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ESTIMATION OF THE ECONOMIC BENEFITS OF PORT DEVELOPMENT ON INTERNATIONAL MARITIME MARKET BY PARTIAL EQUILIBRIUM MODEL AND SCGE MODEL

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Abstract: In this research, we propose a partial equilibrium model that can measure the economic benefit of port development in Japan, and estimate the parameters of the demand and supply function concerning the long-distance container transportation market (i.e. North America Pacific Coast route, North America East Coast route and European route) which arrive at and depart from Japan. Then we evaluate the effectiveness of the investment for port development up to now with this model. As a result, we would conclude that port development in Japan has been effective in general. We also examine spatial incidence or distribution of economic benefits measured by the above-mentioned partial equilibrium model with simplified international Spatial Computable General Equilibrium (SCGE) model, including international induced effects. The results also show that port development in Japan can bring a certain degree of benefit to any regions in the world through the trades.

Key Words: International Maritime Market, Partial Equilibrium Model, SCGE model

1. INTRODUCTION

Maritime transportation is a major means of international trade in Japan, and seaports function as a lifeline of Japan. The volume of international trade has been growing steadily in recent years and the competition among seaports of neighboring Asian countries has become severe in the international transportation market. Continuous port development is strongly required.

The most typical economic effect of port investment is to reduce transportation costs. Recently carriers have reduced transportation costs by increasing vessel size at the international container transportation markets. In parallel with this, large container terminals are being developed in the world. As for understanding the economic effect of port investment, measuring social economic effects or cost-benefit analysis of each port-development project has been done until now. However, no quantitative analysis was done about the economic benefit which port investment in the whole country brings by affecting maritime transportation markets. So, neither macroscopic economic evaluation, nor analysis of the scale and economic effects of port investments has been done.

In this research, we develop models that macroscopically analyze and measure economic benefit of port investments in Japan. First we develop “Partial Equilibrium Model”(Only for the international container transportation markets) in which stock of port facilities is introduced as a variable, and “Spatial Computable General Equilibrium Model”(SCGE Model) that describes the extending process of change in the international container transportation markets through the commodities transaction in international trade. Next, we measure the benefits and induced effects that port investments in the past brought to the users (shippers) and suppliers (carrier) by using the Partial Equilibrium Model. Third, by inputting the transportation cost reduction estimated by the Partial Equilibrium Model into the SCGE Model, we examine spatial incidence or distribution of economic benefits.

Above-mentioned analyses enable us to generally understand the effect of port investments in Japan and to get useful information for policy making in the future.

2. PARTIAL EQUILIBRIUM MODEL OF INTERNATIONAL CONTAINER TRANSPORTATION MARKET

In this chapter, we develop a partial equilibrium model that describes international container transportation markets and estimate parameters concerning the long-distance route which arrive at and depart from Japan. Economic effects of port investment in the past are measured with estimated demand and supply functions.

2.1 Concept of Partial Equilibrium Model in International Container Transportation Market

Port investment reduces transportation costs of supplier in international container transportation market by expanding the capacity of seaports and port facilities. Reduction of the transportation costs decreases the freight rate in the perfectly competitive market and increases consumer surplus (shippers' benefit) and producer surplus (carriers' benefit). In this research, we supposed that these chains properly occur through the competitive market mechanisms and measure user and producer benefit as economic benefit of port investment.

Concretely, amount of port investment is introduced as explanatory variable into the supply function of international container transportation market, then surplus is measured based on the difference between supply function with the port investment (with) and without the port investment (without).

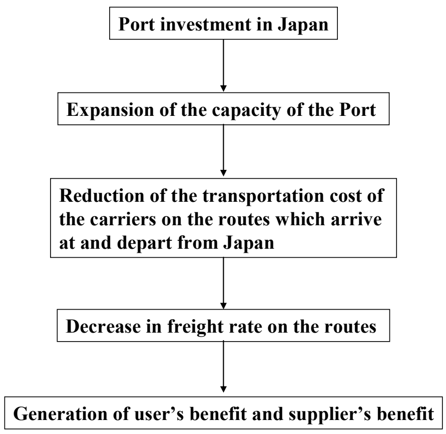

Figure 1.User’s Benefit and Supplier’s Benefit by Port Investment.

2.2 Selecting Shipping Route that Partial Equilibrium Model Treats

The target market in this research is the long-distance route of international container transportation market which arrives at and departs from Japan (i.e. North America Pacific Coast route, North America East Coast route and European route). Two reasons we selected these routes are as follows:

a. The vessel size in these three routes is increased rapidly, so the economic benefit of the development of large ports seems to be large in these three routes.

b. We can suppose that long-distance international container transportation market is perfectly competitive, because there are many shipping firms in this market and the freight rate in these three routes is decreasing continuously, so competition of the market is considered to be hard.

