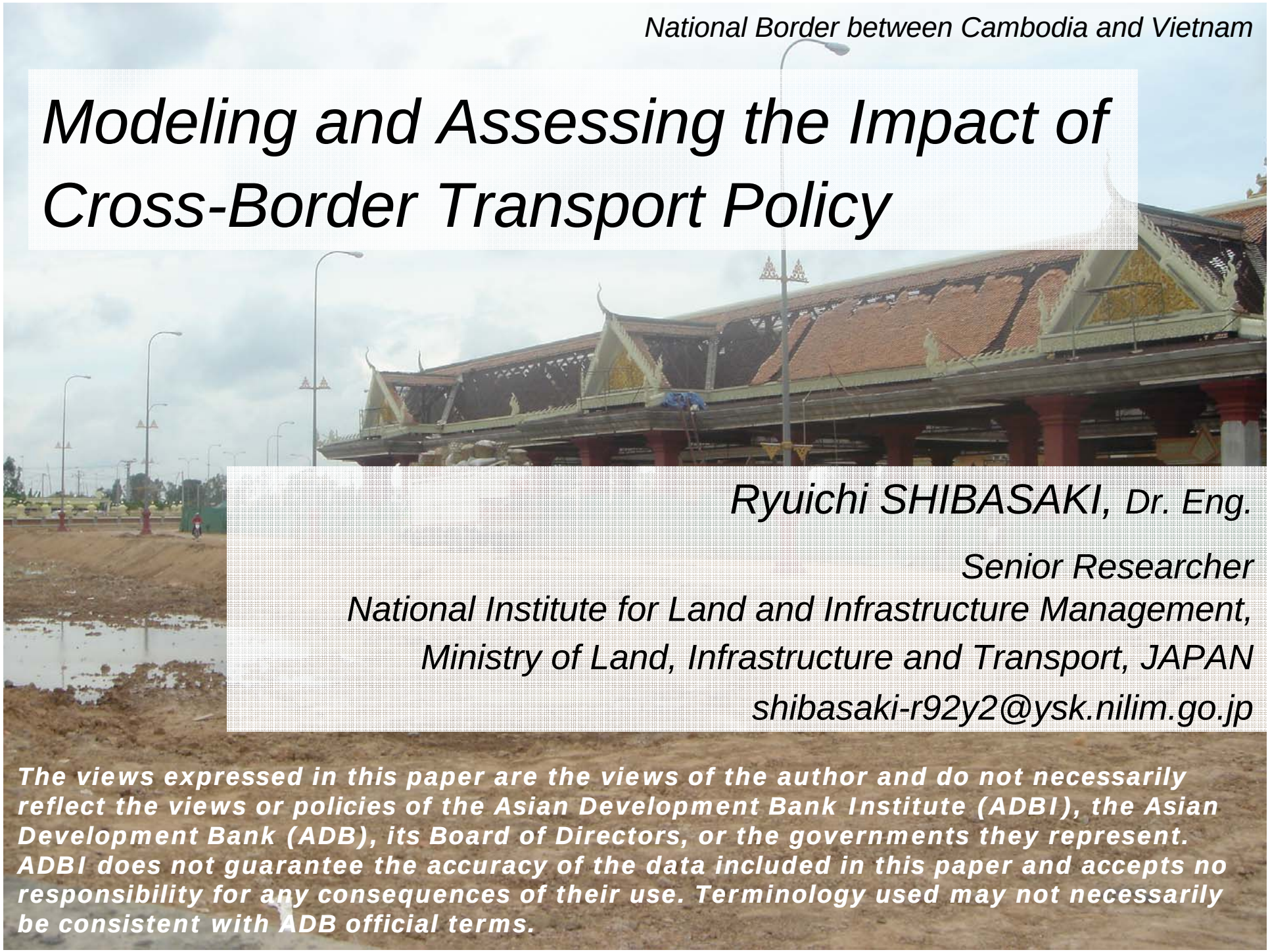

National Border between Cambodia and Vietnam

Modeling and Assessing the Impact of Cross-Border Transport Policy

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- Infrastructure Improvement in Lower Mekong Area

IV. ADITTIONAL MODEL – TRADE ESTIMATION MODEL
- For Assessing Impact of Trade Policy like FTA

bet. Thailand and Laos (Friendship Bridge)

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I. BRIEF OVERVIEW OF "MICCS"
- Model for International Container Cargo Simulation -

Port of Shenzhen

Model for International Cargo Simulation (MICS)

Model Inputs

Service Level of Each Port
(Policy Variables)
- Number of Berths by depth
- Port Entrance Charge,
  Handling Charge, Terminal Charge
- Handling Time, Operation Hours, etc.

Information on Transport Network
- Physical Distance
- Transportation Cost (Maritime & Road)
- Containership Size

Container OD Volume by region

Outputs

Container Movements
on Maritime / Land
Transportation Network

Total and Transshipped
Container Volume by Port

We apply and arrange for describing Worldwide Container Movement…

Network Assignment Methodologies

which is
- *normally used for traffic assignment of vehicles on road transport network*
- *one of most popular methodology of transport demand forecasting*

Structure of the Model

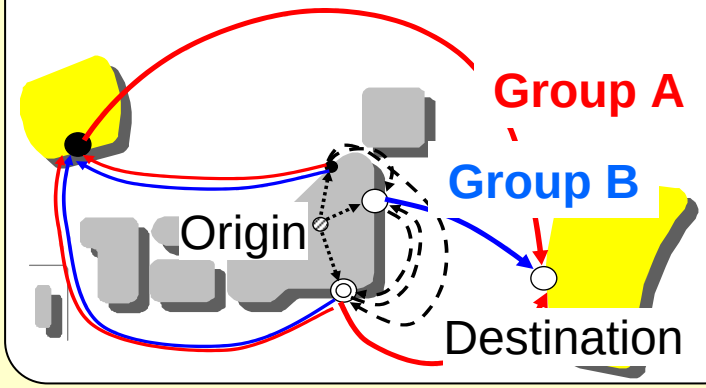
Input

- Level of Service of Port
- Container OD Flow by Region
- Transportation Cost
- Initial Link Flow

Model for International Cargo Simulation (MICS)

Shipper Sub-Model (Assignment by SA)

Choose
- Loading / Unloading Port
- Shipping Group



"Perceived" Cost Minimization by Individual Container

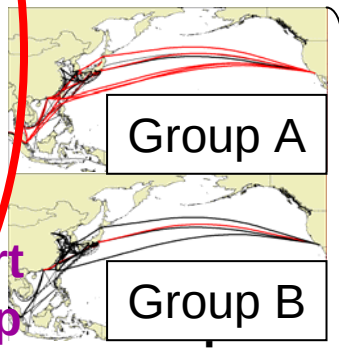
OD Cargo Flow for each Shipping Group

General Cost on International Maritime Transport by Shipping Group

Repeat until Convergence

Carrier Sub-Model (Assignment by GSO)

Decide Transport Pattern (Ship-size, Transship Port) **by Shipping Group**



Interference of link flow

- **Congestion in berthing**
- **Scale economy of terminal cost**

Total Cost Minimization by Shipping Group

Output

- Converged Container Flow between Ports by Ship-size and Group
- Total and Transshipment Container Volume by Port

Container Ports in the Model [1] … 40 Japanese Ports'

(at maximum 65) 8 big Ports

Other Ports

Ishikariwan

Tomakomai

Hachinohe

Akita

Fushiki - Toyama

Kanazawa

Niigata

Sendai-Shiogama

Hiroshina

Tsuruga

Iwakuni

Maizuru

Hitachi

Tokuyama-Kudamatsu

Fukuyama

Hitachi-Naka

Mitajiri-Nakanoseki

Sakai

Tokyo

Chiba

Shimonoseki

Kawasaki

Yokohama

Kitakyusyu

Mikawa

Shimizu

Imari

Osaka

Nagoya

Hakata

Kobe

Yokkaichi

Matsuyama

Oita

Mizushima

Hososhima

Mishima-Kawanoe

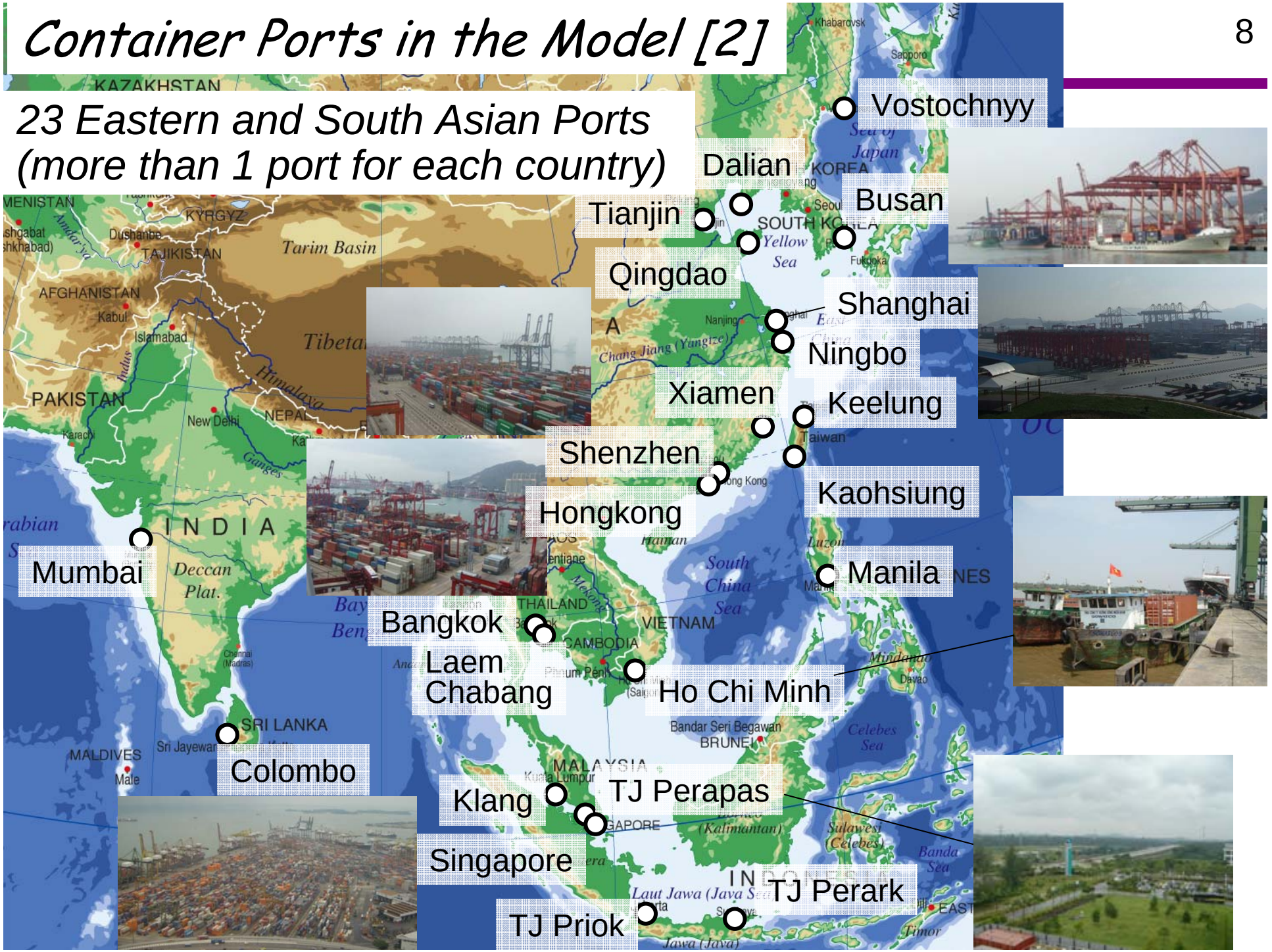
Shibushi

Imabari

Naha

Container Ports in the Model [2]

23 Eastern and South Asian Ports
(more than 1 port for each country)



Container Ports in the Model [3]

… 17 Other Region Ports (representative port for each region & 1 port for each APEC country)

EU (Rotterdam)

Mediterranean (Gioia Tauro)

Middle East (Dubai)

Black Africa (Durban)

Port Moresby

Melbourne

Oceania

Auckland

WCNA

Vancouver

Seattle

Los Angels

ECNA (New York)

Vera Cruz

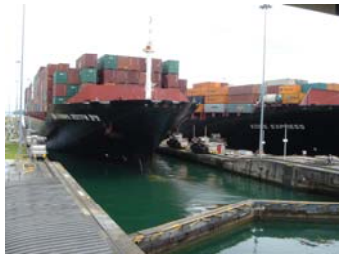
Guayaquil

Callao

WCSA

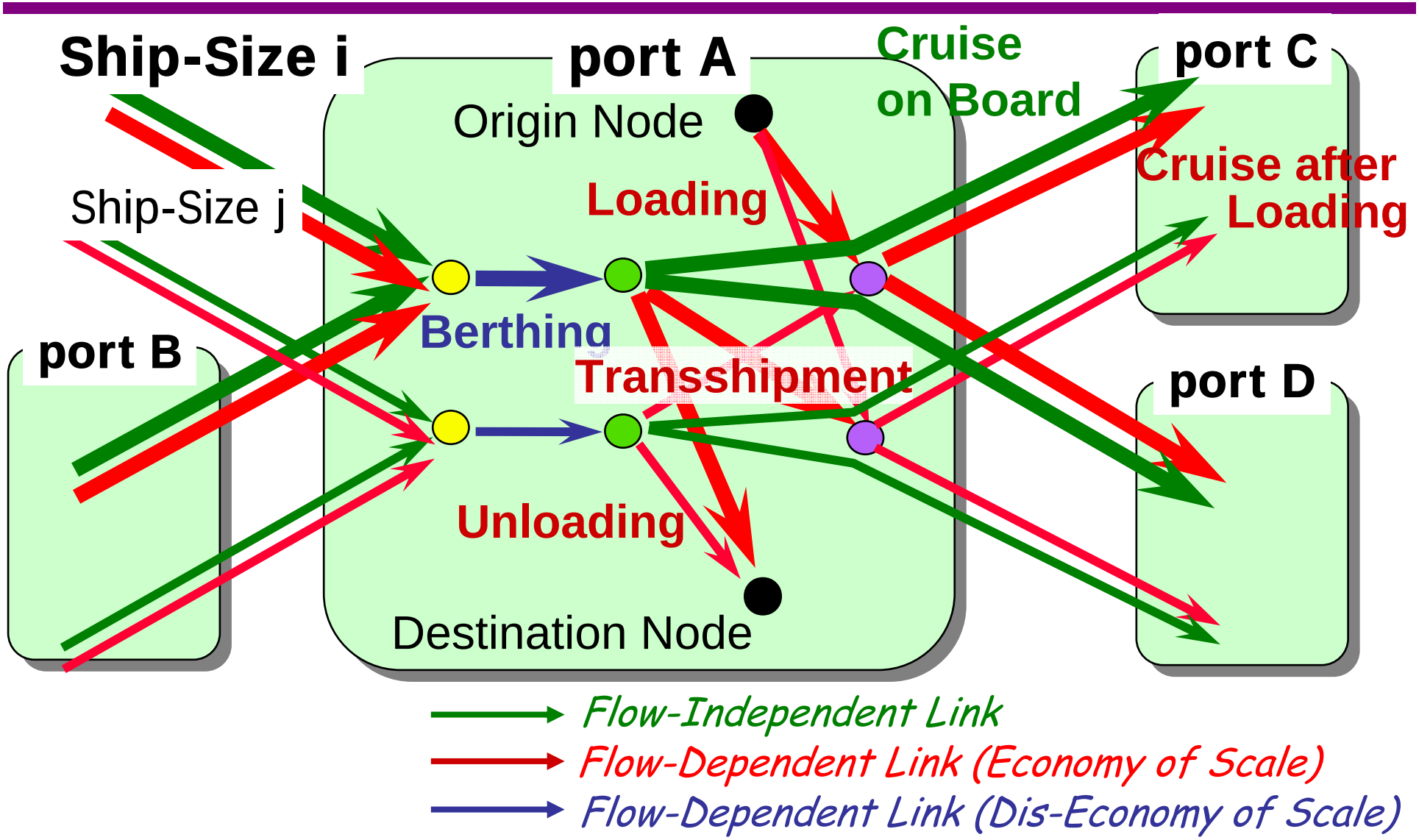
ECSA (Santos)

Central America (Colon)



San Antonio

Network Structure of Carrier Sub-Model



- Express as different links for different size of containership
- Consider transshipment etc. by detailed intra-port network

Link Cost Function for Carrier Model [1] Cruise Link

Cruise after Loading Link

(1,000 JPY/TEU)

$$CCL_{pqsk} = \frac{Cop_s + Cfix_s}{f_{pq} \cdot cap_s} \cdot l_{pq} + vt_{carr} \cdot \left\{ \frac{l_{pq}}{v_s} + \frac{T \cdot f_{pq} \cdot cap_s}{2(XCL_{pqsk} + XCB_{pqsk})} \right\}$$

