A SIMULATION ANALYSIS OF FUTURE MARITIME CARGO MOVEMENT IN THE WORLD

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abstract: We have built a simple model which divides the world into ten areas. Our aim is to simulate the effects of Eastern Asia's economic growth on world maritime cargo movement. In our base case, the share of loaded dry cargo volume (excluding Japan) in the world will increase from 15.2% to 26%. Despite the difficulty involved in gathering the necessary data, we attempted to make a model from the first stage.

1. AIMS OF THE STUDY

Many economists predict today that the East Asian region will become the hottest spot in the world economic activities at least into the early 21st century. The economic growth of the region has been accelerating in the last decade, the volume of trade is increasing rapidly, and the movement of passengers and cargo is expanding violently year by year. New port construction or rehabilitation projects are common throughout this area.

This study is concerned with a primitive world wide model which includes GDP, export / import value and loaded / unloaded cargo volume of areas of the world as variables. There are two aims of the study. The first is methodological and the second is practical.

Generally speaking, the demand forecasts used for port development are mainly made on the basis of the socio-economic conditions of the concerned country. It has been recognized, however, that this method is inadequate as it fails to take into account international economic relationships. Perhaps, an international econometrics model including transportation would be needed to incorporate all aspects affecting the economy of a country. But, needless to say, such a comprehensive model is difficult to develop. So, in this study, we will try to take only the first step toward such a comprehensive model.

As mentioned later, our method stands on bold assumptions and reckless data handling at this stage. Therefore, we do not insist that results derived from our model are accurate or reflect reality. However, it will be our responsibility to show how our model behaves. We will try to simulate the model based on the assumed GDP of a specific area.

2. METHODOLOGY

2.1 Area Classification for Analysis

In the analysis, the following ten areas will be used in accordance with the data availability.

(1) Western Europe ('W.Europe' for short) :
(2) Eastern Europe and Former USSR (E.E&USSR): Bulgaria, Frm.Czechslovakia, Frm.German D.R., Hungary, Poland, Romania and Frm.USSR
(3) Middle East (M.East) : Bahrain, Cyprus, Democratic Yemen, Iran, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Rep., Turkey, United Arab Emirates, Yemen, Israel
(4) Southern Asia (S.Asia) : Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal,

Pakistan, Sri Lanka
(5) East Asia excluding Japan (E.Asia) : China, Hong Kong, Korea D.P.R., Korea Rep., Macao, Mongolia, Brunei, Cambodia, East Timor, Indonesia, Lao P.D.R. Malaysia, Myanmar, Philippines, Singapore, Thailand, Viet Nam
(6) Japan :
(7) Oceania :
(8) Southern America (S.America) : Latin America & Caribbean, Central America, South America and Northern America area excluding Canada & USA
(9) Northern America (N.America) : only Canada and USA
(10) Africa :

2.2 Model Structure

Our model structure is very simple as seen in the following figure 1. At first, the future GDP of each area will be assumed. At the same time, export and import prices will be given with average changing rates for the past five years. For simplicity, we use only GDP as an operational variable. If needed, however, export / import price can be used as another operational variable.

Next, export and import values in future will be projected for each areas inputting GDP and prices into estimated functions. These values are evaluated by the constant price at 1990, the same as GDP. And they cover all commodities excluding mineral fuels and related materials (SITC 3) most of which are carried by tanker.

In the next step, loaded / unloaded cargo volumes of each area will be calculated with export / import values respectively. The cargo treated in the study is dry type only. This is the reason why we exclude fuels from export / import data.

The same as dry cargo volume, container throughput (total handling of load and unload) for each area will be projected.