These three routes occupy 40% import and 50% export of tons of container routes that depart from and arrive at Japan in 1998.

On the other hand, tons of South-East Asian Route and Inshore Route occupy about 43% of container freights of Japan in 1998 (Both routes are summed), but they are not analyzed. This is because comparatively small-size ships are used in these routes and it is hard to measure how port investments affect the fare directly. Bulk freights are not analyzed because the actual fare data is hard to get.

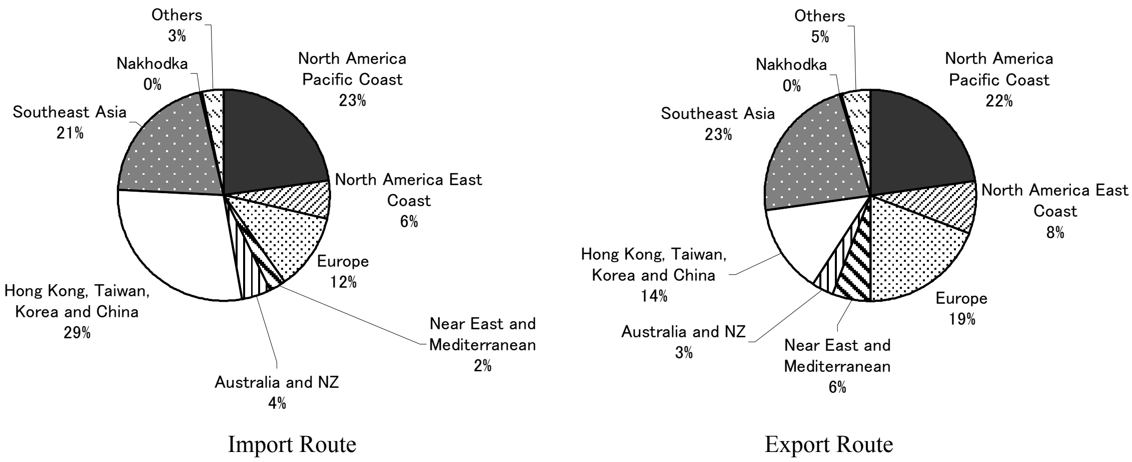

Figure 2. Ratio of Container Volume of the Import and Export Routes of Japan (1998)
Source: Ministry of Land, Infrastructure, and Transportation

2.3 Formulating Partial Equilibrium Model

Concrete demand and supply functions are established as Cobb=Douglas type. We adopted this type because a number of existing estimation of demand and supply functions exist. When we estimate with this function type, each coefficient except on constant and dummy variable ($\alpha1$~$\alpha3$, $\beta1$~$\beta3$ in the expression given below) expresses elasticity of each explanatory variable.

Demand Function : $$Q = f(p, GDP, EX) = \alpha_0 p^{\alpha_1} GDP^{\alpha_2} EX^{\alpha_3} \tag{1}$$

Supply Function : $$p = g(Q, ST_J, FP, DUM) = \beta_0 Q^{\beta_1} ST_J^{\beta_2} FP^{\beta_3} \exp(\beta_4 \cdot DUM) \tag{2}$$

where

p : Freight Rate(yen/freight ton or dollars/freight ton)

Q : Container Volume (freight ton/year)

GDP_J : import country's GDP (yen/year, dollars/year, or mark/year)

EX : Actual Exchange Rate (yen/dollars or yen/mark)

ST_J : Port Stock in Japan (yen)

FP : Fuel Price (yen/barrel or dollars/barrel)

DUM : Dummy variable which expresses the effect of Plaza-Agreement (1985-1994 = 1, other period = 0)

$\alpha_0 \sim \alpha_3, \beta_0 \sim \beta_4$: Coefficients

We should be careful of using German data of exchange rate and GDP about European route. When we compare the amount of trade between Japan-UK, France and Germany, that of Japan-Germany is the largest and occupies about 44% of the trade amount of these 3 countries. Therefore, we used German GDP and exchange rate as representative indicator of whole Europe.

When we estimate coefficients, we take natural logarithm of both functions, and two stage least square method (2SLS) is applied to the linear logarithm equation given below.

$$\ln Q = \ln \alpha_0 + \alpha_1 \ln p + \alpha_2 \ln GDP + \alpha_3 \ln EX \tag{3}$$

$$\ln p = \ln \beta_0 + \beta_1 \ln Q + \beta_2 \ln ST_J + \beta_3 \ln FP + \beta_4 \cdot DUM \tag{4}$$

Then, as to the demand function of the North American Pacific Route, we introduce dummy variable "$DUM_{96\text{-}98}$", which is 0 from 1978 to 1995 and 1 from 1996 to 1998, in order to improve the precision of the estimation.