Monetary Shipping Cost

Shipping Time

Expected Waiting Time on Service Frequency

Cruise on Board Link

$$CCB_{pqsk} = \frac{Cop_s + Cfix_s}{f_{pq} \cdot cap_s} \cdot l_{pq} + vt_{carr} \cdot \frac{l_{pq}}{v_s}$$

XCL_{psqk}: container flow of the link between ports p and q in ship-size s, carrier group k (TEU/year),
XCB_{pqsk}: container flow of the corresponding *Passing & Cruise link* (TEU/year),
l_{pq}: distance (NM), v_s: Speed of ship of size s (knot),
cap_s: capacity of ship (TEU/vessel), f_{pq}: load factor of the link,
T: time unit (in this case 1 year = 8,760 hours),
vt_{carr}: time value of the container transported for carriers (1,000 yen/hour/TEU),
Cop_s, *Cfixs* : operation cost and fixed cost of the ship of size s (1,000 yen/NM/ vessel)

Link Cost Function for Carrier Model [1] Cruise Link

Cruise after Loading Link

(1,000 JPY/TEU)

$$CCL_{pqsk} = \frac{Cop_s + Cfix_s}{f_{pq} \cdot cap_s} \cdot l_{pq} + vt_{carr} \cdot \left\{ \frac{l_{pq}}{v_s} + \frac{T \cdot f_{pq} \cdot cap_s}{2(XCL_{pqsk} + XCB_{pqsk})} \right\}$$

Decreasing Function against Container Volume

Cruise on Board Link

$$CCB_{pqsk} = \frac{Cop_s + Cfix_s}{f_{pq} \cdot cap_s} \cdot l_{pq} + vt_{carr} \cdot \frac{l_{pq}}{v}$$

Calculation results depend on initial link flow

XCL_{psqk}: container flow of the link between ports p and q in ship-size s, carrier group k (TEU/year),

XCB_{pqsk}: container flow of the corresponding *Passing & Cruise link* (TEU/year),

l_{pq}: distance (NM), v_s: Speed of ship of size s (knot),

cap_s: capacity of ship (TEU/vessel), f_{pq}: load factor of the link,

T: time unit (in this case 1 year = 8,760 hours),

vt_{carr}: time value of the container transported for carriers (1,000 yen/hour/TEU),

Cop_s, $Cfixs$: operation cost and fixed cost of the ship of size s (1,000 yen/NM/ vessel)

Link Cost Function of Carrier Model [2] Berthing Link

$$CSB_{psk} = \frac{Cent_{ps}}{\overline{f_{pk}} \cdot cap_s} + vt_{carr} \cdot TW(p,s) \cdot \frac{24}{h_p}$$

Monetary Cost for Entering Port

Waiting Time for Entering Port

Here,

$$TW(p,s) = \gamma_1 \cdot \left(\frac{Tanc_p \cdot \sum_{i=s}^{j} \sum_{k} \left(\frac{XSB_{psk}}{\overline{f_{pk}} \cdot cap_s \cdot T} \right)}{\sum_{i=s}^{j} NB(p,i)} \right)^{\gamma_2}$$

When $\frac{NSB(p,s)}{NB(p,s)} \geq \frac{NSB(p,s-1)}{NB(p,s-1)}$

$\underline{Cent}_{ps}$: port charge at port p for vessel category s (1,000 JPY/vessel),
$\overline{f_{pk}}$: average load factor entering port p,
$TW(p, s)$: expected waiting time for mooring at port p for vessel category s,
h_p: average operation time per day (hours/day),
$Tanc_p$: time required for loading, unloading, and transshipment at port p (hours/vessel),
$\gamma 1$, $\gamma 2$: unknown parameters relating to waiting time for mooring ($\gamma 1$, $\gamma 2 > 0$).,
XSB_{psk}: annual flow of the ship-berthing link defined by the carrier group k (TEU/year)

Link Cost Function of Carrier Model [3]
Loading, Unloading, and Transshipment Link

Loading Link, Unloading Link

$$CLD_p = CUL_p = \left(Chd_p + \frac{Ctm_p}{XHD_p} \right) + vt_{carr} \cdot Tanc_p$$

Transshipment Link

$$CTR_p = 2 \cdot \left(Chd_p + \frac{Ctm_p}{XHD_p} \right) + vt_{carr} \cdot Tanc_p$$

Handling Time

Variable Cost for Handling

Fixed Cost for Handling

Chd_p: handling charge when loading or unloading per TEU at port p (1,000 JPY/TEU),
Ctm_p: annual terminal charge for port handling at port p (1,000 JPY/year),
XHD_p: total handling amount of port p (TEU/year) are defined as follows:

$$XHD_p = XLD_p + XUL_p + 2 \cdot XTR_p$$

where, XL_p, XUL_p, XTR_p: annual flow of *Loading*, *UnLoading*, and *TRansshipment* at port p (TEU/year))

Feature of the Carrier Sub-Model

1) Behave by International Shipping Groups (Global Alliances) at Oligopolistic Container Transport Market

⟶ Cost Minimum Optimization by Shipping Group

2) Multiple Ship-Size Uses for Hub-Spoke Transport

3) Economy and Dis-Economy of Scale in Container Transport

economy of scale

Size of Containership, Service Frequency, Terminal Charge

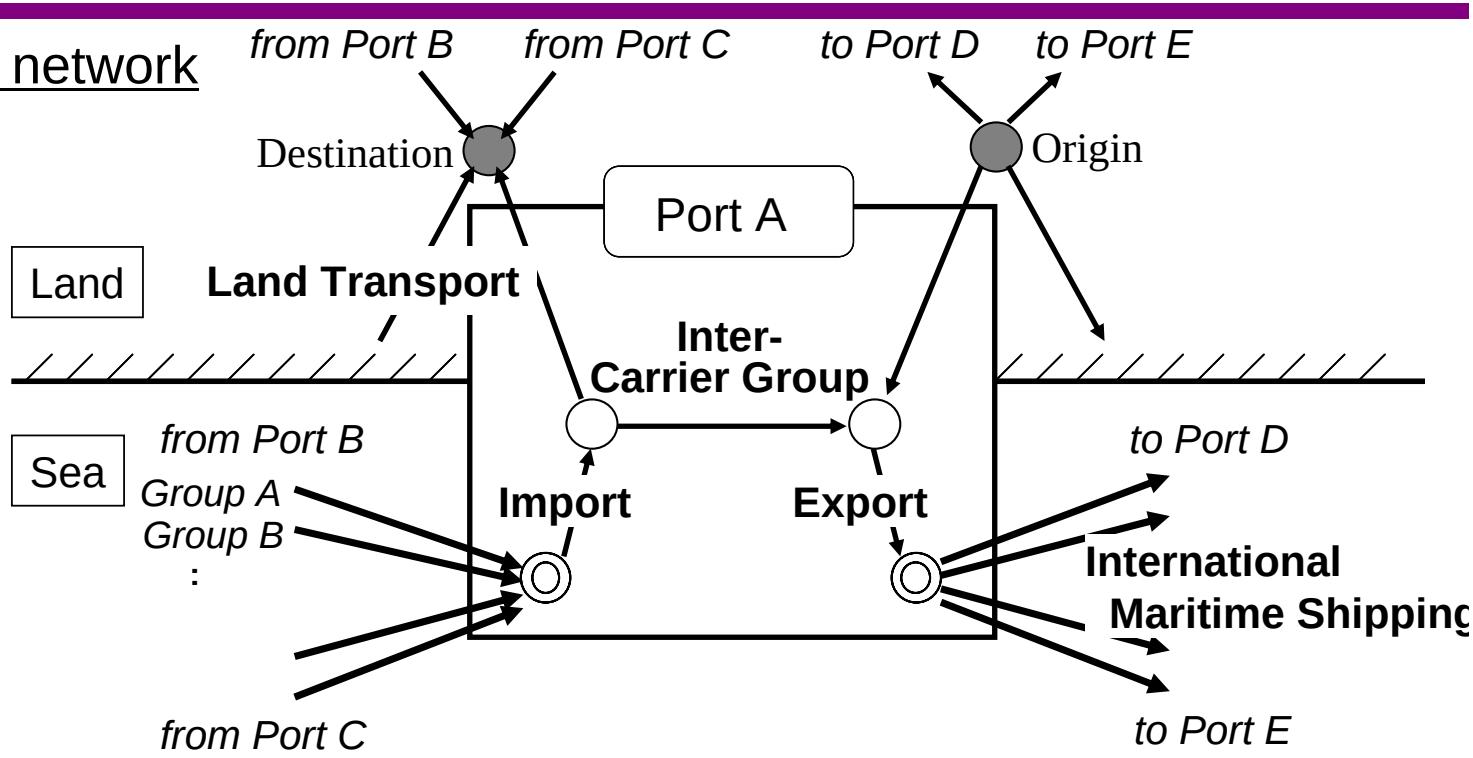
dis-economy of scale

Congestion in Berthing

4) Interference of Link Flow

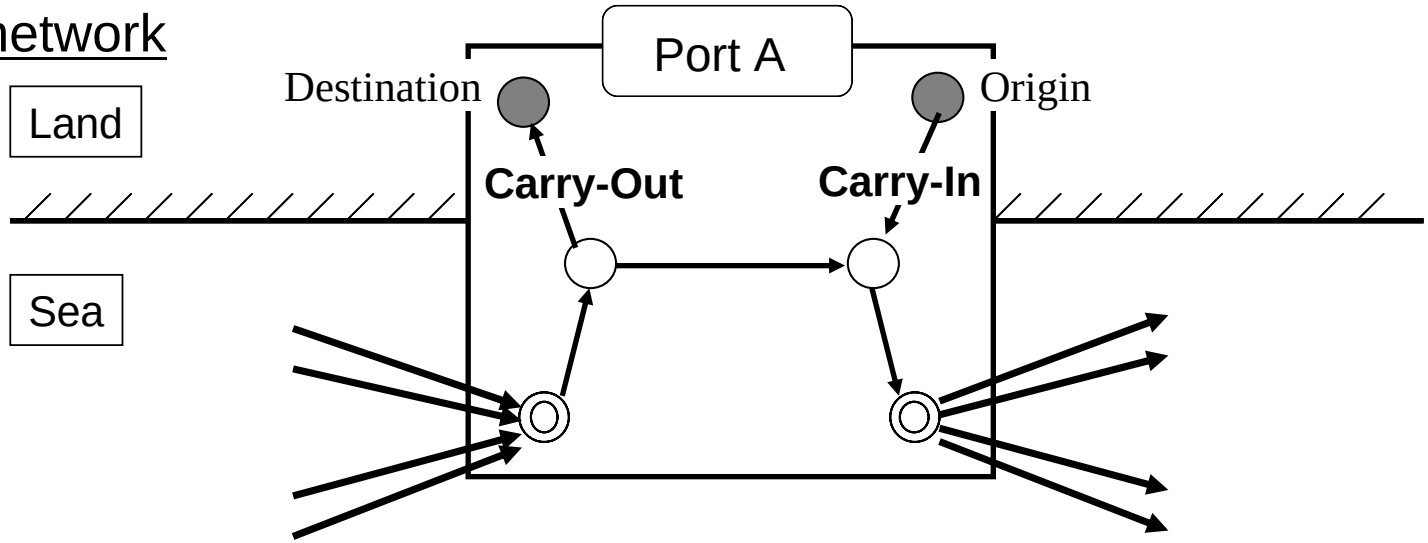
Network Structure of Shipper Sub-Model

Area where inland network are considered



All of links have flow-independent cost function

Area where inland network are not considered



Link Cost Function of Shipper Model [1]

(1,000 JPY/TEU)

International Cruise Link

General cost on the cheapest route among ports by shipping group

$$CIM_{pqk} = C_{pqk}(carr)$$

$C_{pqk}(carr)$: minimum transport cost between ports *p* and *q* of carrier group *k*, acquired from the results of the carrier sub-model

Export Link, Import Link

$$CEX_{pk} = vt_{shpr} \cdot Tle_p \qquad CIM_{pk} = vt_{shpr} \cdot Tli_p$$

vt_{shpr}: time value of the container transported for shippers (1,000 yen/hour/TEU),
Tle_p, Tli_p: time for export (i.e. lead-time) and import at port *p* (hours)

Link Cost Function of Shipper Model [2]

Inter-Carrier Group Link

$$CICG_p = Cicg_p + vt_{shpr} \cdot Ticg_p$$

$Cicy_p$: transfer charge between these container yards (1,000 JPY/TEU),
$Ticy_p$: transfer time between these container yards (hours)

Land Transport Link (Only countries with hinterland network)

$$CLT_{ip} = Copl \cdot \left(2 \cdot lt_{ip}\right) + vt_{shpr} \cdot \frac{lt_{ip}}{vl}$$

Carry-in Link, Carry-out Link (for other countries)

$$CCI_p = CCO_p = Cfixl$$

Copl: unit flow cost of container trailers (1,000 JPY/km/TEU),
Cfixl: fixed cost of container trailers (1,000 JPY/TEU),
lt_{ip}: distance for land transport between origin or destination *i* and port *p* (km),
vl: velocity of container trailers (km/hour)

Feature of the Shipper Sub-Model

1) Shippers choose only Loading/Unloading Port,
Hinterland Transport, and Shipping Group,
not consider Transportation Route on the sea

2) Behavior of Shippers is partly depend on
unexpressed elements

⟶ Stochastic Assignment is applied

Probability of Route Choice (Logit-Type)

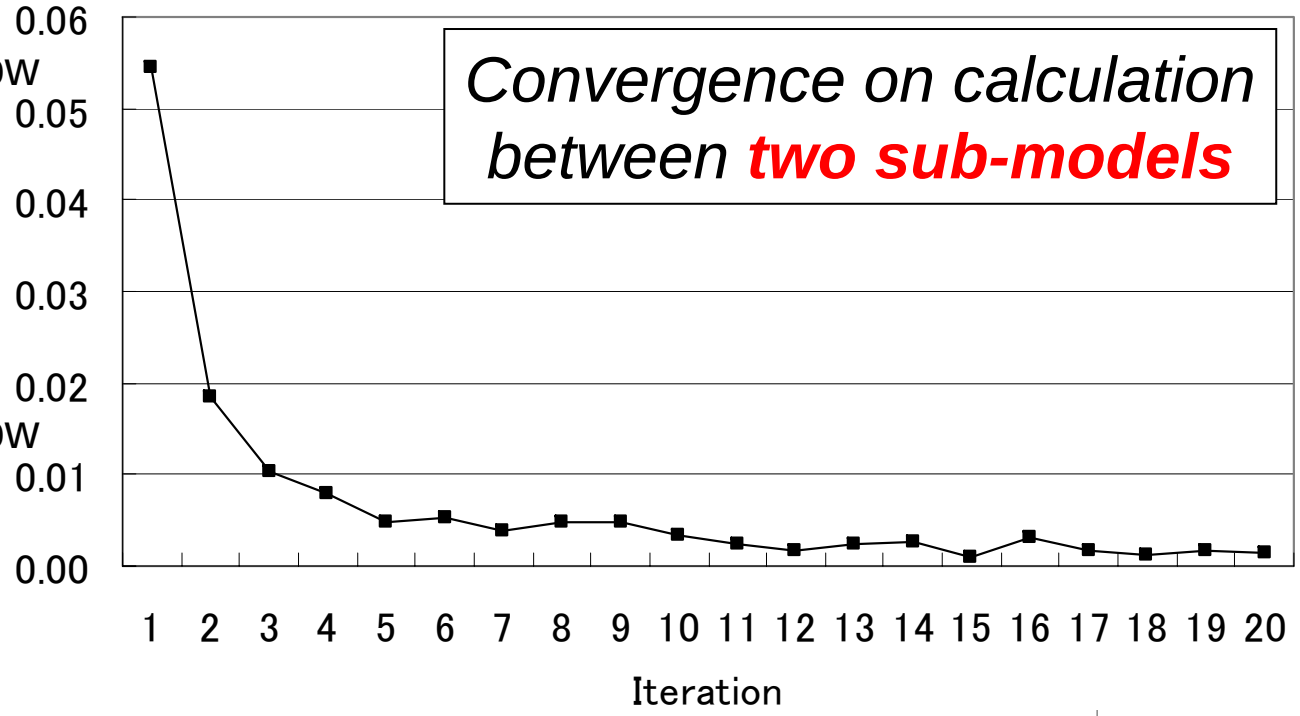
$$P_h = \frac{\exp[-\theta \cdot C_h]}{\sum_h \exp[-\theta \cdot C_h]}$$

P_h : Probability chosen of path *h*
C_h : Total Cost of path *h*
θ : Unknown Parameter on Shape of Probabilistic Distribution on Error Term