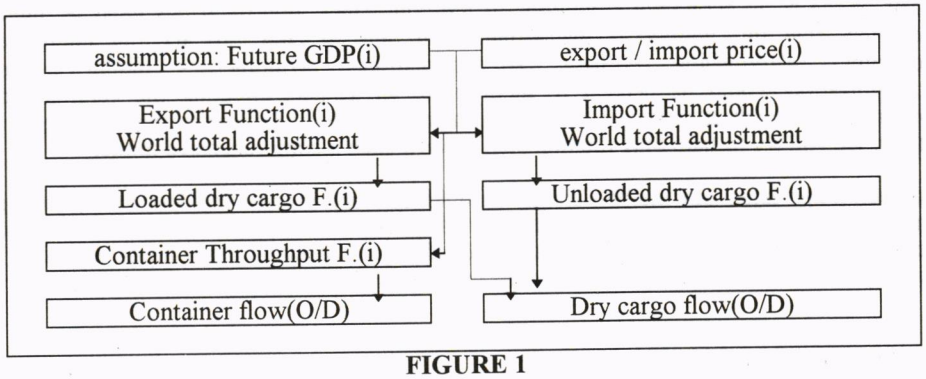

FIGURE 1

Next, future dry cargo and container volume will be developed mathematically to origin-destination flow. At this step, we have two cargo vectors. One (A) is origin basis (loaded) and other (B) is destination basis (unload). Moreover, we need a O-D flow structure matrix (C) for initial condition. An iterative calculation will be done for total adjustment of columns and rows, starting from initial flow matrix. At first, (Step 1) vector data (a) will be given to the top column of the matrix (C), and it will be shared according to initial structure in horizontal direction. Next, (Step 2) vector data (B) will be given to the top row, and it will be shared again according to tentative structure in vertical direction. Next, (Step 3) step 1 will be done again under new tentative structure. And step 2 and 3 will be iterated until convergence is achieved. In case of container, the formula is the same, and vector (A) and (B) is assumed to be half of total throughput.

The entire model system has been developed on a sheet of Micro-Soft Excel. Simulation results will be calculated automatically when we input a set of future GDP levels of all area.

2.3 Export Function

At first, we have estimated a total import (= export [note1]) value function for the entire world.

$$\ln(W\_IMP)=-7.6432+1.05937*\ln(W\_GDP)+0.31851*\ln(W\_IPM_{-1}) \quad \text{.....(1)}$$
$$(4.48) \qquad (2.10)$$
$$R2'=0.992 \qquad DW=1.466 \qquad Term: 1971\text{-}92$$

Here, W_IMP is total world import and W_IPM_{-1} is that of the previous year. W_GDP is sum of GDPs of each area.

Next, export function of each area has been estimated with data from 1970-92. Data is standard type and often adopted in many econometric models. Export from each area is decided with import of whole world and relative export price.

$$\ln(EXP_i)=a+b*\ln(W\_IMP)+c*\ln(PEXi/PWD) \quad \text{.....(2)}$$

Hear, EXP_i is export value of i-area at 1990 constant price. PEXi is export price of i-area and PWD is average export price of the world. Coefficients a and b obtained are shown in Table 1 with t-value, adjusted R-squared (R2') and Durbin-Watson statistic (DW). We have to note that some functions were estimated with dummy variables for some years in addition to above mentioned ones. Coefficient or other statistical information regarding dummy variables are not shown in the table to avoid complexity, and this approach in other groups of function which will be mentioned in following sections.

TABLE 1 EXPORT FUNCTION

	a	b		c		R2'	DW
	coef.	coef.	t-val	coef.	t-val		
W.Europe	-0.8892	1.0105	56.21	-0.2587	-2.43	0.994	0.82
E.E&USSR	5.0119	0.4779	9.77	-1.1249	-16.53	0.962	1.33
M.East	-5.2783	1.0635	12.83	-0.8442	-26.49	0.984	1.12
S.Asia	-1.7589	0.8145	4.52	-0.9502	-2.32	0.944	0.69
E.Asia	-19.4470	2.1725	59.31	-0.8822	-6.94	0.995	0.63
Japan	-7.7837	1.3703	20.75	-0.9851	-2.39	0.957	0.76
Oceania	-0.2766	0.7332	20.10	-0.3631	-4.63	0.981	1.48
S.America	-1.5018	0.8760	14.98	-0.5968	-5.57	0.955	0.96
N.America	0.4700	0.8433	23.23	-0.7066	-6.01	0.980	1.03
Africa	9.6185	0.0838	2.26	-0.8948	-9.67	0.833	1.26

(Note) $\ln(EXP)=a+b*\ln(W\_IMP)+c*\ln(PEX/PWD)$

(DATA-GDP) OECD countries; Gross domestic product - at the price levels and exchange rates of 1990 / Ref.[1], Non-OECD countries / GDP at 1987 price / Ref.[2] (aggregate from FD data base and converted to 1990 price)
(DATA-EXP,IMP-nominal base) World Trade by Commodity Classes and Regions / Ref.[3], Foreign Trade (Custom basis) / Ref.[1], External Trade / Ref.[4]
(DATA-PEX,PIM) OECD countries; Export / Import of goods and services - price indices (1990=100) / Ref.[1], Fuel imports - Unit value indices in U.S. dollar / Ref.[3], Non-OECD Countries; Terms of Trade (Export / Import price 1987=100) / Ref.[2] (aggregate from FD data base and converted to 1990 price with weight)
(NOTE 1) Export value is evaluated by fob and import by cif in original data. But the

accuracy of our model and data is not so high to state the difference between fob and cif. Then, we have adjusted total import value to total export.