2.4 Measuring Economic Effects by Partial Equiribrium Model

2.4.1 Data Source

The sources of the time series data used for Partial Equiribrium model are shown below. The period of the data is from 1978 to 1998.

Table 1.Data Source

Variables	Source
Freight Rate	**Japan Maritime Industry Research Institute**
Container volume	**Ministry of Land, Infrastructure and Transport**
Exchange Rate	**International Financial Statistics (International Monetary Fund)**
GDP of US	**National Income and Production Accounts Tables (U.S.Department of Commerce, Bureau of Economic Analysis)**
GDP of Germany	**International Financial Statistics (International Monetary Fund)**
GDP of Japan	**International Financial Statistics (International Monetary Fund)**
Stock of Port Facilities in Japan	**Social capital stock of Japan. (Cabinet Office, Government of Japan)**

It is noted that we consider only stock of port facilities in Japan, because we cannot collect the data of the stock of port facilities in North America and Europe.

2.4.2 Results of parameter estimation

The results of parameter estimation are shown below. In order to eliminate series correlation, "endogenous variable with linear lag (volume and freight of preceding term)" is introduced to estimation in some cases.

Table 2. Estimation Results of North America Pacific Routes

a. Import Route

DemandFunction

Variable	Coefficient	T-value
Constant	4.759	1.394
$\ln p$	−0.353	−5.515
$\ln GDP$	0.695	3.571
$\ln EX$	−0.052	0.353
$\ln Q_{-1}$	0.695	−0.394

Adjusted R^2 = 0.986

Supply Function

Variable	Coefficient	T-value
Constant	7.514	1.315
$\ln Q$	1.552	2.401
$\ln ST_J$	−1.346	−1.875
$\ln FP$	0.371	1.977
DUM	−0.451	0.353
$\ln p_{-1}$	0.717	−3.565

Adjusted R^2 =0.807

b. Export Route

DemandFunction

Variable	Coefficient	T-value
Constant	−2.039	−0.353
$\ln p$	−0.294	−1.044
$\ln GDP$	0.854	1.378
$\ln EX$	0.387	2.041
$\ln Q_{-1}$	0.626	2.635
DUM_{96-98}	−0.320	−2.033

Adjusted R^2 =0.919

Supply Function

Variable	Coefficient	T-value
Constant	5.978	0.959
$\ln Q$	0.529	1.465
$\ln ST_J$	−0.436	−1.702
$\ln FP$		
DUM	−0.244	−1.978
$\ln p_{-1}$	0.691	2.554

Adjusted R^2 =0.776

Table 3. Estimation Result of North America East Coast Routes

a. Import Route

Demand Function

Variable	Coefficient	T-value
Constant	0.898	0.143
$\ln p$	−0.258	−1.717
$\ln GDP$	0.479	0.959
$\ln EX$		
$\ln Q_{-1}$	0.450	2.081

Adjusted R^2 =0.898

Supply Function

Variable	Coefficient	T-value
Constant	4.985	1.001
$\ln Q$	0.574	1.617
$\ln ST_J$	−0.429	−1.297
$\ln FP$	0.384	2.575
DUM	−0.112	−1.196
$\ln p_{-1}$	0.436	1.931

Adjusted R^2 =0.900

b. Export Route

Demand Function

Variable	Coefficient	T-value
Constant	0.204	0.034
$\ln p$	−0.118	−0.310
$\ln GDP$	0.799	2.080
$\ln EX$	0.508	1.604
$\ln Q_{-1}$		

Adjusted R^2 =0.430

Supply Function

Variable	Coefficient	T-value
Constant	10.703	1.384
$\ln Q$	0.669	1.374
$\ln ST_J$	−0.550	−1.218
$\ln FP$	0.129	0.984
DUM	−0.116	−1.368
$\ln p_{-1}$	0.216	0.780

Adjusted R^2 =0.847

Table 4. Estimation Result of European Routes

a. Import Route

Demand Function

Variable	Coefficient	T-value
Constant	−7.970	−1.249
$\ln p$	−0.099	−0.696
$\ln GDP$	1.073	2.050
$\ln EX$	−0.238	−1.265
$\ln Q_{-1}$	0.549	2.956

Adjusted R^2 =0.983

Supply Function

Variable	Coefficient	T-value
Constant	11.891	1.825
$\ln Q$	0.376	1.065
$\ln ST_J$	−0.791	−1.422
$\ln FP$	0.191	2.114
DUM	−0.035	−0.631
$\ln p_{-1}$	0.646	4.435

Adjusted R^2 =0.966

b.Export Route

DemandFunction

Variable		
Constant	0.859	0.285
$\ln p$	−0.190	−1.688
$\ln GDP$	0.441	0.679
$\ln EX$	0.039	0.190
$\ln Q_{-1}$	0.763	2.725

Adjusted R^2 =0.964

Supply Function

Constant	6.671	0.604
$\ln Q$	0.133	0.202
$\ln ST_J$	−0.346	−0.377
$\ln FP$		
DUM		
$\ln p_{-1}$	0.830	4.161

Adjusted R^2 =0.724

At first, sign condition of all the variables introduced to each route is satisfied. Second, a few of t-value are larger than 2, but many of those are larger than 1. Considering restriction of data, it seems to be acceptable. At last, adjusted R-squared except of demand function of North America Coast Route and supply function of European Route are larger than 0.8, so these results are appropriate.