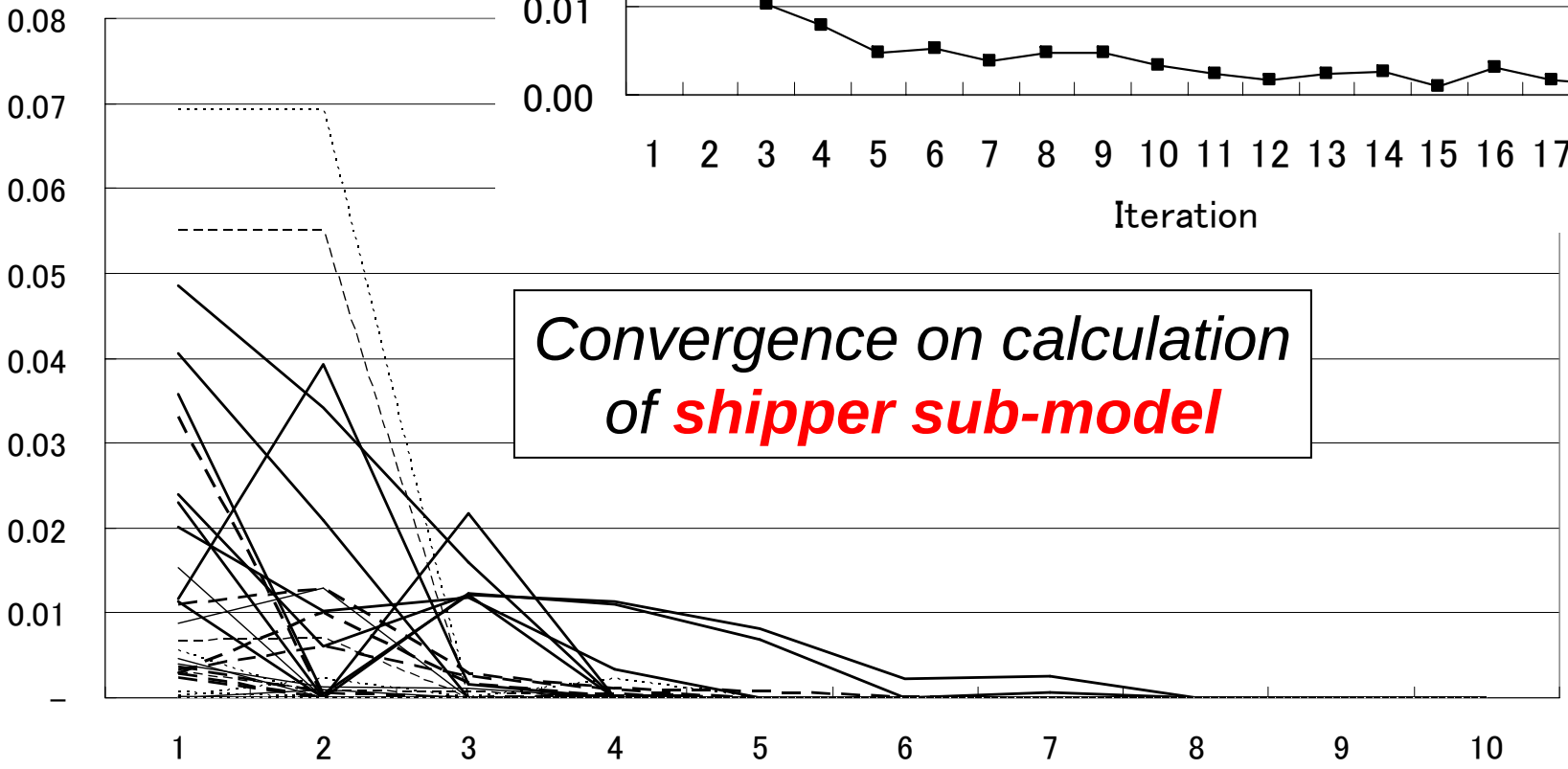
Solved by *Dial's Algorithm* (1971)

Convergence on iterative calculation

Convergence Rate on Flow
(Difference between
The previous iteration)



Convergence Rate on Flow



Estimation Methods and Results of Unknown Parameters

Estimation methodology ("approximative" steepest descent directions search)

1) Calculate approximative partial differential coefficient of the objective function with initial value by parameters

2) Based on the results of 1), acquire steepest descent directions

3) By linear search along the direction of 2), acquire a point that minimize the objective function

4) Return to 1) if it doesn't reach the minimum point

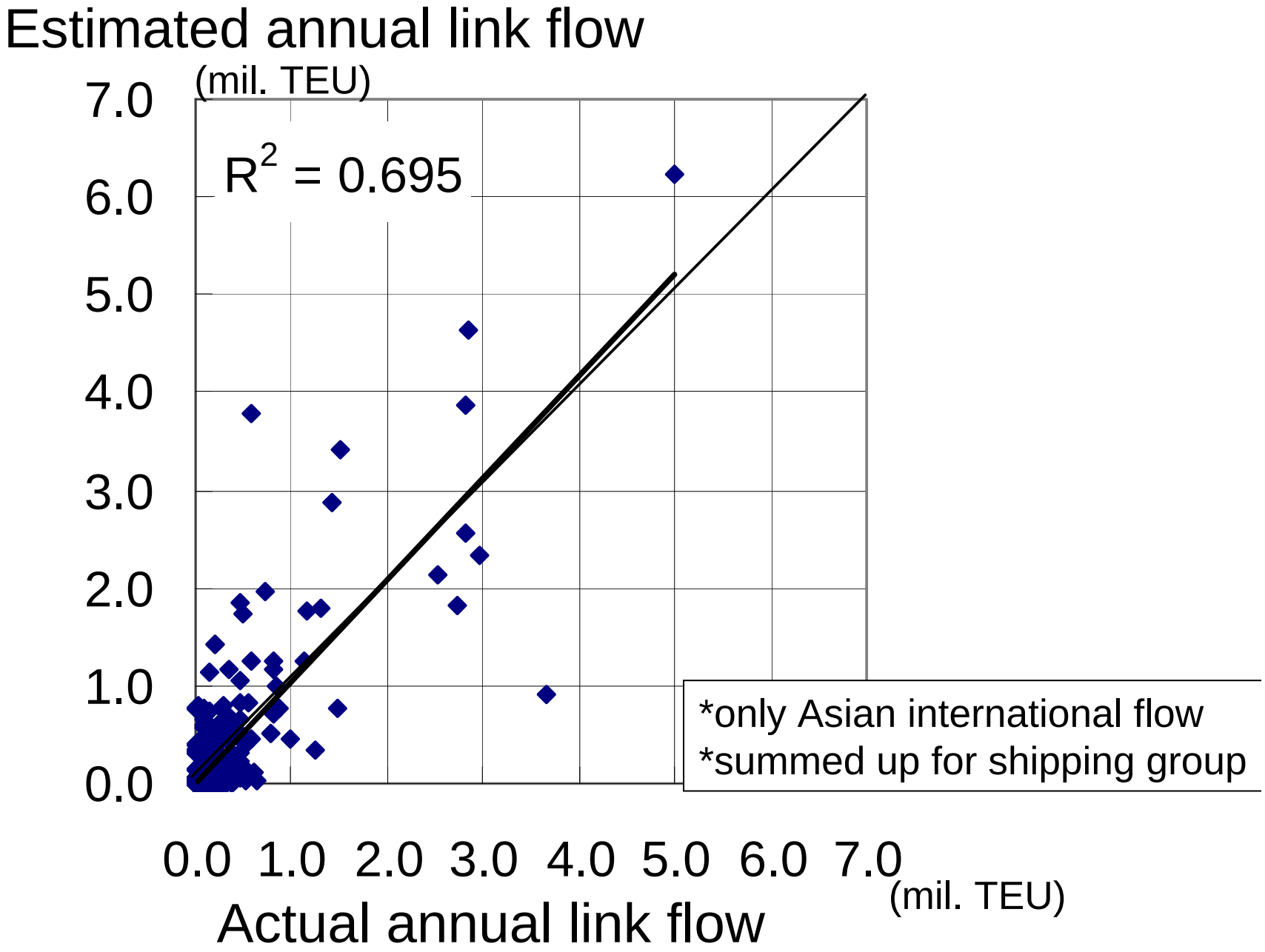
Estimation results

parameter	θ	vt shpr	vt carr	$\gamma 1$	$\gamma 2$	error rate
unit	–	(1,000 JPY/h)		–	–	
initial value	0.01*1	1.348*2	1.348*2	120*1	5*1	0.0792
lower limit	0.001	0.01	0.01	10	1	0.1018
upper limit	0.1	10.0	10.0	1000	10	0.0858
estimated	0.0131	1.350	1.346	119.9	5.03	0.0789

source: *1 empirically set based on past results etc.

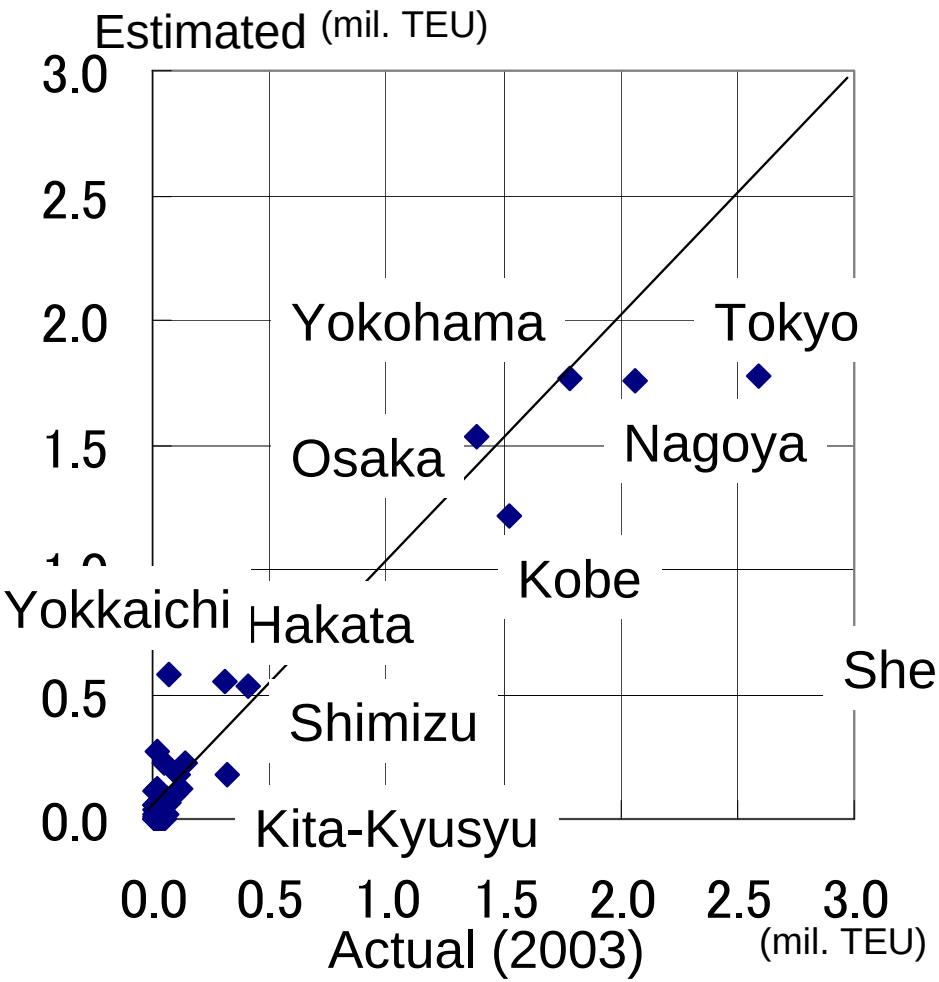
*2 the Guideline of Port Investment Evaluation