2.4 Import Function

The specification of import function prototype is as follows.

$$\ln(IMP_i)=a+b*\ln(GDP_i)+c*\ln(IMPi_{-1})+d*\ln(PIM_i/PEX_i) \quad \text{.....(3)}$$

IMP_i is import value of i-area, and $IMPi_{-1}$ is that one of the previous year. PIM_i is import price of i-area, and PEX_i is export price. Usually, in this type of import function, whole sale price of i-area is adopted as a denominator of the relative price. But, we could not obtain reliable data. So, export price was used instead of whole sale price which shows the level of domestic price.

Table 2 shows the estimation results. The function concerning M.East was not estimated meaningfully. We, in our model, have decided the import value level of M.East as a residual of whole world import and sum of other 9-areas. Moreover, variable GDP in case of E.E. & USSR and variable $IMPi_{-1}$ in case of Oceania and S.America were statistically meaningless.

TABLE 2 IMPORT FUNCTION

	a	b		c		d		R2'	DW
	coef.	coef.	t-val	coef.	t-val	coef.	t-val		
W.Europe	-16.8390	1.9656	33.75			-0.8792	-3.28	0.990	1.44
E.E&USSR	2.0110			0.8350	10.35	-0.1540	-2.08	0.917	1.50
M.East	inf.								
S.Asia	-0.7078	0.6474	4.35	0.2962	1.72			0.951	1.92
E.Asia	-1.4764	0.6554	3.48	1.4151	2.45	-0.0624	-0.51	0.992	1.58
Japan	-6.6045	0.9270	4.48	0.3969	2.69	-0.1414	-0.40	0.966	1.73
Oceania	-6.4371	1.5302	10.44			-0.3046	-2.78	0.909	1.71
S.America	-11.5890	1.6926	9.12			-0.2063	-3.51	0.796	1.73
N.America	-27.9610	2.3609	6.49	0.3248	2.30	-1.8347	-4.79	0.977	1.85
Africa	3.2069	0.2795	1.98	0.4034	2.87	-0.3341	-2.86	0.826	2.25

(Note) $\ln(IMP)=a+b*\ln(GDP)+c*\ln(IMP_{-1})+d*\ln(PIM/PEX)$

2.5 Loaded / Unloaded Dry Cargo Functions

Total dry cargo volume of the whole world has been estimated with total export value.

$$(W\_LO)=353564+0.64551*(W\_IMP) \quad \text{.....(4)}$$
$$(56.88)$$
$$R2'=0.995 \quad DW=2.03 \quad \text{Term:1970-90}$$

Next, loaded dry cargo and unloaded one of each area are estimated with export value and import value respectively as variable. These functions are a kind of converter from monetary base to tonnage base.

$$\text{(LOAD)} \quad (LD_i)=a+b*(EXP_i) \quad \text{.....(5)}$$
$$\text{(UNLOAD)} \quad (UL_i)=a+b*(IMP_i) \quad \text{.....(6)}$$

It is not necessary to explain function valuables, coefficients and other statistical information summarized in Table 3 and 4. Load of M.East and unload of Oceania were estimated infeasibly. They will be replaced with world total minus sum of other 9-areas in our simulation.

TABLE 3 LOADED DRY CARGO FUNCTION

	a	b		R2'	DW
	coef.	coef.	t-val		
W.Europe	126961	0.2501	18.25	0.943	0.77
E.E&USSR	65128	0.1224	4.80	0.871	2.19
M.East	inf.				
S.Asia	5839	0.7486	4.87	0.848	1.85
E.Asia	55985	0.5135	23.01	0.965	0.59
Japan	38199	0.1513	10.93	0.915	1.40
Oceania	8241	6.1596	12.86	0.936	1.78
S.America	112194	1.7548	12.77	0.939	1.30
N.America	165381	0.7955	13.12	0.814	0.99
Africa	39115	2.6925	7.07	0.866	2.60

(Note) (LD)=a+b*(EXP)

TABLE 4 UNLOADED DRY CARGO FUNCTION

	a	b		R2'	DW
	coef.	coef.	t-val		
W.Europe	317301	0.3260	16.83	0.960	2.33
E.E&USSR	28927	0.9092	8.43	0.898	1.99
M.East	54721	0.6496	9.85	0.918	1.82
S.Asia	-12817	1.3844	19.56	0.964	2.09
E.Asia	28759	0.9279	25.76	0.987	1.60
Japan	210878	1.4621	17.91	0.962	2.06
Oceania	inf.				
S.America	19106	0.5666	10.42	0.919	1.41
N.America	155869	0.1305	15.60	0.952	1.51
Africa	22173	0.9815	10.92	0.916	1.83

(Note) (UL)=a+b*(IMP)

(DATA-DRY CARGO VOLUME) Analysis of goods loaded and unloaded international maritime transport / Ref.[5] (aggregate from country base to ten areas)
This important data base has not published since 1991.