2.4.3 Considerations of Coefficients Size

Major coefficients and t-value in demand and supply function in each route are shown below.

Table 5. Major Coefficients of Demand Function

Routes	Freight Rate Elasticity of Demand α_1	GDP Elasticity of Demand α_2
Import Route of North America Pacific Coast Route	-0.353 〔-5.515〕	0.147 〔0.353〕
Export Route of North America Pacific Coast Route	-0.294 〔-1.044〕	0.854 〔1.378〕
Import Route of North America East Coast Route	-0.258 〔-1.717〕	0.479 〔0.959〕
Export Route of North America East Coast Route	-0.118 〔-0.310〕	0.799 〔2.080〕
Import Route of European Route	-0.099 〔-0.696〕	1.073 〔2.050〕
Export Route of European Route	-0.190 〔-1.688〕	0.441 〔0.679〕

〔 〕: T-value

Table 6. Major Coefficients of Supply Function

Routes	Container Volume Elasticity of Freight β_1	Japanese Port Stock Elasticity of Freight β_2
Import Route of North America Pacific Coast Route	1.552 〔2.410〕	-1.346 〔-1.875〕
Export Route of North America Pacific Coast Route	0.529 〔1.465〕	-0.436 〔-1.702〕
Import Route of North America East Coast Route	0.574 〔1.617〕	-0.427 〔-1.297〕
Export Route of North America East Coast Route	0.669 〔1.374〕	-0.550 〔-1.218〕
Import Route of European Route	0.376 〔1.065〕	-0.791 〔-1.422〕
Export Route of European Route	0.133 〔0.202〕	-0.346 〔-0.377〕

〔 〕: T-value

a. Freight Rate Elasticity of Demand: α_1

α_1 is between -0.1 ~ -0.35. This result is nearly the same order as elasticity of price of other research on transportation demand elasticity (ex. Ohashi(2003)).

b.GDP Elasticity of Demand: α_2

α_2 ranges widely from +0.15 to +1.10. GDP Elasticity of import of European Route is larger than those of other routes. This is because among items of container freights from Europe, necessities of life such as daily necessities or food industrial products are a lot.

c. Container Volume Elasticity of Freight Rate: β_1

β_1 is larger in North American Route than in European Route. The size of this coefficient means marginal cost of increasing container volume by 1%. The main reason is that container volume itself of North America Pacific Route is 1.5 times larger at 1998 than that of European Route and additional cost for increasing 1% of container volume is large.

Moreover, as the figure below shows, one of the factors is that economies of scale works and transportation cost for 1TEU has become smaller because the size of the ships of European Route is larger than that of North American Route.

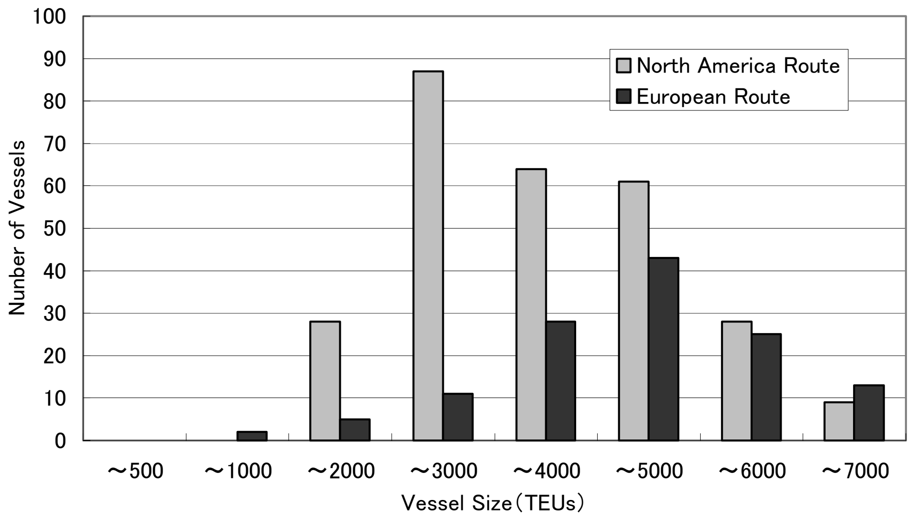

Figure 3. Comparing Distribution of Vessel Size of North America Route and European Route(2000)
Source: International Transportation Handbook

d. Japanese Port Stock Elasticity of Freight Rate: β_2

This indicator expresses how Japanese port stock affects each route, and the value of North America Pacific Route is large. The reason is because large-sized ships can be thrown into by port development in this route.