Model Accuracy [1]: Link Flow between Ports

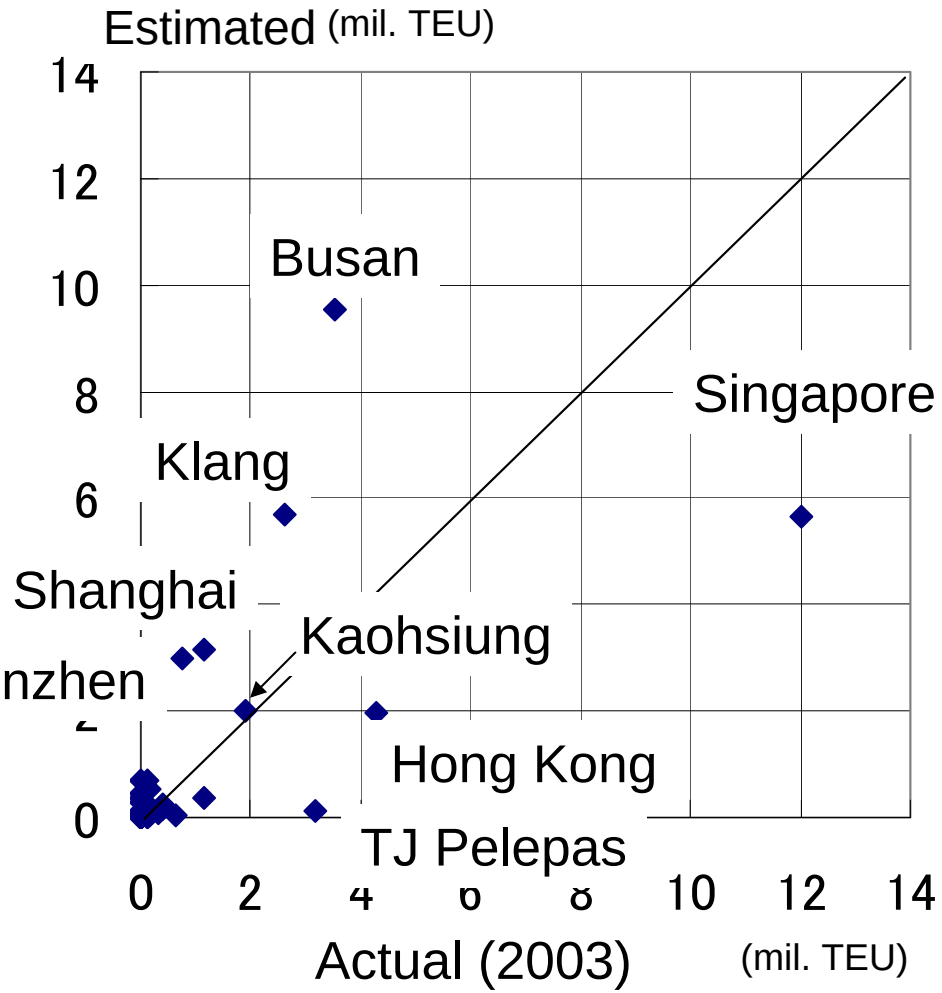


Model Accuracy [2]: Volume by Ports

Total Volume Handled
for Each Japanese Port



Transshipped Volume Handled
for Each Asian Port

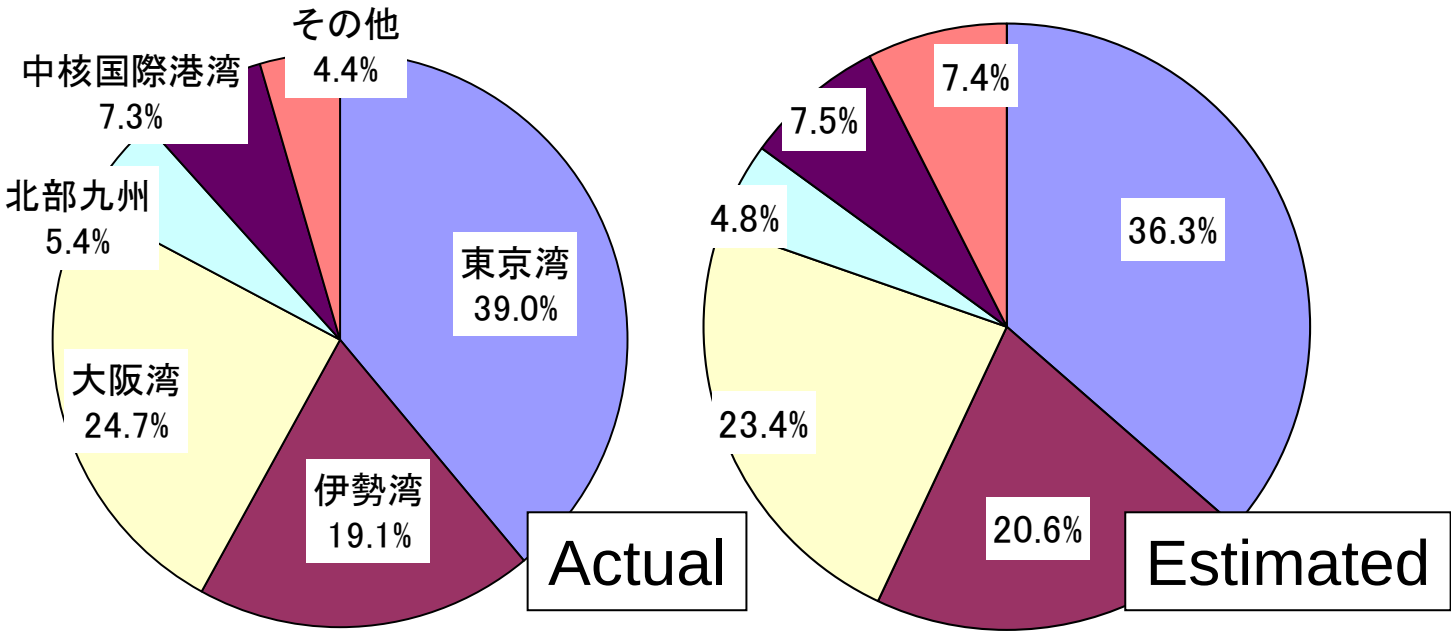


Model Accuracy [3]: Volume by Japanese Region

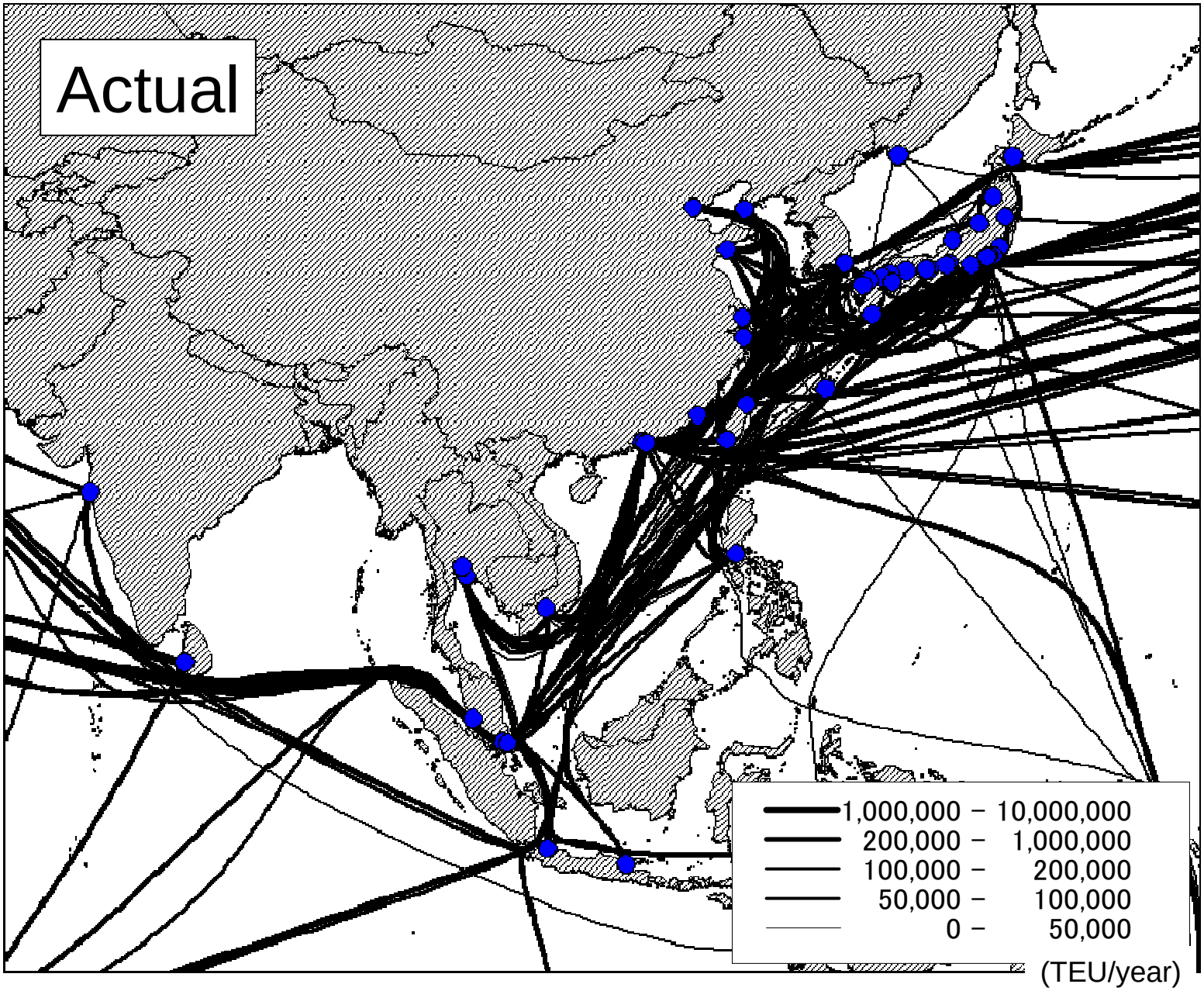
(TEU)

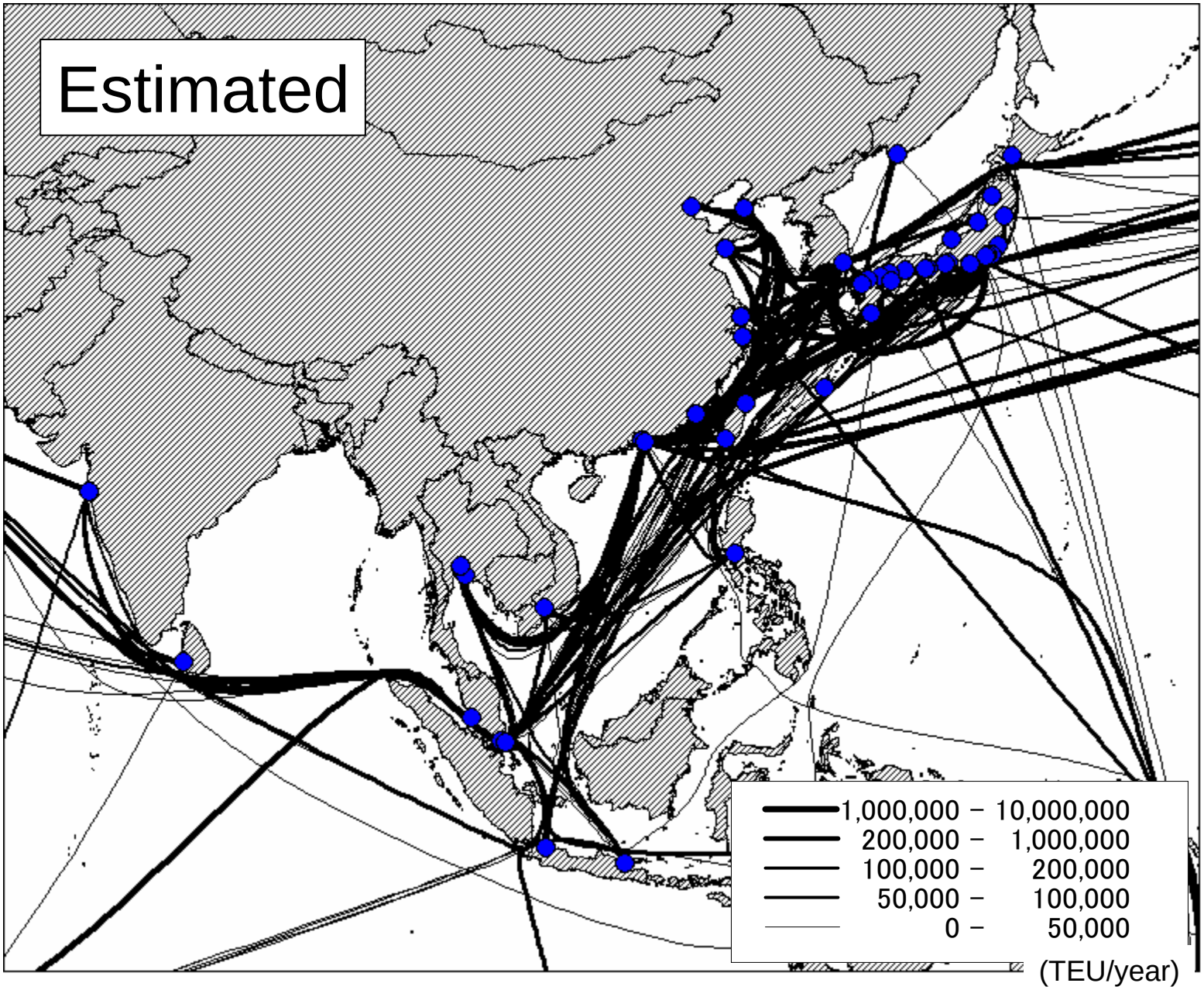
	Total Volume		Transshipped Volume	
	real	estimated	real	estimated
Tokyo Bay*1	4,233,000	3,902,000	526,000	250,000
Ise Bay*2	2,075,000	2,212,000	0	151,000
Osaka Bay*3	2,684,000	2,514,000	83,000	198,000
Nrthern Kyusyu*4	588,000	518,000	0	11,000
Core International Ports*5	792,000	806,000	0	4,000
Others	481,000	794,000	0	34,000
Total	10,855,000	10,749,000	610,000	651,000

*1 Tokyo, Yokohama, Kawasaki, Chiba
*2 Nagoya, Yokkaichi
*3 Kobe, Osaka
*4 Hakata, Kitakyusyu
*5 Tomakomai, Sendai, Hitachi-Na



Model Accuracy [4]: Container Flow bet. Ports




Estimated
1,000,000 – 10,000,000
200,000 – 1,000,000
100,000 – 200,000
50,000 – 100,000
0 – 50,000
(TEU/year)

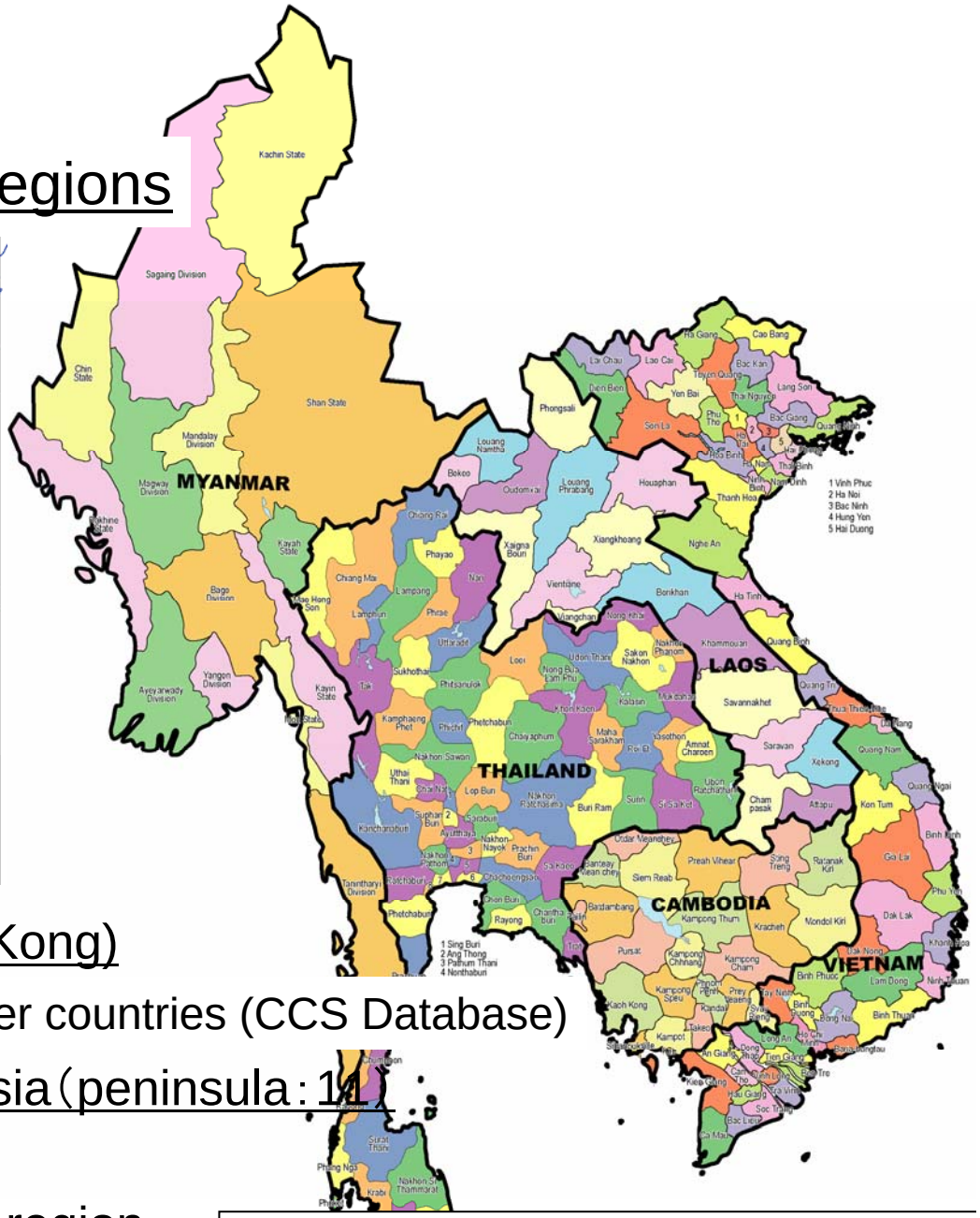
II. MODEL EXTENTION FOR CONSIDERATION OF NATIONAL BORDER

- Including Hinterland Transport in Southeast Asia
- Setting Border Levels by Experimental Calculation

bet. China and Vietnam (Kunming-Hanoi)

Model Extension [1]

Division Asian countries into regions



China: 31 Provinces (except Hong Kong)

Trade amount by provinces by partner countries (CCS Database)

Vietnam（64）・Thailand（76）・Malaysia（peninsula：11）・Cambodia（5）

Gross Regional Product for each region

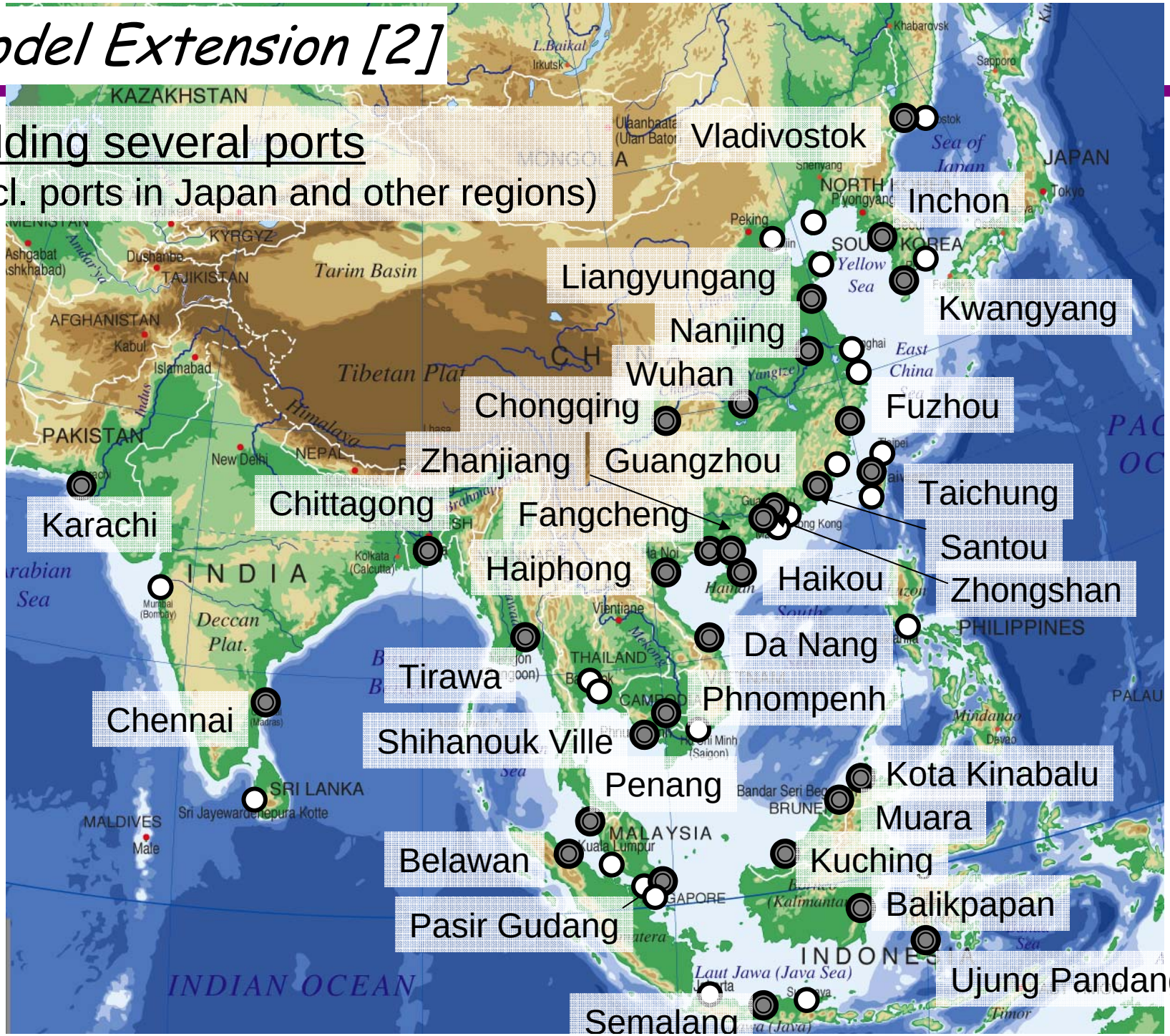
Laos（1）・Singapore（1）・Myanmar（1）

dividing OD matrix bet. countries into regional basis

Model Extension [2]