2.6 Container Throughput Function

And finally, container throughput function of each area has been estimated. Its specification is as follows. As seen in Table 5, sum of loaded dry cargo volume and unloaded one is used as an independent variable in almost all functions. For Africa, GDP is used while total trade value is used in the case of Japan.

$$\ln(CON_i)=a+[b*\ln(GDP_i)]+[c*\ln(EXP_i+IMP_i)]+[d*\ln(LD_i+UL_i)] \quad \text{.....(7)}$$

In this step, there is a big problem in using the results of these functions directly. Since our function does not reflect the effect of containerization. The estimated coefficients might overemphasize the recent trend of rapid containerization. It would be better to use containerized cargo ratio as another variable. However, such data is difficult to obtain for all areas.

An easy but untheoretical way is to introduce a guideline regarding the total container volume of the world in future, and to adjust the volume of each area from function with it. The guideline we adopted is as follows in which future growth decreases.

Growth rate of world container throughput: 9.5% for 1995-2000
7.5% for 2001-2005

TABLE 5 CONTAINER THROUGHPUT FUNCTION

	a	[b][c][d]			R2'	DW
	coef.	coef.		t-val		
W.Europe	-54.6760	d	4.1164	14.18	0.954	1.04
E.E&USSR	-3.7400	d	0.5563	5.36	0.921	1.33
M.East	-11.6170	d	1.0607	11.05	0.963	0.90
S.Asia	-28.3730	d	2.5422	16.04	0.989	2.12
E.Asia	-22.2260	d	1.8901	31.56	0.990	1.82
Japan	-20.1250	c	1.7133	20.35	0.980	0.42
Oceania	-11.7360	d	0.9959	13.15	0.945	0.83
S.America	-19.1120	d	1.6054	16.23	0.967	1.52
N.America	-16.5680	d	1.4340	15.31	0.963	0.72
Africa	-48.3310	b	3.8584	12.14	0.953	1.20

(Note) ln(CON)=a+[b*ln(GDP)]+[c*ln(EXP+IMP)]
+[d*ln(LD+UL)]

(DATA-Container throughput) Ref.[6] (aggregate from region or country base to ten area)
(NOTE 2) In setting our guideline for the study, we referred to ref.[6].

2.7 Dry Cargo Flow Structure

As mentioned above, we need a dry cargo flow matrix of base year. But, we could not discover such data. Then, we had to introduce a big assumption in which cargo flow between each area was nearly proportional to the monetary trade flow. A trade matrix without fuel was made on 1990-92 average basis.

There was another problem. Above data of international trade contains all cargo which is carried by all modes. Especially, a lot of cargo moves internationally in Europe. The lack of data prevented us from dividing the flow by mode. All we could do was reduce the diagonal cell of W_Europe and E.E&USSR by 65%, that of N_America by 21%.

Using the estimated loaded / unloaded dry cargo vector at 1995 (base year), convergence formula was done on the above trade matrix. Initial flow structure obtained finally is shown in Table 6.

(DATA-TRADE MATRIX) World Trade by Commodity Classes and Regions / Ref.[3], International trade by various modes of transport / Ref.[7]

2.8 Container Flow Structure

We could not get an actual world container flow. Then, we tried to make a flow matrix roughly. We can know the container volumes carried main routes at the end of 1994 according to Ref.[]. But, volumes of a diagonal (inner area movement) are unknown. So, we made them up¥ using ratios between trade value and container volume of inter-area. With the container throughput and flow matrix, convergence formula was obtained. Table 7 shows an initial container flow structure, which is compressed in seven areas because of base data.