2.4.4 The Result of the Final Test

Following graphs are the results of the final test as to North America Pacific Coast Import Route. These figures show that the model show that the estimated model can calculate container volume and its freight rate with reasonable accuracy. As for other routes, the model can also replicate the observed date well. (The figures as to the other routes are omitted due to limitations of space)

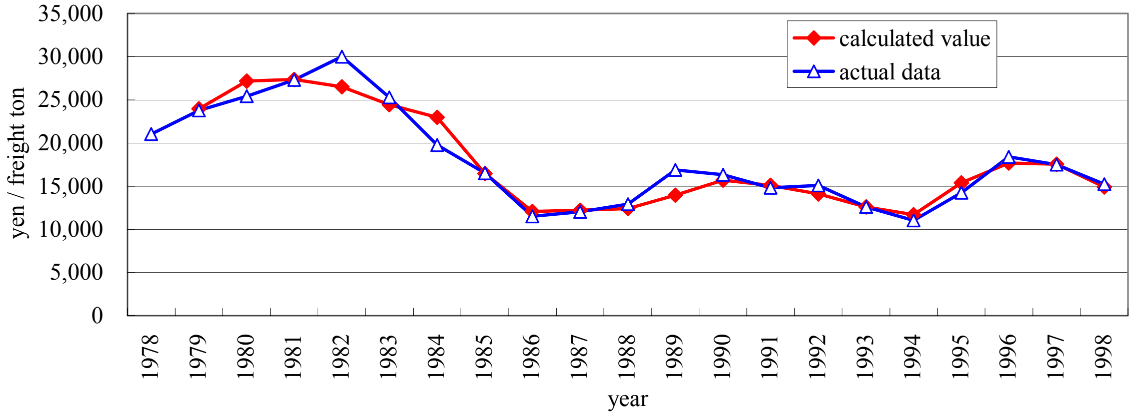

Figure 4. Results of the Final Test (Freight Rate, North America Pacific Coast Import Route)

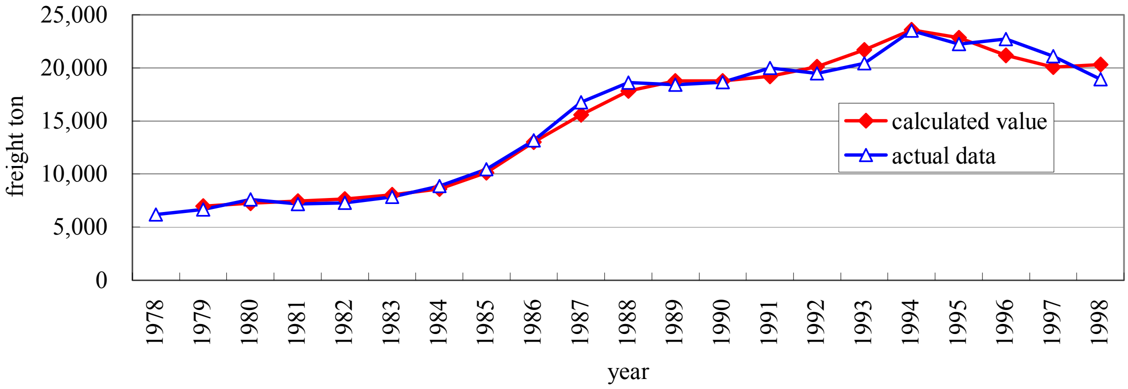

Figure 5. Results of the Final Test (Container Volume, North America Pacific Coast Import Route)

3. ESTIMATING ECONOMIC BENEFIT OF PORT INVESTMENT

Economic benefit of port investment after 1984 was estimated by estimated demand and supply function of each route. The reason we treated port investment after 1984 is that container terminal development with deeper-than-14meter depth berth started around 1984, and it seems good to measure effect of deep berth development for this term.Concretely, conditions of with and without case are as follows:

With case: Port investment was done as it experienced.
Without case: No port investment was done from 1983 to 1998

We calculated user benefit (carrier's benefit), supplier benefit (shipper's benefit) and social benefit (sum of user and supplier benefit) of each year. We can interpret that this is the benefit that might be lost when no port investment was done from 1983 to 1998.

Estimation results of user benefit and supplier benefit are given below. For example, this indicates that social benefit of 1.24 trillion yen/year is generated in 1998 comparing to the case that there is no port investment after 1988. Moreover, user benefit is 1.01 trillion yen/year and supplier benefit is 0.23 trillion yen/year. User benefit occupies 80% of social benefit. This means shippers suffer 1.01 trillion yen/year loss and carriers suffer 0.23 trillion yen/year if the port development level of 1998 is the same as that of 1983.