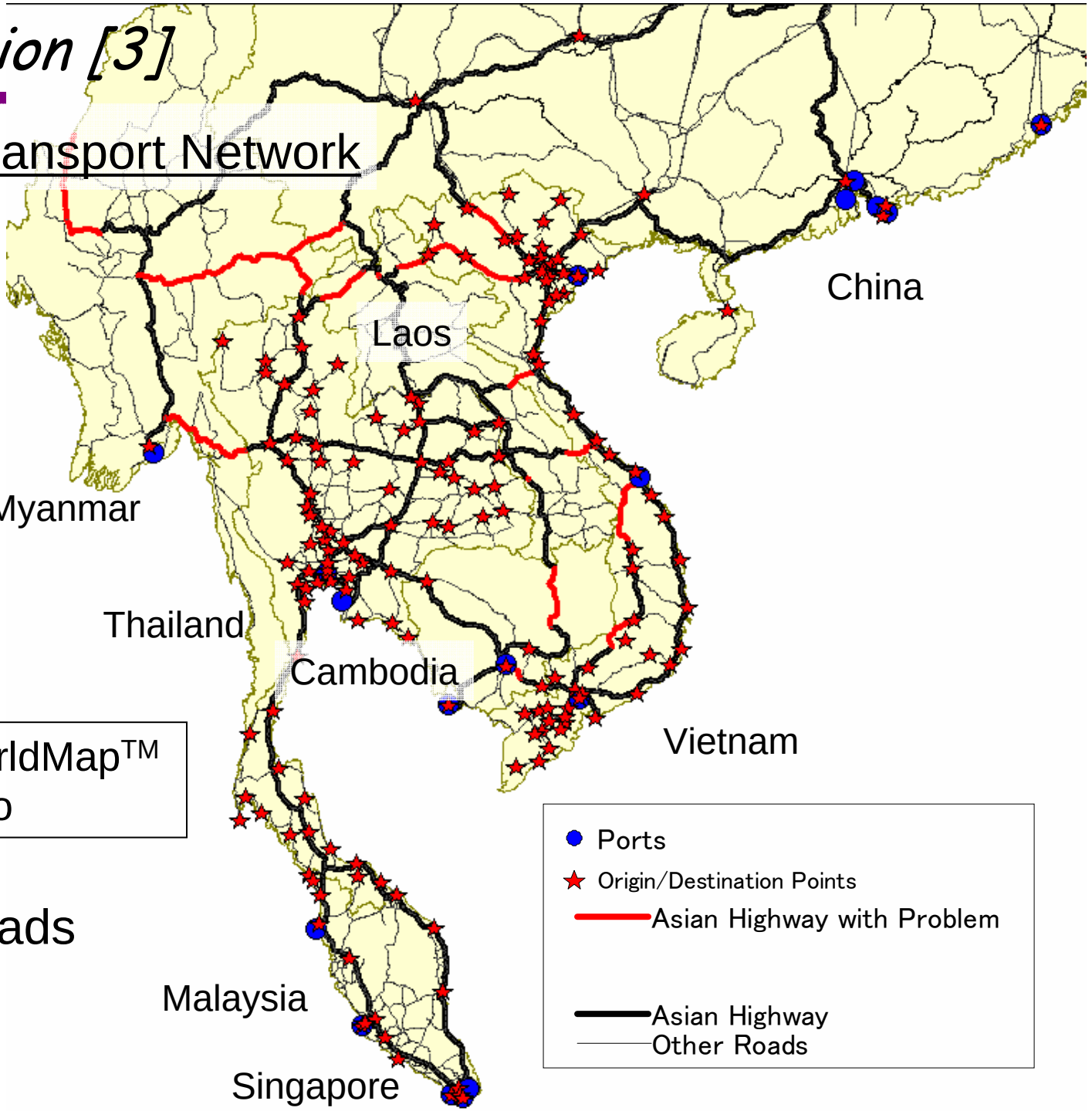
Adding several ports

(incl. ports in Japan and other regions)



Model Extension [3]

Including Land Transport Network



Processing ADC WorldMap™
Database on MapInfo

Only consider roads tentatively

Model Extension [4]

Setting National Border (30 points)

Based on several reports e.g. ADB

No	国	都市	国	都市	国境通過時間(hour)	国境通過費用(千円)	ゲートオープン時間(hour)	Asian Highway No.
1	China	Shenzhen	China	Hong Kong	0.0	0	18.0	
2	China	Ping Xiang	Vietnam	Dong Dang	3.0	15	11.8	1
3	China	Hekou	Vietnam	Lao Kai	3.0	15	11.8	14
4	China	Mohan	Laos	Bung Nua	3.0	15	15.5	
5	China	Mohan	Laos	Boten	3.0	15	15.5	3
6	China	Daluo	Myanmar	Keng Tung	3.0	15	15.5	3
7	China	Ruili	Myanmar	Muse	3.0	15	15.5	
8	Laos	Vantao	Thailand	Chong Mek	7.8	16	15.5	
9	Laos	Savannakhet	Thailand	Mukdahan	7.8	16	15.5	16
10	Laos	Thakhek	Thailand	Nakhon Phanom	7.8	16	15.5	15
11	Laos	Tanaleng	Thailand	Nong Khai	7.8	16	15.5	12
12	Laos	Houay Xay	Thailand	Cheng Khong	7.8	16	15.5	3
13	Vietnam	Dien Bien Phu	Laos	Muang Khoua	2.0	16	11.8	
14	Vietnam	Tin Tio	Laos	Nam Kahn	2.0	16	11.8	
15	Vietnam	Keo Neua	Laos	Nam Phao	2.0	16	11.8	15
16	Vietnam	Lao Bao	Laos	Deng Savan	2.0	16	11.8	16
17	Laos	Veun Kam	Cambodia	Stoeng Treng	2.0	10	11.8	11
18	Vietnam	Ban quan su mien	Cambodia	Snuol	2.0	10	11.8	
19	Vietnam	Tay Ninh	Cambodia	Suong	2.0	10	11.8	
20	Vietnam	Moc Bai	Cambodia	Bavet	2.0	10	11.8	
21	Vietnam	Chau Doc	Cambodia	Kompong Chery	2.0	10	11.8	
22	Thailand	Hat Lek	Cambodia	Koh Kong	4.0	10	15.5	
23	Thailand	Aranyaprathet	Cambodia	Poipet	4.0	10	15.5	
24	Thailand	Mae Sai	Myanmar	Tachilek	15.0	7	15.5	
25	Thailand	Mae Sot	Myanmar	Myawadi	15.0	7	15.5	1
26	Thailand	Phra Chedi Sam Ong	Myanmar	Maulamyaing	15.0	7	15.5	
27	Thailand	Sungai Kolok	Malaysia	Rantau Panjang	5.0	8	15.5	18
28	Thailand	Betong	Malaysia	Pengklan Hulu	5.0	8	15.5	
29	Thailand	Sa Dao	Malaysia	Bukit Kayu Hitam	5.0	8	15.5	2
30	Malaysia	Johor Bahru	Singapore	Singapore	2.0	17	15.5	

Bet. Mainland China and Hong Kong


Bet. Singapore and Malaysia

bet. China and Vietnam (Nanning-Hanoi)

bet. China and Laos


ด่านพาสิ
CUSTOM HOUSE
PARKING CHECK

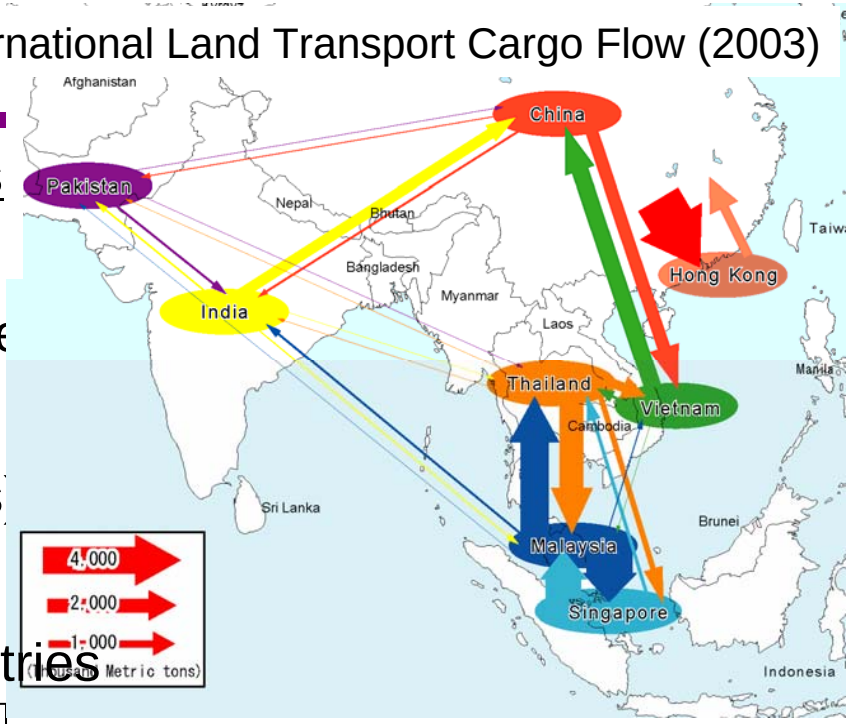

bet. Thailand and Myanmar

bet. Thailand and Laos (Nong Khai – Vientiane)


UNION OF MYANMAR

Model Extension [5]

International Land Transport Cargo Flow (2003)



OD Cargo Flow Estimation in Regional Basis including International Land Transport Cargo

Trade Amount bet. Countries (GTA Database)

⟵ Global Insight Database

Cargo Volume bet. Countries (tonnage basis)

⟵ Global Insight

Cargo Volume by Transport Mode bet. Countries

Air (excluded)

Land

Volume of international land transport per unit is assumingly equal to the volume of maritime container per TEU

Maritime

⟵ Global Insight

Maritime Container Cargo Volume bet. Countries (non-containerized cargo are excluded)

⟵ Global Insight

Maritime Container Cargo Volume bet. Countries (in TEU basis)

⟵ CCS Database (China)
Socio-Economic Data of each country
Handled volume by ports (in TEU basis)

OD Flow of International Cargo bet. Region

Consideration of Resistance across National Border [1]

"Narrow" resistance

- Time Required in Crossing (2 hours – half a day)
- Cost Required in Crossing (at maximum around 100 US$)
- Gate Open Hours of Border per day (normally only daytime)

→ To acquire is very difficult, but not impossible

"General" resistance

- Monetary and time cost when transshipped of truck near the border
- Protocol cost and time due to difficulty of communication, difference of commercial practice, and lack of harmonization of documents and formats
- Inconsistent technical standards, specifications, traffic rules
- Additional cost based on special regimes such as negotiation with custom and government

→ Difficult to numerically convert all of these resistances into monetary and time cost

Consideration of Resistance across National Border [2]

Hypothetical general resistance cost at national border

Border Level	1	2	3	4	5
Monetary Cost (1,000 yen/unit)	0.0	10.0	20.0	40.0	∞
Time (day)	0.0	1.0	2.0	4.0	∞

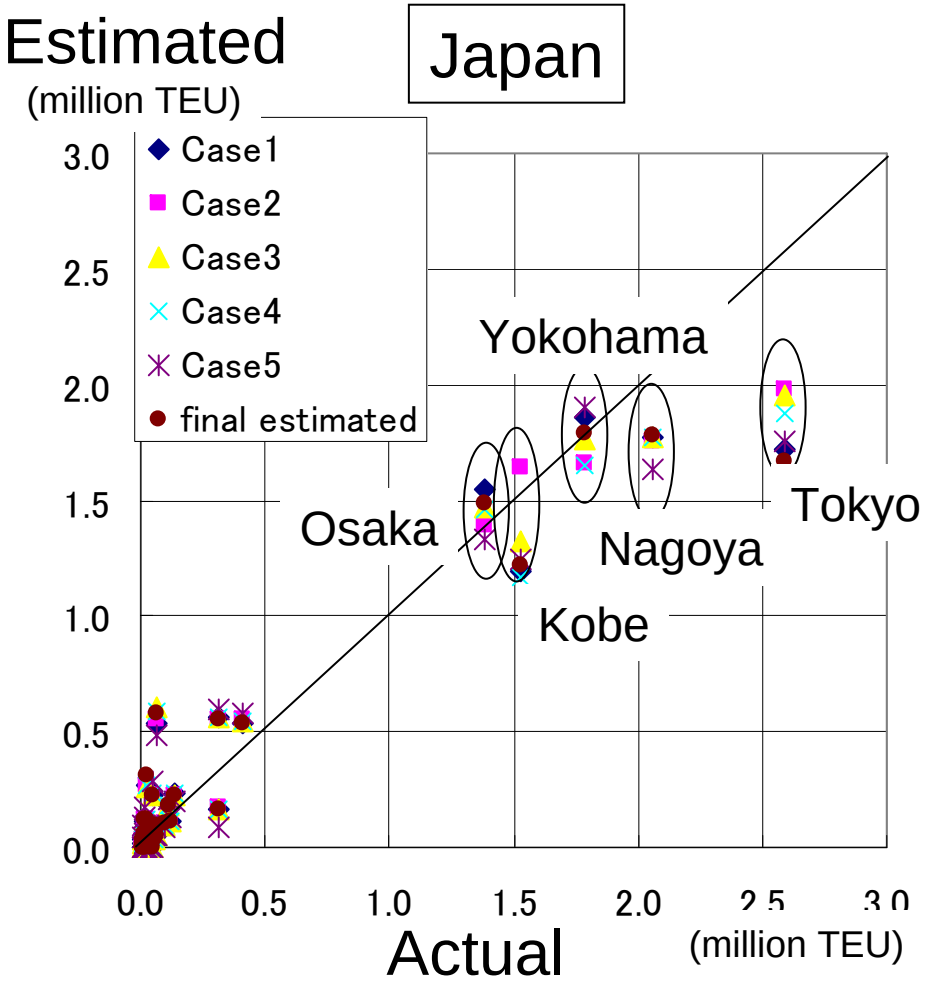
→ Set the border level for each border point considering model reproducibility and political situation etc.

