1.2721	2	1.2093	5	1.1870	5
Subway construction	1.2348	3	1.2514	3	1.2168	2
Break water, Pier, and Harbor construction	1.0230	10	0.9965	10	0.9587	12
Airport construction	1.1989	4	1.0239	9	0.9993	10
Construction	1.0711	8	1.0331	8	1.0234	8
Service	0.7690	17	0.7704	17	0.7742	18
Dummy sectors	1.4431	1	1.2668	2	1.3156	1
Passenger transportation	0.9087	12	0.9529	13	0.9694	11
Wholesale and Retail trade	0.7589	19	0.7500	18	0.7772	17
Railroad freight transportation	0.8167	15	1.1735	6	1.1382	7
Road freight transportation	0.8669	13	0.9567	12	0.9581	13
maritime freight transportation	1.1326	7	1.2784	1	1.2065	4
Air freight transportation	1.1436	6	1.1400	7	1.1670	6
Warehousing and Cargo loading or unloading operations	0.7572	20	0.7193	20	0.7648	19
Logistics service	0.8506	14	0.7417	19	0.7459	20

Table 6
The forward linkage effect

The impact factor	1995	rank	2000	rank	2003	rank
Agriculture, Forestry, and Fishing	0.8503	4	0.7491	7	0.6990	7
Mining and Quarrying	0.8249	5	0.9602	3	0.9028	3
Manufacturing	6.4173	1	6.4203	1	6.2796	1
Electricity, Gas, Water supply	0.7529	7	0.7627	6	0.7891	5
Road construction	0.4445	16	0.4229	16	0.4263	16
Railroad construction	0.4445	16	0.4229	16	0.4263	16
Subway construction	0.4445	16	0.4229	16	0.4263	16
Break water, Pier, and Harbor construction	0.4445	16	0.4229	16	0.4263	16
Airport construction	0.4445	16	0.4229	16	0.4263	16
Construction	0.5800	9	0.5209	9	0.5273	10
Service	3.1123	2	3.4359	2	3.6672	2
Dummy sectors	0.8752	3	0.8363	4	0.8378	4
Passenger transportation	0.5633	10	0.5066	12	0.5087	11
Wholesale and Retail trade	0.7727	6	0.7954	5	0.7568	6
Railroad freight transportation	0.4659	14	0.4580	13	0.4392	14
Road freight transportation	0.5870	8	0.5203	10	0.5619	9
maritime freight transportation	0.4678	13	0.4456	14	0.4377	15
Air freight transportation	0.4575	15	0.4372	15	0.4395	13
Warehousing and Cargo loading or unloading operations	0.5199	12	0.5081	11	0.4565	12
Logistics service	0.5303	11	0.5289	8	0.5652	8

4. 4 The supply-driven model: the supply-shortage effects

Through the supply-driven model, we can examine the production decreases of other industries that follow the output amount decrease of a certain area. The total averages of the supply-shortage effects are 2.6199, 4.4192 and 3.9335. However, taking into consideration that the supply-shortage effects of the mining goods area, which supplies the basic materials of all the industries, are 13.9948, 44.5968, 36.9531, the average does not have significant meaning. The average of the

supply-shortage effect in 1995 was 1.1986, 1.1368 in 2000, and 1.1820 in 2003. This means that when a supply shortage of 100 million won occurs in the maritime freight transportation industry, approximately 119 million won, 113 million won, 118 million won of supply shortage occurs in the economy as a whole. When compared to other industries, this industry triggers weak supply shortage effects.

Table 7
The supply-shortage effects

Sector	1995		2000		2003	
	value	rank	value	rank	value	rank
Agriculture, Forestry, and Fishing	2.8131	7	3.1395	5	3.1172	7
Mining and Quarrying	13.9948	1	44.5968	1	36.9531	1
Manufacturing	2.6321	8	2.7259	8	2.7426	9
Electricity, Gas, Water supply	2.9508	6	2.7987	7	2.7980	8
Road construction	1.0000	16	1.0000	16	1.0000	16
Railroad construction	1.0000	16	1.0000	16	1.0000	16
Subway construction	1.0000	16	1.0000	16	1.0000	16
Break water, Pier, and Harbor construction	1.0000	16	1.0000	16	1.0000	16
Airport construction	1.0000	16	1.0000	16	1.0000	16
Construction	1.2076	14	1.2435	14	1.2026	14
Service	1.9798	11	1.9516	11	1.9217	12
Dummy sectors	2.9639	5	3.2883	4	3.3045	4
Passenger transportation	1.6908	13	1.6761	13	1.6978	13
Wholesale and Retail trade	1.7184	12	2.0125	10	1.9567	11
Railroad freight transportation	3.3982	2	7.9741	2	4.9674	2
Road freight transportation	2.5910	9	2.3578	9	3.3645	3
maritime freight transportation	1.1986	15	1.1368	15	1.1820	15
Air freight transportation	2.1119	10	1.9486	12	2.0107	10
Warehousing and Cargo loading or unloading operations	3.0984	3	3.5555	3	3.2288	5
Logistics service	3.0484	4	2.9779	6	3.2218	6
Total average	2.6199		4.4192		3.9335	

Figure 3 shows the trend of the supply shortage effects of the logistics industry. Besides the deep decrease in 2000~2003 for railroad freight transportation, the supply shortage effects are slowly increasing for other areas.