If we assume that project life is 50 years and that the social discount rate is 4%, the total social benefit in 1998 is 28 trillion yen. On the other hand, the cost of port investment from 1984 to 1998 is approximately 15 trillion yen, so we would conclude that the port investment from 1984 to 1998 is effective in general, and that steady port investment is still required to accommodate future international trade cargoes.

And when we examine the benefit of each route, benefit of North America Pacific coast route is higher than other route. One of the factor is that the container volume of this route is the largest.

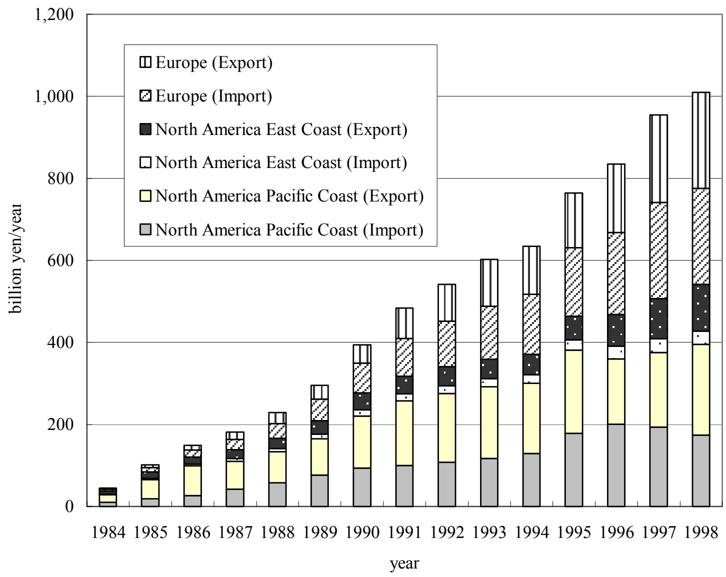

Figure 6. User's Benefit (Carrier's Benefit) of Port Investment of Each Route in Japan (Price in 1995)

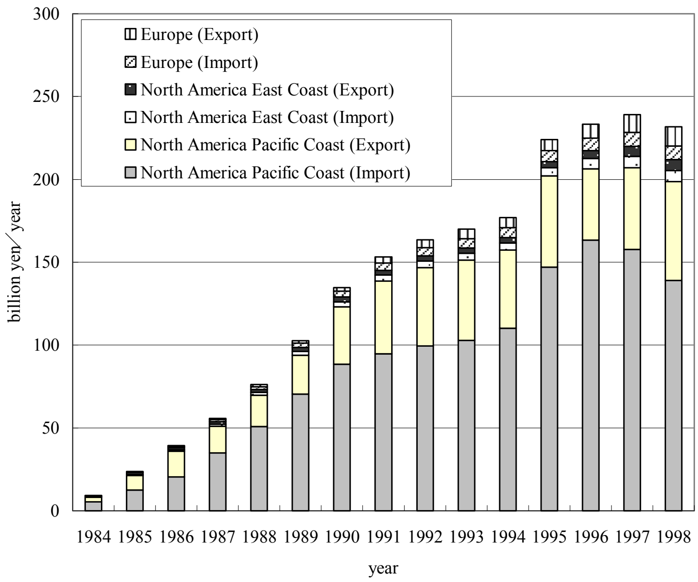

Figure 7. Supplier's Benefit (Shipper's Benefit)of Port Investment of Each Route in Japan (Price in 1995)

4. MEASURING INDUCED EFFECT OF PORT INVESTMENT BY INTERNATIONAL SCGE MODEL

In this chapter, we measure social benefit including induced effect by international SCGE Model, based on the result of measuring economic benefit of port investment by Partial Equilibrium Model in preceding chapter.

Since the spatial impacts of a large-scale transportation infrastructure are of great interest in Japan, many SCGE Models have been developed and applied in practical works of project evaluation (Miyagi(1996), Mun(1997), Koike and Ueda(2000) etc.). We explain the SCGE Model developed in this research at first, then we show a study about benefit incident.