Calculation case of the model for setting border level

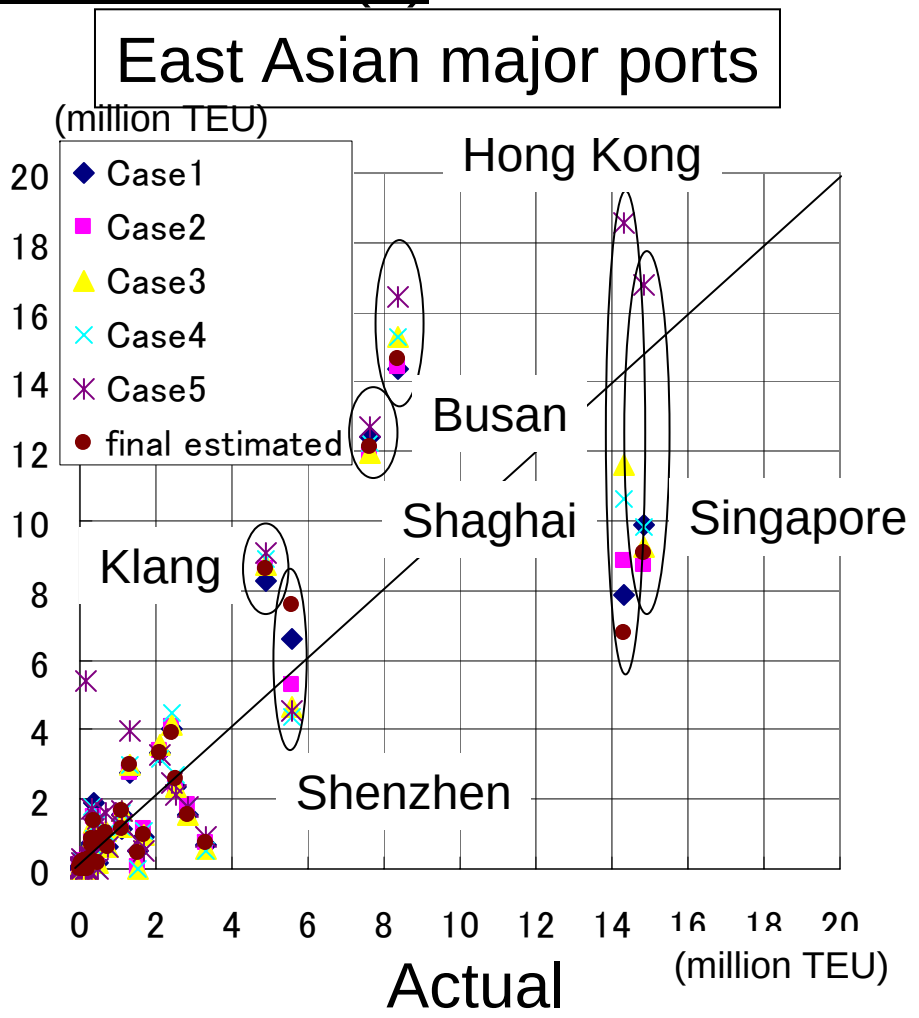
Calculation Case	Description
Case 1	General resistance cost at all border in SE Asia is at Level 1
Case 2	General resistance cost at all border in SE Asia is at Level 2
Case 3	General resistance cost at all border in SE Asia is at Level 3
Case 4	General resistance cost at all border in SE Asia is at Level 4
Case 5 (reference)	General resistance cost at all border in SE Asia is at Level 5 (except point No. 10)

Consideration of Resistance across National Border [3]

Model reproducibility in each calculation case (1)



No significant differences bet. calculation case



Big differences are only observed in Case 5 (no allowed crossing border) at Honkong and Singapore

Model reproducibility in each calculation case (2)

Calculation results by case of the total volume handled in Southeast Asian ports

		actual*	Case Calculation					Ratio of Case 4/Case 1	Final Estimation
			Case 1	Case 2	Case 3	Case 4	Case 5		
CN	Hong Kong	14,296	7,846	8,838	11,626	10,625	18,582	135%	6,772
VN	Haiphong	274	296	299	313	291	322	98%	308
	Da Nang	24	54	48	60	63	73	–	60
	Ho Chi Minh	1,085	1,562	1,529	1,682	1,617	1,677	104%	1,683
CB	**Shihanouk Ville**	**117**	**0**	**0**	**24**	**108**	**135**	–	**97**
	Phnompenh	6	0	0	0	0	0	–	0
MM	**Tirawa**	**67**	**41**	**41**	**42**	**42**	**82**	**102%**	**53**
TH	Laem Chabang	2,546	2,346	2,301	2,349	2,707	2,125	115%	2,577
	Bangkok	1,292	2,777	2,771	3,009	2,988	3,947	108%	3,001
ML	Pasir Gudang	353	1,886	1,520	1,294	889	1,151	47%	1,377
	TJ Perapas	3,333	672	740	551	535	891	80%	731
	Klang	4,873	8,275	8,616	8,752	8,886	9,056	107%	8,603
	Penang	**323**	**749**	**816**	**871**	**1,810**	**1,728**	**242%**	**860**
SP	Singapore	14,835	9,871	8,745	9,266	9,824	16,774	100%	9,061

for most of ports in this region, difference of the total volume handled in between Case 1 and Case 4 is small, excluding in port of Sihanoukville and Penang

Consideration of Resistance across National Border [5]

Model reproducibility in each calculation case (3)

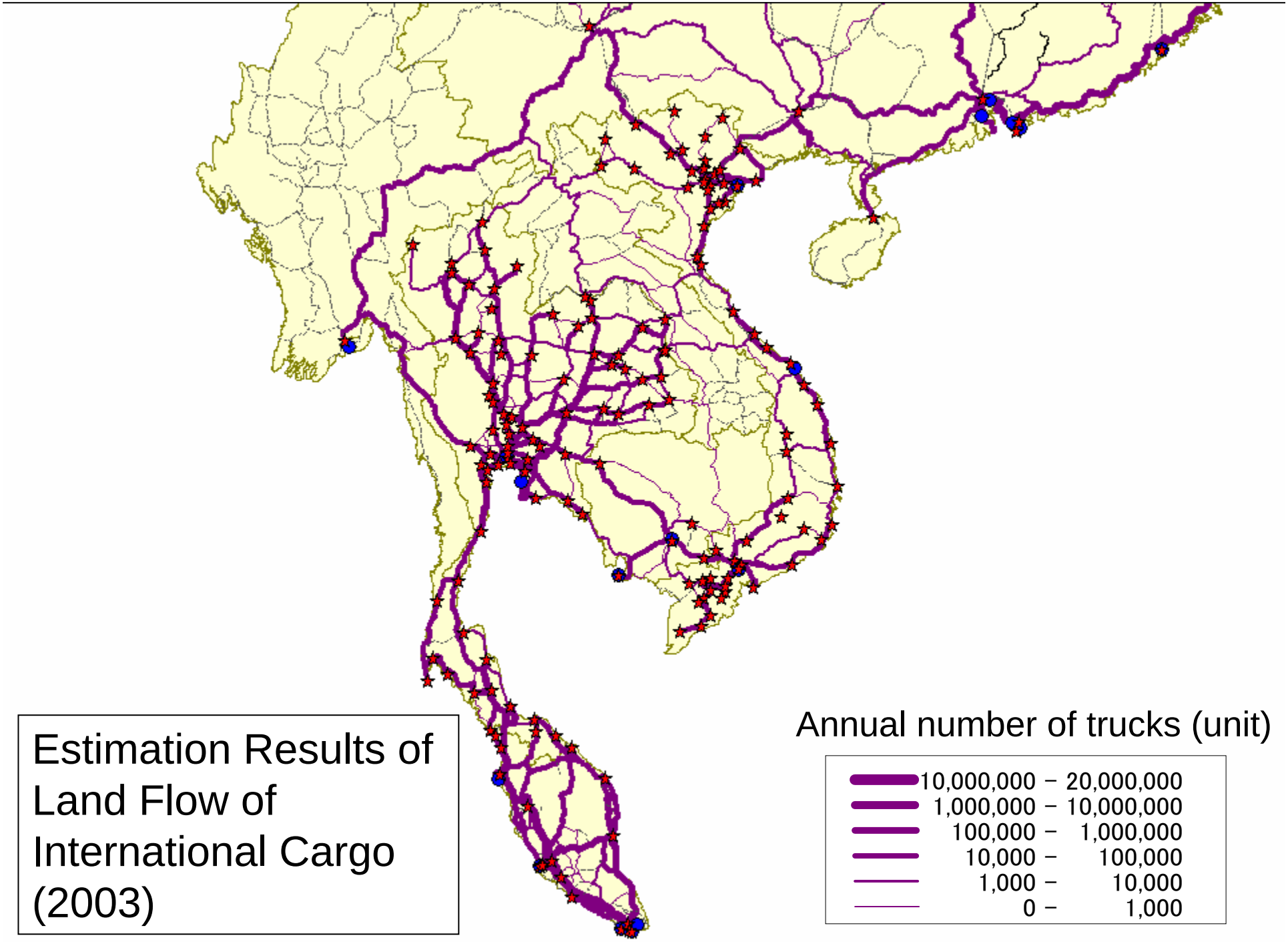
Border Level Finally Set

No.	border point 1		border point 2		Actual	source	c					border level	Estimated
							Case 1	Case 2	Case 3	Case 4	Case 5		
1	CN	Shenzhen	CN	Hong Kong	10,950,000	a	**8,548,788**	7,287,982	6,470,453	5,701,576	0	1	9,035,211
2	CN	Ping Xiang	VN	Dong Dang			97,953	63,670	**61,869**	32,282	0	3	44,342
3	CN	Hekou	VN	Lao Kai	41,382	b	42,850	39,481	**37,019**	14,142	0	3	36,082
4	CN	Mohan	LA	Bung Nua	3,585	b	2	2	1	**0**	0	4	0
5	CN	Mohan	LA	Boten			7,503	7,392	7,272	**6,496**	0	4	6,618
6	CN	Daluo	MM	Keng Tung	133,418	b	15,326	15,326	15,326	**15,326**	0	4	15,326
7	CN	Ruili	MM	Muse			0	0	0	**0**	0	4	0
8	LA	Vantao	TH	Chong Mek			12,400	8,079	**2,962**	0	0	3	4
9	LA	Savannakhet	TH	Mukdahan			17,569	11,599	**6,005**	2,287	0	3	3,477
10	LA	Thakhek	TH	Nakhon Phanom			64,609	17,797	**12,652**	5,645	0	3	7,967
11	LA	Tanaleng	TH	Nong Khai			29,325	29,883	**29,908**	29,685	38,60	3	31,854
12	LA	Houay Xay	TH	Cheng Khong			4,539	4,329	**4,086**	3,032	0	3	3,349
13	VN	Dien Bien Phu	LA	Muang Khoua			3,320	3,191	3,065	**2,790**	0	4	2,969
14	VN	Tin Tio	LA	Nam Kahn			54	54	54	**54**	0	4	54
15	VN	Keo Neua	LA	Nam Phao			64,581	17,680	12,591	**6,532**	0	4	8,530
16	VN	Lao Bao	LA	Deng Savan			17,651	11,100	5,153	**4,661**	0	4	4,091
17	LA	Veun Kam	CB	Stoeng Treng			16,600	12,197	7,083	**80**	0	4	27
18	VN	Ban quan su m	CB	Snuol	10,906	b	18,472	12,788	7,102	**16**	0	4	40
19	VN	Tay Ninh	CB	Suong			3,833	4,071	2,123	**440**	0	4	753
20	VN	Moc Bai	CB	Bavet			332,079	148,411	102,615	**10,214**	0	4	16,902
21	VN	CNau Doc	CB	Kompong Chery	1,612	b	11,876	9,723	2,991	**742**	0	4	1,316
22	TH	Hat Lek	CB	Koh Kong	0	b	38,543	13,134	**5,462**	2,276	0	3	3,344
23	TH	Aranyaprathet	CB	Poipet	84,442	b	212,984	50,906	**25,118**	13,421	0	3	15,234
24	TH	MLe Sai	MM	Tachilek			0	0	0	**0**	0	4	0
25	TH	MLe Sot	MM	Myawadi			1,426	1,423	1,422	**1,419**	0	4	1,421
													(2,374,659)

As a matter of course, the number of trucks crossing each border largely depends on the border level

*from Malaysia to Singapore

source: a; interview by authors, b; ADB (2005a), c; JICA (2006)


Estimation Results of Land Flow of International Cargo (2003)
Annual number of trucks (unit)
10,000,000 – 20,000,000
1,000,000 – 10,000,000
100,000 – 1,000,000
10,000 – 100,000
1,000 – 10,000
0 – 1,000

III. SIMULATION USING MODEL

- *Improvement for Entire Land Transport Network*
- *Infrastructure Improvement in Lower Mekong Area*

bet. Thailand and Laos (Cheng Khong - Houey Xay)

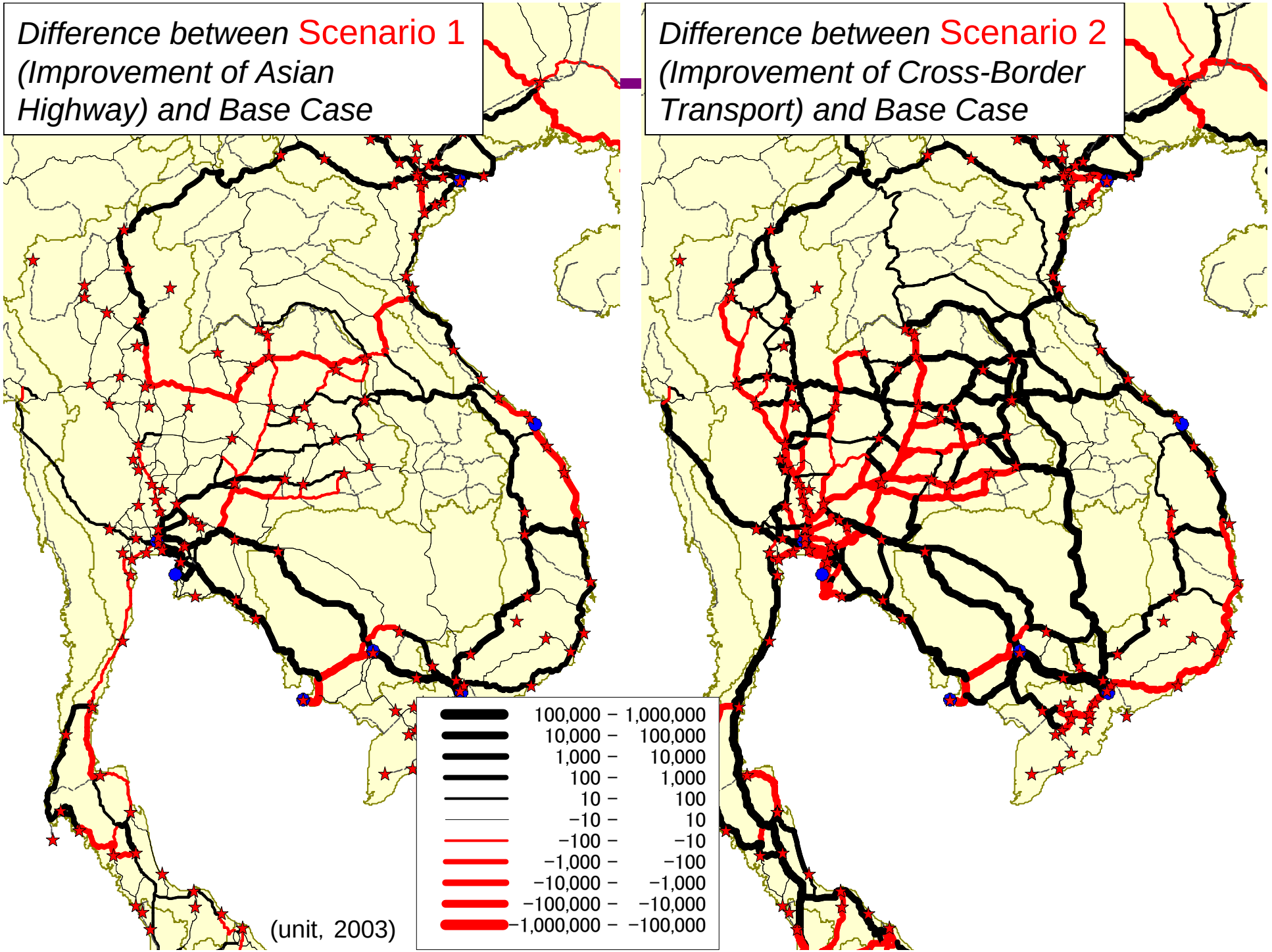
Simulation on the improvement for entire land transport network in Southeast Asia

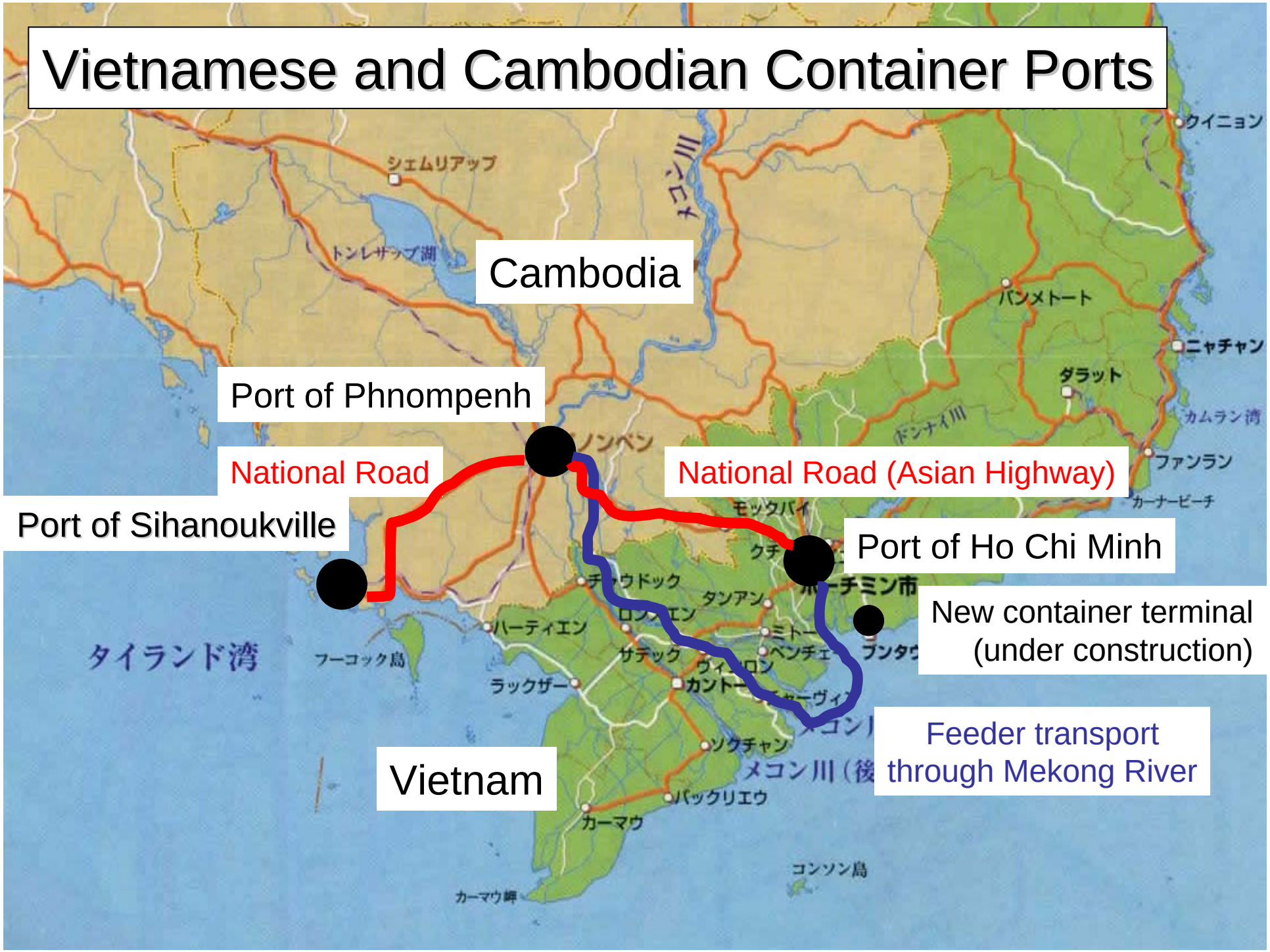
Scenario 1: *Improvement in Asian Highway*

All of Asian Highway with problem reported in ESCAP are improved.