Also, the supply-shortage effects of the maritime logistics industry was the lowest, and it appears to be decreasing, consistently.

Figure 3. The trend of the supply shortage effects of the logistics industry

Table 8 shows the exogenous specification of the supply shortage effects of the maritime freight transportation industry. It was found that the maritime freight transportation areas exert strong supply shortage effects on the manufacturing and service industries.

Table 8.

The supply shortage effects of the maritime freight transportation industry in 1995~2003 (exogenous specification)

10	1995		2000		2003	
	maritime freight transportation	rank	maritime freight transportation	rank	maritime freight transportation	rank
Agriculture, Forestry, and Fishing	0.0044	8	0.0016	8	0.0037	6
Mining and Quarrying	0.0008	12	0.0002	16	0.0003	15
Manufacturing	0.1150	1	0.0707	1	0.1212	1
Electricity, Gas, Water supply	0.0060	5	0.0023	5	0.0031	7
Road construction	0.0032	9	0.0016	9	0.0019	9
Railroad construction	0.0003	16	0.0003	12	0.0003	14
Subway construction	0.0005	13	0.0002	13	0.0002	16
Break water, Pier, and Harbor construction	0.0004	15	0.0001	17	0.0004	12
Airport construction	0.0001	17	0.0002	15	0.0000	19
Construction	0.0183	3	0.0075	3	0.0104	3
Service	0.0223	2	0.0116	2	0.0206	2
Dummy sectors	0.0056	6	0.0019	7	0.0044	5
Passenger transportation	0.0056	7	0.0023	4	0.0026	8
Wholesale and Retail trade	0.0064	4	0.0020	6	0.0086	4
Railroad freight transportation	0.0001	18	0.0000	18	0.0000	18
Road freight transportation	0.0024	10	0.0006	10	0.0015	10
maritime freight transportation	-	-	-	-	-	-
Air freight transportation	0.0005	14	0.0002	14	0.0005	11
Warehousing and Cargo loading or unloading operations	0.0024	11	0.0003	11	0.0004	13
Logistics service	0.0001	19	0.0000	19	0.0001	17
Total average	0.1944		0.1035		0.1800	

5. Conclusion

As stated above, in this research, the economy pervasive effect of the maritime freight transportation industry was measured. The following is a summary of this research that incorporated the discussions above. First, although its production-inducing effect and added value driven effects decreased in 2003, the maritime freight transportation industry still appears to be very influential on the economy as a whole, especially on the main national industries, such as the manufacturing and service industries. Second, because of the fact that the impact factor is over 1, and the index of the sensitivity of dispersion is under 1, the maritime freight transportation industry was classified as a final demand manufacturing industry, through the inter-industry linkage effect classification process. Third, the supply-shortage effect was shown to be weaker than that of other industries.

The implications from those analyses are as follows:

First, the maritime freight transportation industry is classified as an industry that has a strong pervasive effect on other areas. The production-driven effect and the added-value driven effect are also relatively high, and thus continuing development can be expected.

Second, as shown in the forward backward linkage effect, the industry form is developing into a final demand manufacturing industry. Lastly, the maritime freight transportation industry is an industry that greatly influences the pivotal industries of the country, such as manufacturing and the service industries. Also, due to the problem of the data sources, the most recent data used is the 2003 input-output table, which is from approximately four years ago. This poses limits. The supply-driven model, as well as the preexisting demand driven model, and the usual method of linkage effects between industries were applied. And also, a more precise measurement was attempted by simultaneously applying the exogenous specification method. Additionally, by analyzing the years from 1995 to 2003, the trend of the maritime freight transportation industry was examined, and thus, development and pervasive effects trends were also examined. It is difficult to postulate that the input-output analysis, used in this research, can perfectly replace all the other methods.

However, it is evident that this type of analysis is useful for researchers and policy decision-makers for analyzing the status and role of the maritime freight transportation industry in the economy as a whole. The methodology of this research will be used in many future studies, because of its usefulness, flexibility, and precision. We hope in the future that not only input-output analysis but also many other methods will be used in numerous studies as well so that they can yield important implications for meaningful policy decisions or decision making with respect to the maritime freight transportation industry which is being embossed in society as an important industry for the country.

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