4.1 Developing SCGE Model

4.1.1 Model Structure

The structure of SCGE Model developed in this research is given below:

a. We consider the world which consists of 4 regions; Japan, US, Europe(UK, France and Germany) and Asia(Indonesia, Malaysia, Philippines, Singapore, Thailand, China, Taiwan and Korea). We won't consider trade between these 4 regions and other area.
b. Representative firms and households are in each region. Carriers carry commodities and services between the regions. To simplify the model, we assume there is only one kind of commodities and services.
c. Firms produce commodities and services by intermediate goods, capital and labor as product factor in order to maximize the profit. Production function of firms is assumed to be Leontief type and Cobb=Douglas type.
d. Households supply firms with capital and labor, and consume commodities and services produced in their own region or other regions by these incomes (excluding net foreign investment), and maximize their utility. Net foreign investment is supposed to be constant, and it is not affected by interest rate. Utility function of a household is assumed to be Cobb=Douglas type.
e. Carriers produce regional transportation service of commodities and services that fills the firms' demand of intermediate goods and households' final demand.
f. No labor and capital transfers between regions.
g. All the income tax, consumption tax etc are assumed to be returned to household as income by public expenditure. Transportation margin is supposed to include tariffs.
h. All markets in the economy are assumed to be in long run competitive equilibrium.

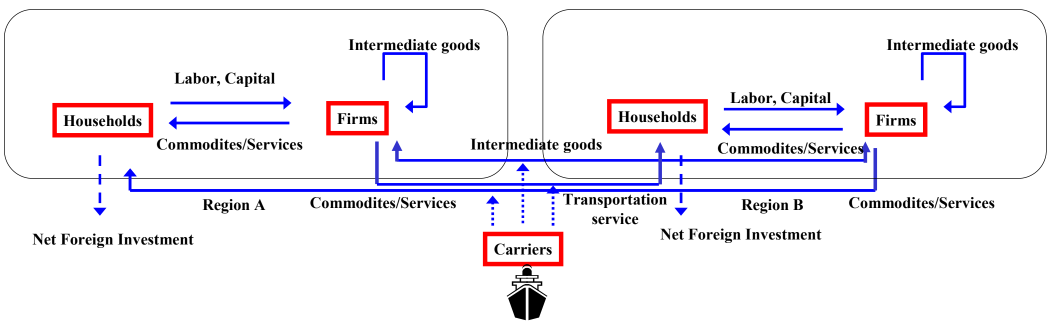

Figure 8. Structure of SCGE Model (World is described as 2 regions)

4.1.2 Firms Behavior

We show the structure of the production function below. As this figure shows, the production function is formulated as a nested type function.

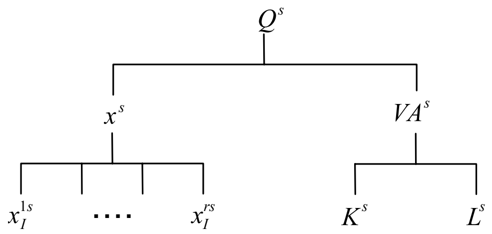

Figure 9. Structure of Production Function

Firms in region s produces output Q^s . We adopt a Leontief type technology for the intermediate good x_I^s and value added VA^s

$$Q^s = \min\left[\frac{VA^s}{a_v^s}, \frac{x_I^s}{a_I^s}\right] \tag{5}$$

a_v^s, a_I^s : input coefficients

The intermediate good x_I^s is regarded as a composite factor whose ingredients are the intermediate goods x_I^{rs} from their own region or other regions.

$$x_I^s = \eta^s \prod_r \left(x_I^{rs}\right)^{\alpha_I^{rs}} \tag{6}$$

η^s, α_I^{rs} : parameters

The value added VA^s is regarded as a composite factor whose ingredients are the capital K^s and the labor L^s from their own region.

$$VA^s = \phi^s K^{s\,\alpha_K^s} L^{s\,\alpha_L^s} \tag{7}$$

$\phi^s, \alpha_K^s, \alpha_L^s$: parameters

4.1.3 Households Behavior

We assume that a representative household consumes commodities/services x_H^{rs} from their own region or other regions to maximize its utility u^s . The maximization problem is shown below.

.

$$\max\ u^s = \prod_r \left(x_H^{rs}\right)^{\beta^{rs}}$$
$$s.t.\quad \sum_r p^r\left(1+\tau_H^{rs}\right)x_H^{rs} = \gamma^s K^s + w^s L^s - NI^s \tag{8}$$

β^{rs} : parameter, p^r :producer price of the commodities/services , τ_H^{rs} :transport margin, γ^s :rent of capital, w^s :wage rate, K^s :capital, L^s : labor, NI^s :net foreign investment

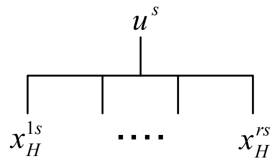

Figure 10 Structure of Utility Function

4.1.4 Equilibrium Conditions

The equilibrium conditions in this model are formulated as follows:

Transport market: $$x_F^r = \sum_r \tau_I^{rs} x_I^{rs} + \sum_r \tau_H^{rs} x_H^{rs} \tag{9}$$

Capital market: $$\phi^{s^{-1}}\left[\frac{\alpha_L^s}{\alpha_K^s}\bullet\frac{\gamma^s}{w^s}\right]^{-\alpha_L^s} \times a_v^s \times Q^s = \overline{K}^s \tag{10}$$

Labor market: $$\phi^{s^{-1}}\left[\frac{\alpha_K^s}{\alpha_L^s}\bullet\frac{w^s}{\gamma^s}\right]^{-\alpha_K^s} \times a_v^s \times Q^s = \overline{L}^s \tag{11}$$

Commodities/services market: $$\sum_r x_I^{sr} + \sum_r x_H^{sr} + x_F^s = Q^s \tag{12}$$

4.2. Data Set

We use the 1990 Japan-US-EU-Asia Input-Output Table as benchmark equilibrium data set.