Scenario 2: *Improvement of resistance at national border*

In addition to Scenario 1, according to conclusion of cross-border transport agreement (CBTA) etc.,
general resistance cost at all of national borders
in this region with border level 4 is decreasing to the level 3.


Difference between Scenario 1 (Improvement of Asian Highway) and Base Case
Difference between Scenario 2 (Improvement of Cross-Border Transport) and Base Case
100,000 – 1,000,000
10,000 – 100,000
1,000 – 10,000
100 – 1,000
10 – 100
−10 – 10
−100 – −10
−1,000 – −100
−10,000 – −1,000
−100,000 – −10,000
−1,000,000 – −100,000
(unit, 2003)


Vietnamese and Cambodian Container Ports
Cambodia
Port of Phnompenh
National Road
National Road (Asian Highway)
Port of Sihanoukville
Port of Ho Chi Minh
New container terminal
(under construction)
Feeder transport
through Mekong River
Vietnam
シェムリアップ
トンレサップ湖
メコン川
クイニョン
バンメトート
ニャチャン
ダラット
カムラン湾
ファンラン
カーナービーチ
ドンナイ川
モックバイ
チャウドック
タンアン
ハーティエン
ミトー
ベンチェ
ブンタウ
タイランド湾
フーコック島
サデック
ラックザー
カントー
ソクチャン
メコン川（後
バックリエウ
カーマウ
コンソン島
カーマウ岬

Simulation on the infrastructure improvement in Lower Mekong Area

Scenario 3: *Improvement of Arterial Road and Resistance at Border*

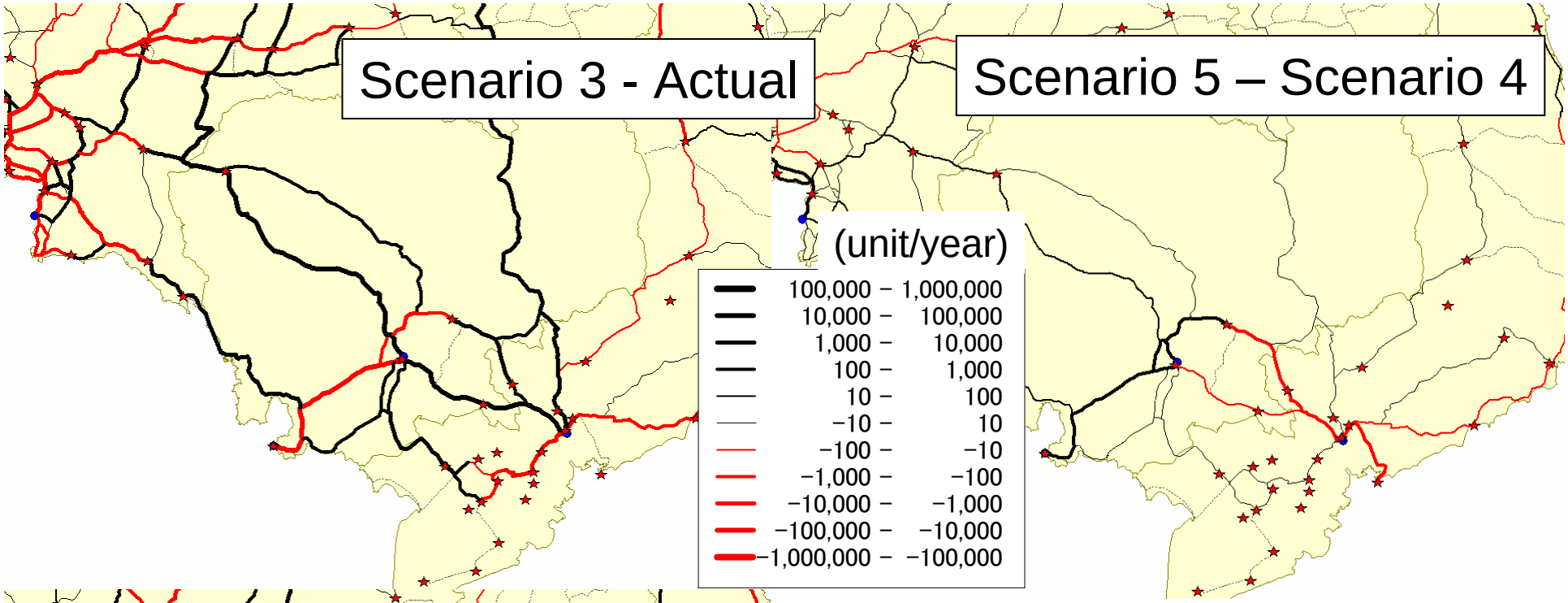
On the national highway connecting Ho Chi Minh and Phnom Penh, the bridge across Mekong River is completed and road condition is improved wholly within. In addition, the general resistance cost only at the national border along this highway is reduced to level 3 from level

Scenario 4: *Construction of Cai Mep Terminal*

In addition to Scenario 3, two berths with the depth of 14.0m are newly constructed in the port of Ho Chi Minh.

Scenario 5: *Improvement of level of service in Cambodian Port*

In addition to Scenario 4, in order to cope with the above investments, the level of service i.e. the handling charge in the port of Sihanoukville is reduced to the same level of the port of Laem Chabang, Thailand.



Scenario 3
Increasing in Phnompenh - Hochiminh route

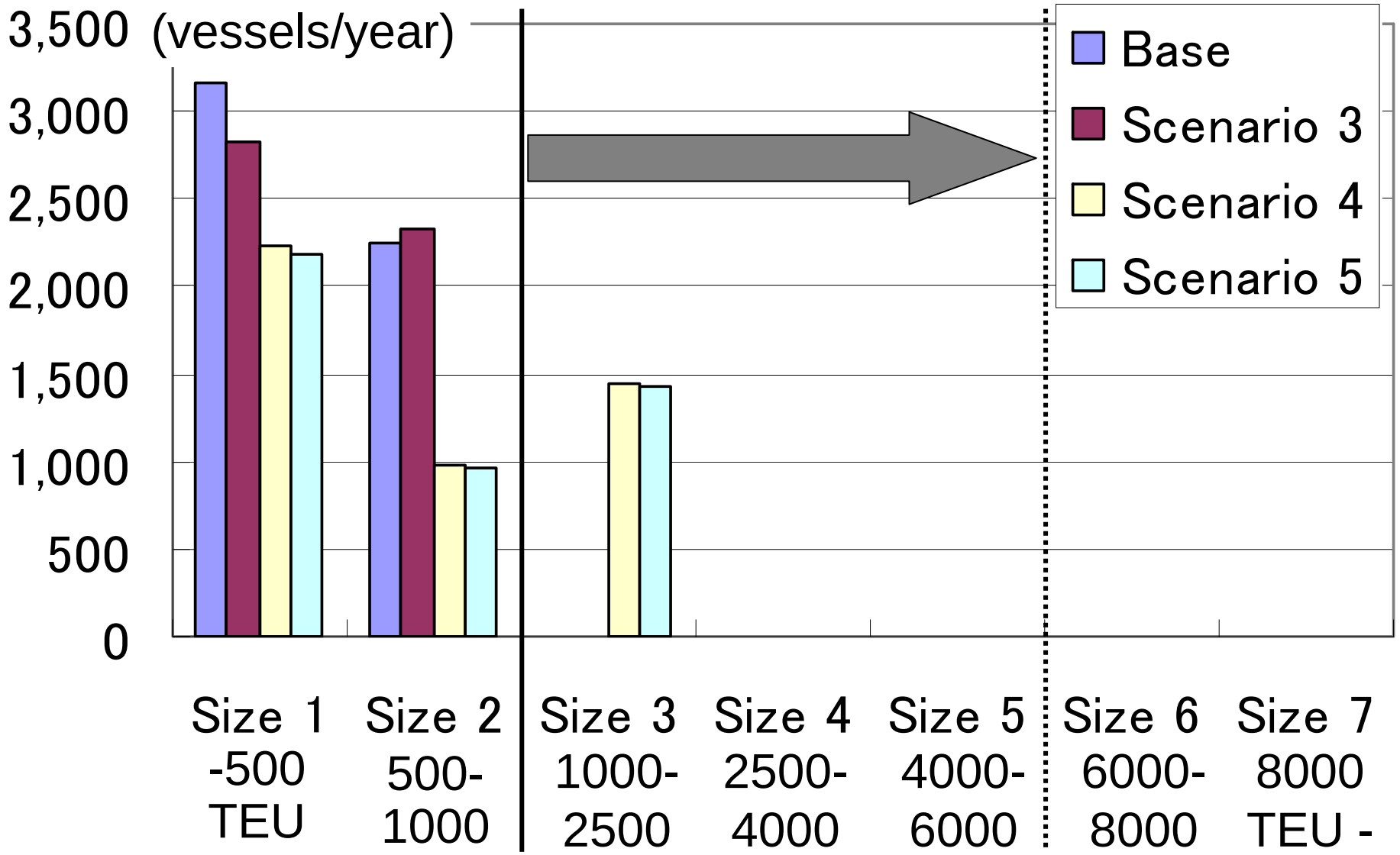
Scenario 4
Increasing in Phnompenh - Sihanoukville route

Scenario 5
Limited effects compared with above scenarios

Changes in container volume by ports

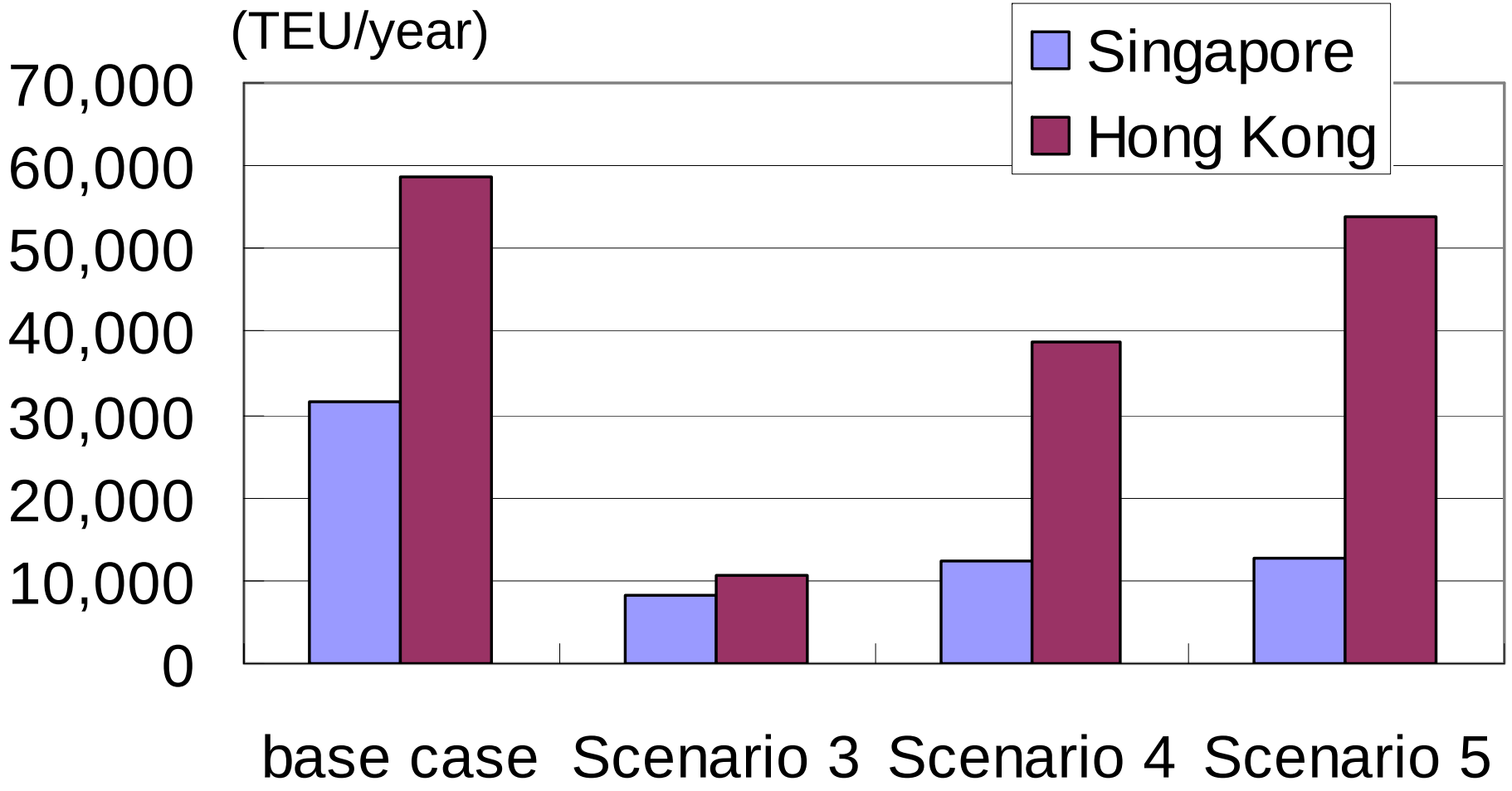
		Base Case	Scenario 3		Scenario 4		Scenario 5	
			Volume	Increasing Rate to Base Case	Volume	Increasing Rate to **Scenario 3**	Volume	Increasing Rate to **Scenario 4**
VN	Haiphong	308	324	5.2%	313	−3.2%	313	0.0%
	Da Nang	60	55	−	59	−	59	0.2%
	Ho Chi Minh	1,683	1,694	0.6%	2,142	26.4%	2,123	−0.9%
CB	Shihanouk Ville	97	19	−80.5%	51	171.6%	67	30.0%
	Phnompenh	0	0	−	0	−	0	−
MM	Tirawa	53	54	1.2%	42	−21.4%	42	0.0%
TH	Laem Chabang	2,577	2,714	5.3%	2,150	−20.8%	2,144	−0.3%
	Bangkok	3,001	2,954	−1.6%	3,146	6.5%	3,149	0.1%

Number of Ships At Port of Ho Chi Minh by Size by Scenario



- Ship of Size 3 is newly appeared by constructing deeper berths
- Decreasing in the total number