(DATA-Main Roots Container Movement) Ref.[8]

TABLE 6 DRY CARGO FLOW / INITIAL STRUCTURE (BASE YEAR 1995)

per millage

	W.E	E.E.	M.E	S.A	E.A	Ja	Oc	S.A	N.A	Af
W.Europe	36.72	33.04	21.75	5.70	34.52	17.17	5.59	5.85	16.24	15.41
E.E&F.USSR	3.22	2.81	4.53	1.04	8.63	2.58	0.13	0.74	0.80	1.33
M.East	21.12	4.89	3.25	4.20	5.03	2.28	0.40	0.09	0.93	1.79
S.Asia	4.68	1.41	0.55	0.99	3.29	1.13	0.20	0.02	1.23	0.33
E.Asia	35.76	5.03	6.94	3.53	37.55	32.01	4.55	2.11	17.65	3.13
Japan	7.50	0.39	1.42	0.60	14.50	0.00	1.13	0.64	4.04	0.53
Oceania	17.99	1.38	3.61	3.86	38.41	33.81	16.25	0.65	5.28	1.26
S.America	50.40	6.19	4.33	0.38	18.06	14.86	0.99	16.86	30.89	2.77
N.America	67.35	5.61	9.25	3.34	48.22	39.43	6.97	16.55	13.47	4.38
Africa	39.21	2.52	2.78	2.08	3.18	4.25	0.15	0.21	1.42	6.77

TABLE 7 CONTAINER FLOW / INITIAL STRUCTURE (BASE YEAR 1995)

per millage

	Eu	M.E	S.A	E.A	Oc	S.A	N.A	Af
Europe	38.61	12.65	6.09	105.21	4.36	14.36	42.83	9.87
M.East	12.65	0.22	1.55	19.83	0.47	0.00	2.62	0.80
S.Asia	6.09	1.55	0.15	10.85	0.14	0.51	2.53	0.57
E.Asia	105.21	19.83	10.85	180.88	13.32	14.48	81.71	9.98
Oceania	4.36	0.47	0.14	13.32	1.07	0.35	3.05	1.68
S.America	14.36	0.00	0.51	14.48	0.35	7.50	12.93	7.43
N.America	42.83	2.62	2.53	81.71	3.05	12.93	7.67	0.97
Africa	9.87	0.80	0.57	9.98	1.68	7.43	0.97	1.61

3. SIMULATION ANALYSIS

3.1 Base Case

We can conduct a simulation analysis by using the model which is prepared in the above section. A simulation case will be examined as a base for comparison with other cases. First, the case for the year of 1995 will be executed as a base case. Second, simulations for the year of 2000 and 2005 will be done for comparison.

In the base case, 1970-92 Trend Growth Rate was utilized to predict the GDP Growth Rate of each area which is an exogenous variable. Table 8 shows 1970-92 Trend Growth Rate. The growth rates of E.E. and U.S.S.R were calculated based on the past actual trend up to 1989, because these areas have experienced large negative economic growth since 1990 in an effort to shift to a market economy. It is also assumed that the economy in these areas would recover to the same level of 1990 GDP by 2005.The annual average growth rate during this stage is 5.16%. Table 8 also shows the trend of GDP in the recent past, from 1980-92. According to this table, the economy of South and East Asia has accelerated while the economy in the Middle East and South America has decelerated.

All preparations for the simulation have now been completed. The result of BASE CASE is summarized in Table 10. The noteworthy results, mainly concerning East Asia, are as follows;

TABLE 8 GDP GROWTH TRENDS % per annum

	W.Eu	*E.Eu	M.Ea	S.As	E.As	Ja	Oc	S.Am	N.Am	Af	Total
1970-92 Trend Growth Rate of GDP											
RATE	2.40	3.86	3.77	4.64	7.77	4.10	2.84	3.05	2.64	3.32	3.02
R2'	0.99	0.98	0.88	0.99	0.99	1.00	0.99	0.91	0.98	0.96	0.99
1980-92 Trend Growth Rate of GDP											
RATE	2.45	3.14	2.65	5.44	8.52	4.11	2.90	1.72	2.77	2.28	2.95
R2'	0.98	0.99	0.81	0.99	1.00	0.99	0.95	0.89	0.96	0.98	0.98

(NOTE) E.E&USSR was calculated for 1970-1989,1980-1989

As for the export/import price change rates in future, those will be assumed to be the same as the average change rates for five years between 1987 to 1992 as shown in Table 9.

TABLE 9 EXPORT / IMPORT PRICE CHANGE RATES

% per annum

	W.Eu	*E.Eu	M.Ea	S.As	E.As	Ja	Oc	*S.Am	N.Am	Af	Total
1987-92 average											
EXP.	3.68	4.31	7.45	2.02	3.22	4.06	3.22	4.05	2.28	4.17	2.90
IMP.	3.76	3.00	3.93	3.39	4.71	2.58	2.42	3.76	2.93	3.82	-

(NOTE) Export of E.E&USSR and S.America was calculated for 1985-1990.