4.3. Study About Benefit Incident

We study the benefit measured by SCGE Model. But we have to pay attention that this result does not include the route which is not treated in the Partial Equilibrium Model. And we do not consider industrial structure of each area explicitly because we assumed that commodities are single kind of composed goods. We also have to pay attention that this is a result based on the strong assumptions; transportation cost is paid finally by commodities/services demand side, utility function and added-value function are Cobb=Douglas type(elasticity of substitution is fixed as 1).

From the benefit estimation result of 1998 in preceding chapter, Benefit Incidence Table (BIT) made by the result of SCGE model is shown in Table 7..

Paying attention to Japan at first, user benefit of 197 billion yen/year for households and benefit of 394 billion yen/year for firms is generated. Households' user benefit comes down to households directly, and firms' user benefit comes down to Japanese households through the changes of price of commodities/services and wages (Some of benefit (approx.15billion yen) extends to other area). In other area, user benefit of households and firms also generates and it comes down to households in the same manner.

Table 7. Benefit Incidence Table of port investment in Japan
(Price in 1995)

billion yen/year

	Japan			US			EU			Asia			Other	Total
	House holds	Firms	Total	House holds	Firms	Total	House holds	Firms	Total	House holds	Firms	Total	Shipping Enterprises	
Freight Revenue Change	0	0	0	0	0	0	0	0	0	0	0	0	-1,054	-1,054
User's Benefit	197	394	591	273	138	411	147	105	252	0	0	0	0	1,254
Change in prices of Commodities/Services	382	-397	-15	492	-479	13	306	-301	5	140	-143	-4	0	0
Wage Change	4	-4	0	-227	228	2	-123	124	1	-85	86	1	0	3
Capital Dividend Change	0	0	0	-112	113	1	-71	71	1	-57	58	1	0	2
Change in Shipping Enterprises Costs	0	0	0	0	0	0	0	0	0	0	0	0	1,054	1,054
Total	583	-7	576	426	0	427	259	-1	259	-3	1	-2	0	1,259

Note: Values in the hatched cell should theoretically be 0, but actually non-zero because of calculation residuals.

We can understand following points from the BIT.

- Annual benefit of about 580billion yen comes down to Japan by port investment from 1984 to 1998.

- Annual benefit of approx. 430billion yen accrues to US and 260 billion yen to EU. Therefore 46% of total benefit accrues to Japan. When we analyze European and American port investment, the effect of the development is considered to accrue to Japan too.

- Price of commodities/services decreases in Japan, US, Europe and Asia, and the indirect effect is about 1.32trillion yen. This is canceled out socially, but we can understand that Japanese port development may affect price system of commodities and services in each area.

5. CONCLUSIONS

The main results of this research are as follows:

a. We developed Partial Equilibrium Model and SCGE Model that can measure economic benefit of port investment in Japan. These models can measure Japanese general effect of port investment including the induced effect of other market.

b. As a result of estimating the benefit of past port investment including by Partial Equilibrium Model for the international container transportation market, we found Japanese port investment had generated larger benefits than the amount of port investment. This result included only the long-distance container route (North America Pacific Coast Route, North America East Coast Route and European Route), so actual effect may be larger if other route and bulk freight are included to analysis.

c. By inputting the transportation cost reduction estimated by the Partial Equilibrium Model into the SCGE Model, we made the BIT of Japanese port investment. The BIT showed that Japanese port development may affect price system of commodities and services in the whole world.

Future research directions are as follows:

a. As to Partial Equilibrium Model, we should construct same kind of models including bulk freight transportation market, domestic freight transportation market and ferry transportation market.

b. The SCGE Model developed in this research is simple in that it treats single kind of commodity/service, so we need to segment the kind of commodities, services and areas in order to improve the model to more detailed one.

c. Although we develop static SCGE Model in this study to examine the distribution of benefits, we would need to describe the interregional migration flows and capital flows in order to take into consideration the effects of FTA or EPA in the future by developing dynamic SCGE Model. Dynamic SCGE Model can be more complicated and difficult to calculate, but it is a useful tool to forecast trade volumes and capital flows in the future. We would try to construct practical dynamic SCGE model in order to evaluate port development policy more precisely.

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