(1) In case of 7.8% annual high economic growth for the next decade, GDP of the area will increase more than two times of present GDP and the share of the GDP in the world will vary from 7% to more than 10%. The share of GDP in West Europe and North America will decrease. Japan's economic growth rate in BASE CASE, however, seems to be slightly higher than the actual growth rate observed these days.

(2) Export of the area in the year 2005 will be 2.7 times and import of the area will be 2.2 times of the year 1995. The magnification is more than that of GDP in the area, namely, the elasticity values for GDP exceed one(1). The import share of the area in the world will increase by 8.5% from 14.8%. The export share of the area in the world will widely vary from 19% to 30%.

(3) As for the dry cargo volume of loading/unloading, export and import volume of the area will increase 2.7 times and 2.2 times respectively reflecting the estimation of export and import. The share of loading in the world will vary from 15.2% to 26% and the share of unloading will increase from 22% to 31%.

(4) Finally, container throughput in the area in 2005 will amount to more than three times of 1995 and its share in the world will increase from 36% to 50%. Container throughput for EE & USSR shows extraordinarily high values. This is because the figures in base year(1995) were extremely low.

TABLE 10 RESULTS OF BASE CASE

	W.Eu	E.Eu	M.Ea	S.As	E.As	Ja	Oc	S.Am	N.Am	Af	Total
GDP LEVEL (1995=100)											
2000	113	121	120	125	145	122	115	116	114	118	118
2005	127	146	145	157	211	149	132	135	130	139	139
GDP SHARE(%) OF THE WORLD & SHARE CHANGE FROM 1995 (percentage)											
1995:S	33.6	2.9	1.5	2.2	7.0	13.9	1.7	5.6	29.8	1.8	100.0
2000:SC	-1.4	0.1	0.0	0.1	1.7	0.5	0.0	-0.1	-0.9	0.0	0.0
2005*SC	-3.0	0.1	0.1	0.3	3.7	1.0	-0.1	-0.2	-2.0	0.0	0.0
EXPORT LEVEL (1995=100)											
2000	120	101	104	123	163	129	113	115	121	93	128
2005	143	101	108	150	266	164	126	130	144	85	166
EXPORT SHARE(%) OF THE WORLD & SHARE CHANGE FROM 1995 (percentage)											
1995:S	45.6	2.1	1.1	1.2	19.0	8.7	1.4	4.2	15.3	1.3	100.0
2000:SC	-2.7	-0.4	-0.2	0.0	5.2	0.0	-0.2	-0.4	-0.9	-0.3	0.0
2005:SC	-6.2	-0.8	-0.4	-0.1	11.5	-0.1	-0.3	-0.9	-2.0	-0.6	0.0
IMPORT LEVEL (1995=100)											
2000	121	179	108	121	147	129	119	124	119	103	128
2005	152	229	111	149	223	177	146	159	146	111	166
IMPORT SHARE(%) OF THE WORLD & SHARE CHANGE FROM 1995 (percentage)											
1995:S	42.2	5.4	4.2	1.6	17.0	4.0	1.5	5.2	16.8	2.0	100.0
2000:SC	-2.2	2.2	-0.7	-0.1	2.6	0.0	-0.1	-0.2	-1.2	-0.4	0.0
2005:SC	-3.6	2.0	-1.4	-0.2	5.9	0.3	-0.2	-0.2	-2.0	-0.7	0.0
LOAD CARGO LEVEL (1995=100)											
2000	122	105	109	127	163	122	118	115	121	99	125
2005	147	109	118	159	272	150	137	132	146	97	158
LOAD CARGO SHARE(%) OF THE WORLD & SHARE CHANGE FROM 1995 (percentage)											
1995:S	19.7	2.7	1.8	1.4	15.2	3.2	12.6	14.8	22.1	6.4	100.0
2000:SC	-0.4	-0.4	-0.2	0.0	4.7	-0.1	-0.6	-1.1	-0.6	-1.3	0.0
2005:SC	-1.3	-0.8	-0.5	0.0	11.0	-0.2	-1.6	-2.4	-1.6	-2.5	0.0
UNLOAD CARGO LEVEL (1995=100)											
2000	114	180	105	124	146	115	119	122	107	102	125
2005	134	231	107	156	221	141	147	153	116	108	158
UNLOAD CARGO SHARE(%) OF THE WORLD & SHARE CHANGE FROM 1995 (percentage)											
1995:S	29.3	6.6	6.0	2.7	22.1	15.2	0.9	4.6	8.7	3.9	100.0
2000:SC	-2.6	3.0	-0.9	0.0	3.9	-1.2	0.0	-0.1	-1.3	-0.7	0.0
2005:SC	-4.5	3.1	-1.9	0.0	8.8	-1.6	-0.1	-0.1	-2.3	-1.2	0.0
CONTAINER LEVEL (1995=100)											
2000	163	1121	72	161	192	157	84	109	113	171	157
2005	222	1175	53	199	312	249	68	96	136	230	226
CONTAINER SHARE(%) OF THE WORLD & SHARE CHANGE FROM 1995 (percentage)											
1995:S	23.3	0.0	3.8	2.2	36.0	7.6	2.4	5.8	15.4	3.3	100.0
2000:SC	0.8	0.3	-2.1	0.1	7.9	0.0	-1.1	-1.8	-4.4	0.3	0.0
2005:SC	-0.4	0.2	-2.9	-0.3	13.7	0.8	-1.7	-3.3	-6.1	0.1	0.0

Next, the result of OD flow deployed in the year 2005 is shown in Table 11.

TABLE 11 DRY CARGO FLOW / INCREASE CONTRIBUTION RATE (1995-2005)

per-millage

	W.E	E.E	M.E	S.A	E.A	Ja	Oc	S.A	N.A	Af	TOT
W.Europe	20	79	2	6	59	6	-7	5	-2	3	171
E.E&F.USSR	0	3	-2	0	6	-1	0	0	0	0	6
M.East	-21	-2	-4	-3	-3	-2	-1	0	-1	-2	-38
S.Asia	3	4	0	1	6	1	0	0	0	0	15
E.Asia	98	32	13	13	190	75	-3	7	25	6	458
Japan	4	1	0	1	24	0	-1	1	-1	0	29
Oceania	11	4	1	5	71	14	-19	1	0	0	87
S.America	26	15	0	0	30	5	-1	14	-4	1	87
N.America	46	15	2	4	92	18	-8	17	0	1	187
Africa	-2	3	-1	1	3	-1	0	0	-1	-2	0
Total	185	155	11	28	478	114	-39	45	15	7	1000

According to this table, approximately half of the dry cargo flow increase during 1995 and 2005 will be handled in East Asia. The flow in East Asia will increase approximately by 20%. The main destinations of the cargo generated from the East Asia will be West Europe, Japan, East Europe & USSR and the North America, the main origins of the cargo carried to the area will be North America, West .Europe and the Oceanic.

TABLE 12 CONTAINER FLOW / INCREASE CONTRIBUTION RATIO (1995-2005)

per-millage

	Eu	M.E	S.A	E.A	Oc	S.A	N.A	Af	TOT
Europe	25	2	8	61	-1	10	25	43	173
M.East	2	1	1	-5	0	1	1	1	1
S.Asia	8	1	12	12	1	0	4	4	40
E.Asia	61	-5	12	310	7	17	102	16	521
Oceania	-1	0	1	7	-1	0	-1	-1	5
S.America	10	1	0	17	0	-3	10	-3	32
N.America	25	1	4	102	-1	10	12	5	158
Africa	43	1	4	16	-1	-3	5	5	71
Total	173	1	40	521	5	32	158	71	1000

Table 12 shows the container flow/increase contribution ratios which are predicted by container throughput and container initial flow as final output in BASE CASE. Those ratios represent ratios of container flows between areas during 1995 and 2005. The ratio of East Asia including Japan is 52%. Breaking down this figure, 31% is internal flow of the area, 10% is between the North America and 6% is between Europe including EE & USSR.

3.2 Results of Induction Test

Next, results of simulation in case of change of exogenous variable GDP are shown in this section. That is induction test. As main subject in this report is the cargo generated to/from

East Asia, GDP growth rate in the area is changed in induction test.

Table 13 shows results of the test in case of changing GDP growth rate in East Asia by 1% from 5% to 10%. The GDP of East Asia in the year 2005 will be between 163 and 259 in case of the area's GDP in 1995 is 100.

TABLE 13 SIMULATION OF GDP GROWTH RATE OF E.ASIA

	5%	6%	7%	8%	9%	10%
GDP LEVEL (1995=100)						
2000	128	134	140	147	154	161
2005	163	179	197	216	237	259
SHARE(%) IN THE WORLD & SHARE CHANGE FROM 1995 (percent point)						
1995:S	7.0	7.0	7.0	7.0	7.0	7.0
2000:SC	0.7	1.0	1.4	1.7	2.1	2.5
2005*SC	1.4	2.2	3.0	3.9	4.8	5.8
EXPORT LEVEL (1995=100)						
2000	158	160	161	163	165	167
2005	249	255	261	268	275	284
SHARE(%) IN THE WORLD & SHARE CHANGE FROM 1995 (percent point)						
1995:S	19.0	19.0	19.0	19.0	19.0	19.0
2000:SC	4.8	5.0	5.1	5.2	5.3	5.4
2005:SC	10.6	10.9	11.2	11.6	11.9	12.4
IMPORT LEVEL (1995=100)						
2000	131	137	143	149	155	162
2005	173	190	208	227	248	271
SHARE(%) IN THE WORLD & SHARE CHANGE FROM 1995 (percent point)						
1995:S	17.0	17.0	17.0	17.0	17.0	17.0
2000:SC	0.7	1.4	2.0	2.7	3.5	4.2
2005:SC	1.4	3.0	4.6	6.3	8.0	9.8
LOAD CARGO LEVEL (1995=100)						
2000	159	160	162	164	166	168
2005	253	259	266	273	281	290
SHARE(%) IN THE WORLD & SHARE CHANGE FROM 1995 (percent point)						
1995:S	15.2	15.2	15.2	15.2	15.2	15.2
2000:SC	4.4	4.5	4.7	4.8	4.9	5.0
2005:SC	10.0	10.3	10.7	11.0	11.4	11.9
UNLOAD CARGO LEVEL (1995=100)						
2000	132	137	142	148	153	159
2005	177	192	208	225	243	262
SHARE(%) IN THE WORLD & SHARE CHANGE FROM 1995 (percent point)						
1995:S	22.1	22.1	22.1	22.1	22.1	22.1
2000:SC	1.6	2.4	3.2	4.1	4.9	5.7
2005:SC	3.5	5.4	7.3	9.3	11.3	13.4
CONTAINER LEVEL (1995=100)						
2000	179	184	188	193	198	202
2005	273	287	301	315	329	342
SHARE(%) IN THE WORLD & SHARE CHANGE FROM 1995						
1995:S	36.0	36.0	36.0	36.0	36.0	36.0
2000:SC	5.0	6.1	7.1	8.2	9.2	10.2
2005:SC	7.4	9.7	11.9	14.2	16.4	18.5

Export value will be between 249 and 284 if GDP in 1995 is 100. According to the increase of GDP growth rate, the elasticity of export value against GDP conversely falls. This means

the value has a suppression effect on enlargement of share in the world in high economic growth. The volume of loaded dry cargo increases to the level of 253 to 290 in proportion to export value.

Import value will be between 173 and 271 and the elasticity of import value against GDP is nearly one(1). Namely, imports will increase in proportion to demand(GDP) in the area. Unload cargo levels correspond to import levels.

Level of container throughput will be between 273 and 342 and the level shows the largest ratio among six factors in Table 13. In case of 7%, total container throughput of Japan and East Asia results in 187 mil. TEU. On the other hand, 179 mil. TEU was predicted in Ref.[6].

Among results of simulations, two results concerning dry cargo of 5% case and 10% case were developed to OD flow. Table 14 shows the difference of cargo flow between the two cases in 2005. According to the difference of GDP growth rate in East Asia, total cargo flow in the world will increases by 292 mil. tons. The difference of import cargo (unloaded) in East Asia increases by 530 mil. tons and the difference in other areas equally decreases. On the other hand, the difference of export cargo (loaded) for East Asia in each area increases.

TABLE 14 DIFFERENCE OF CARGO FLOW BETWEEN 5% & 10% CASE (2005: million ton.)

	W.E	E.E	M.E	S.A	E.A	Ja	Oc	S.A	N.A	Af	TOT
W.Europe	-8	-17	-3	-2	82	-2	0	-2	-2	-3	42
E.E&F.USSR	-2	-3	-2	-1	10	-1	0	0	0	-1	1
M.East	0	0	0	0	4	0	0	0	0	0	4
S.Asia	-2	-1	0	-1	7	0	0	0	0	0	3
E.Asia	-10	-4	-1	-1	184	-5	0	-1	-3	-1	158
Japan	-6	-1	-1	-1	21	0	0	-1	-2	0	8
Oceania	-13	-2	-2	-4	66	-20	-2	-1	-3	-1	19
S.America	-9	-3	-1	0	44	-2	0	-4	-3	0	22
N.America	-30	-5	-3	-2	106	-14	-1	-9	-4	-2	37
Africa	-4	-1	0	0	6	0	0	0	0	-1	0
Total	-85	-37	-13	-11	530	-45	-3	-17	-19	-9	292

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