Number of Ships at Port of Shihanoukville by Routes



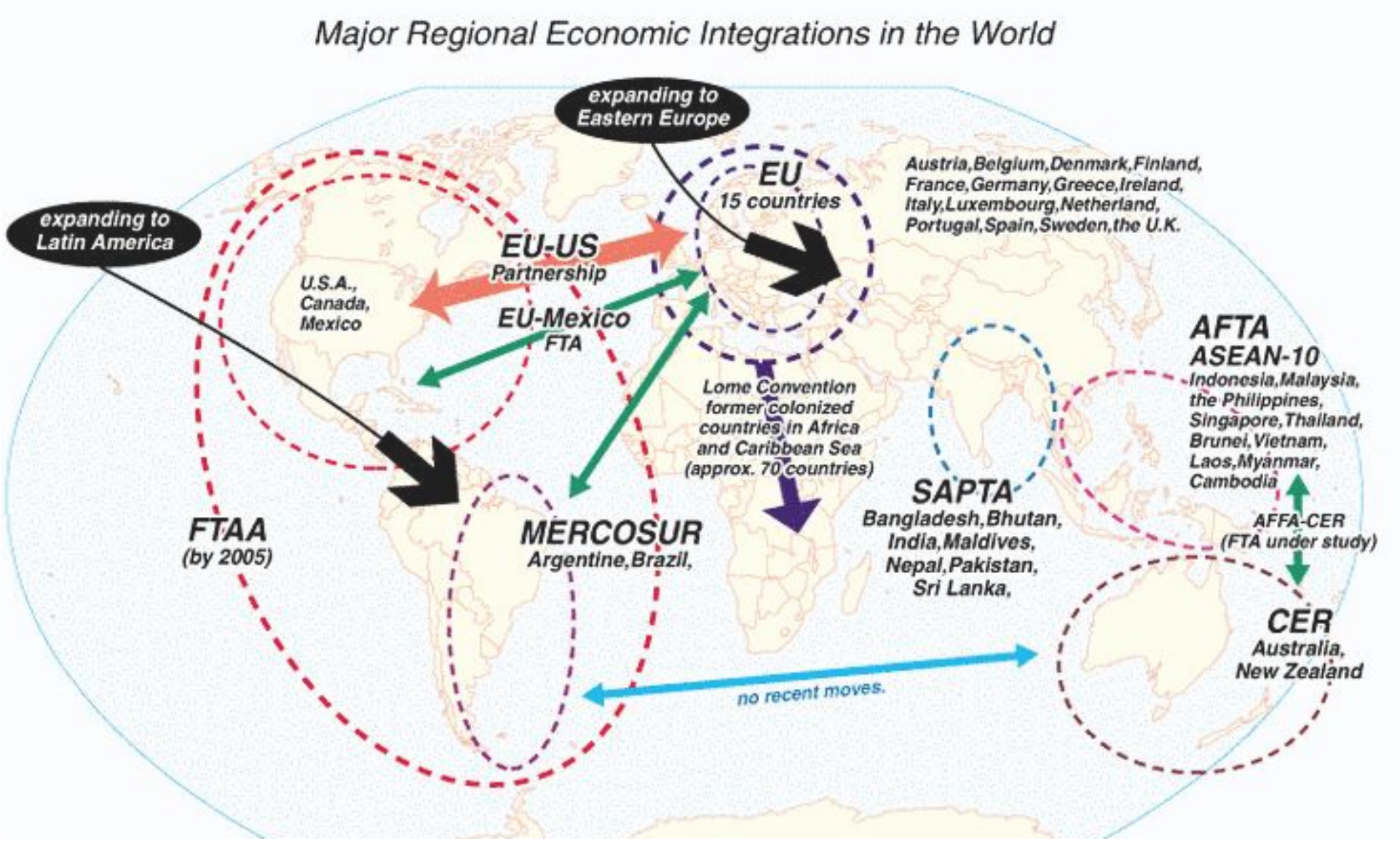
Transport volume from/to Hong Kong recovers in Scenario 4 & 5, while from/to Singapore doesn't recover

IV. ADITTIONAL MODEL: TRADE ESTIMATION MODEL

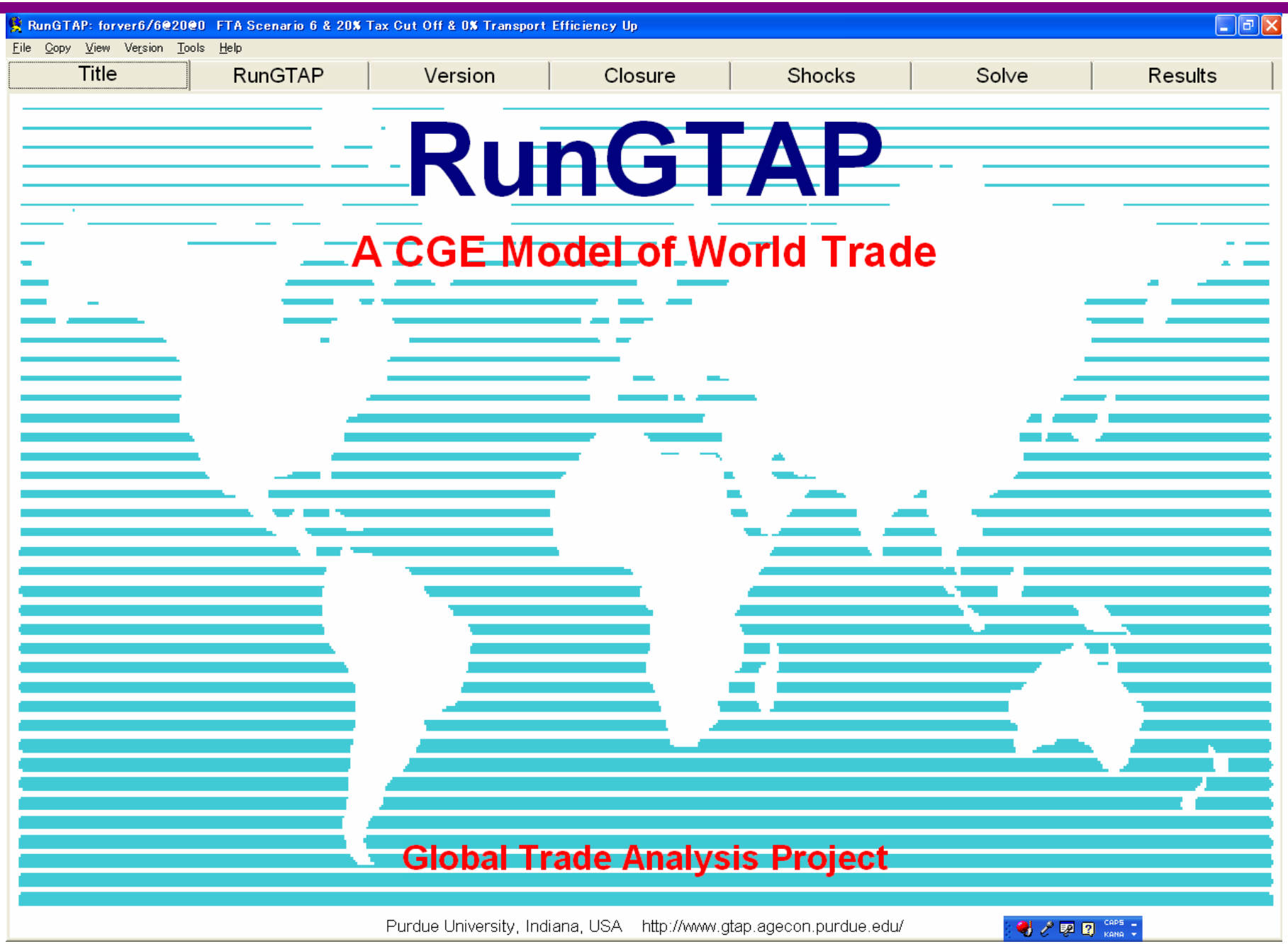
- For Assessing Impact of Trade Policy like FTA

Port of Hong Kong

Major Regional Economic Integration in the World

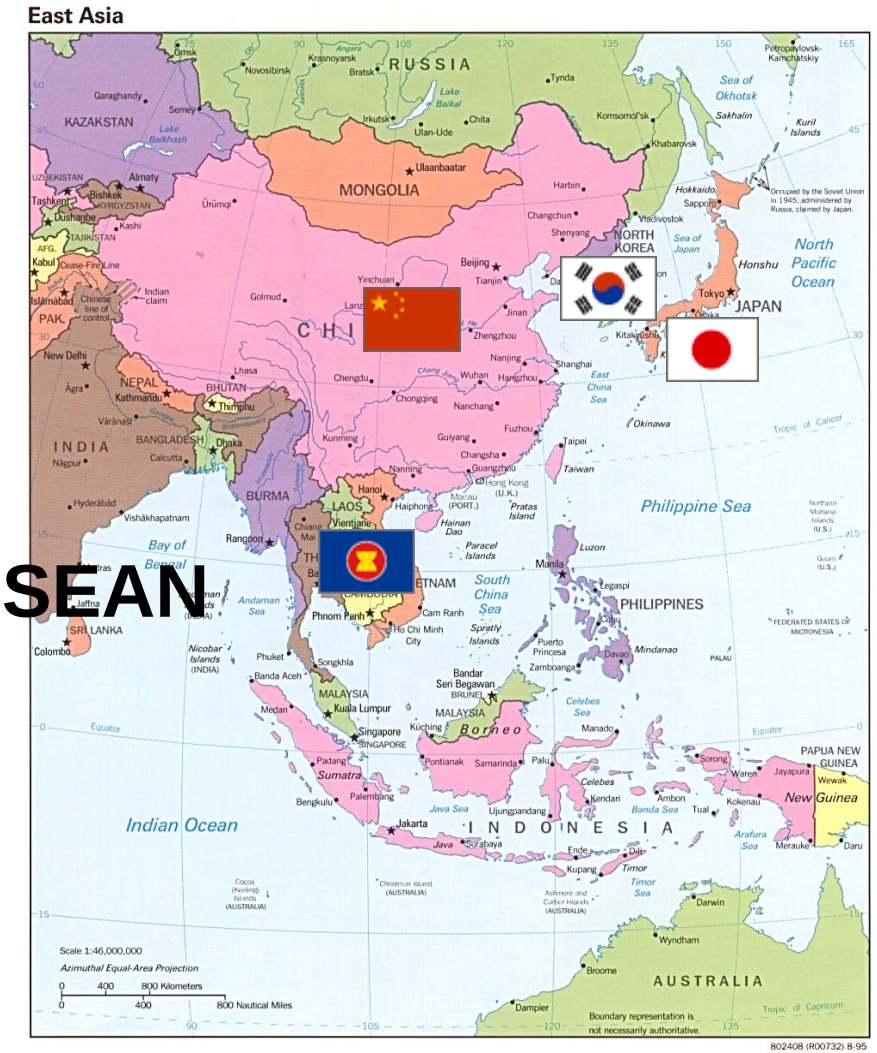


Global Trade Analysis Project (GTAP) Model



FTA Scenario under Several Participation Patterns

1. **Japan - Korea**
2. **Japan - ASEAN**
3. **Japan - China**
4. **Japan - China - Korea**
5. **Japan - China - Korea – ASEAN (ASEAN+3)**



FTA tariff reduction sets

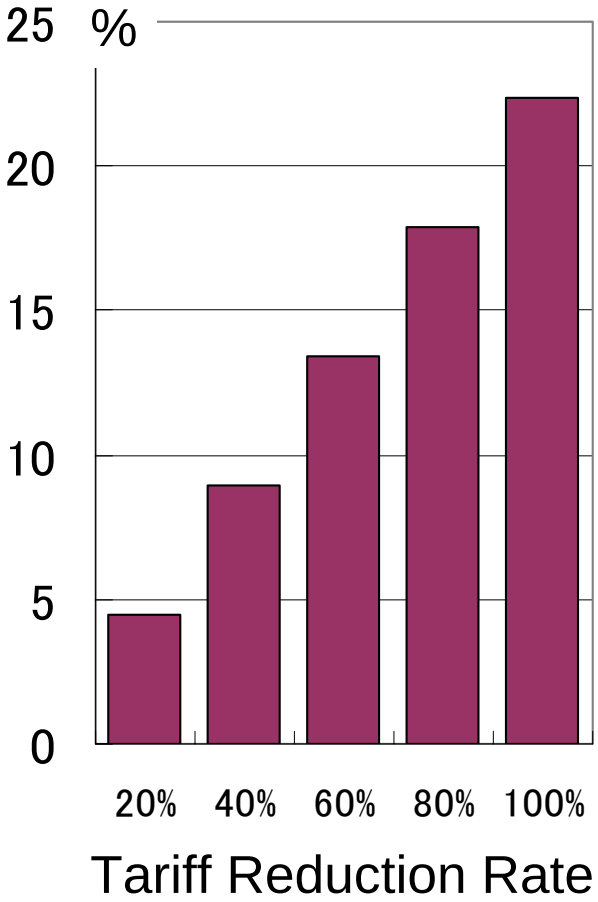
Reduction Rate :

20%, 40%, 60%, 80%, 100%

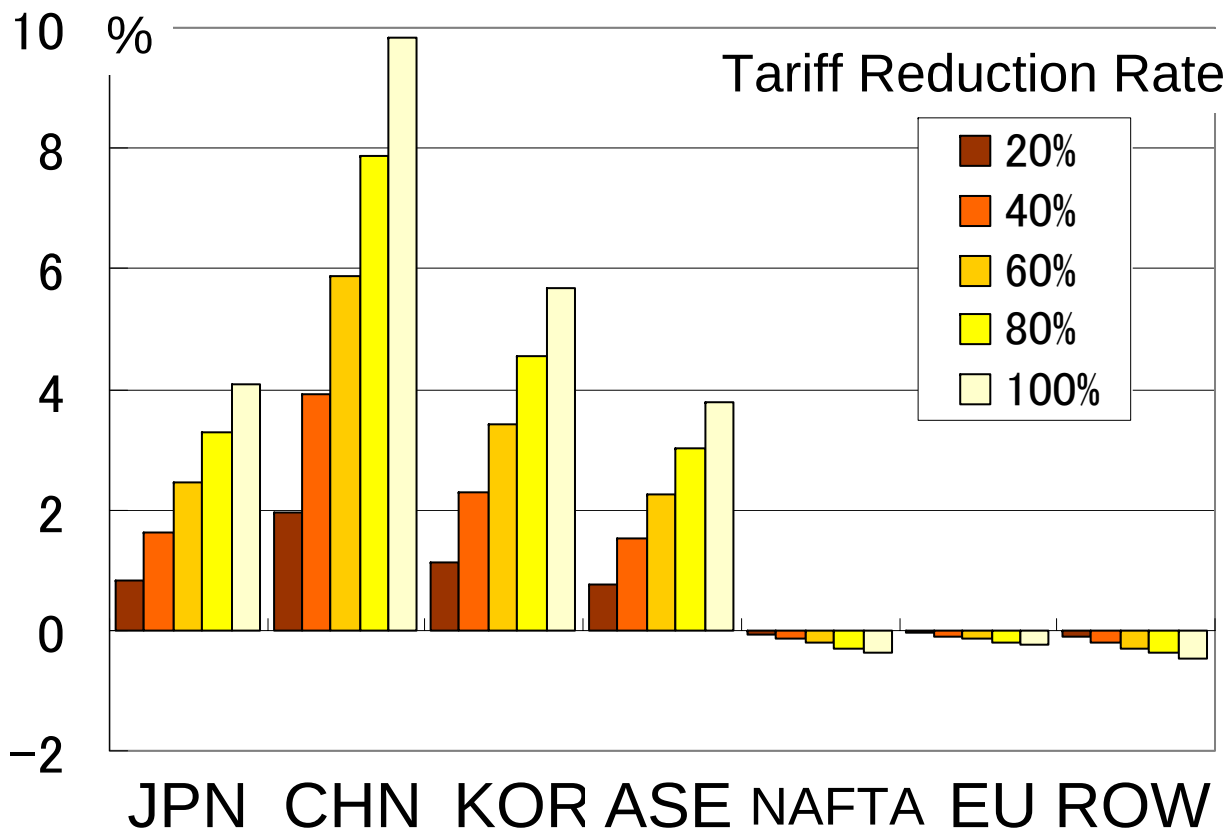
Tariff Reduction Rate and Magnitude of Effect

Japan - China - Korea - ASEAN FTA (ASEAN+3) Case

Total Trade Amount Change of all FTA member countries

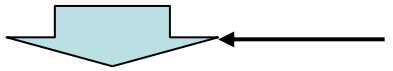


Trade Amount Change of each country



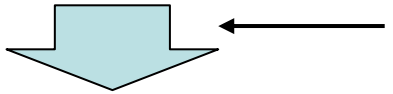
Conversion of Trade Amount into Int'l Maritime Container Cargo Volume

Trade Amount bet. Countries



Global Insight Database

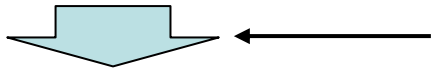
Cargo Volume bet. Countries (tonnage basis)



Global Insight

Cargo Volume by Transport Mode bet. Countries

Maritime

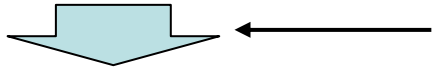


Global Insight

Air (excluded)

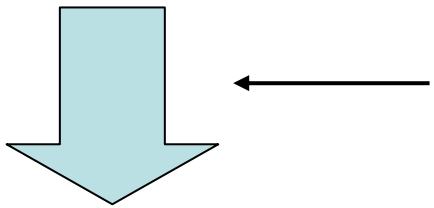
Land (excluded)

Maritime Container Cargo Volume bet. Countries
(non-containerized cargo are excluded)



Global Insight

Maritime Container Cargo Volume bet. Countries (in TEU basis)



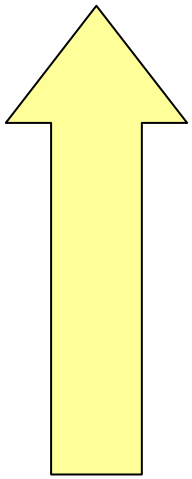
CCS Database (China)
Socio-Economic Data of each country
Handled volume by ports

OD Flow of International Cargo bet. Region (in TEU basis)

Summary of Effects on Japanese Economy for FTA

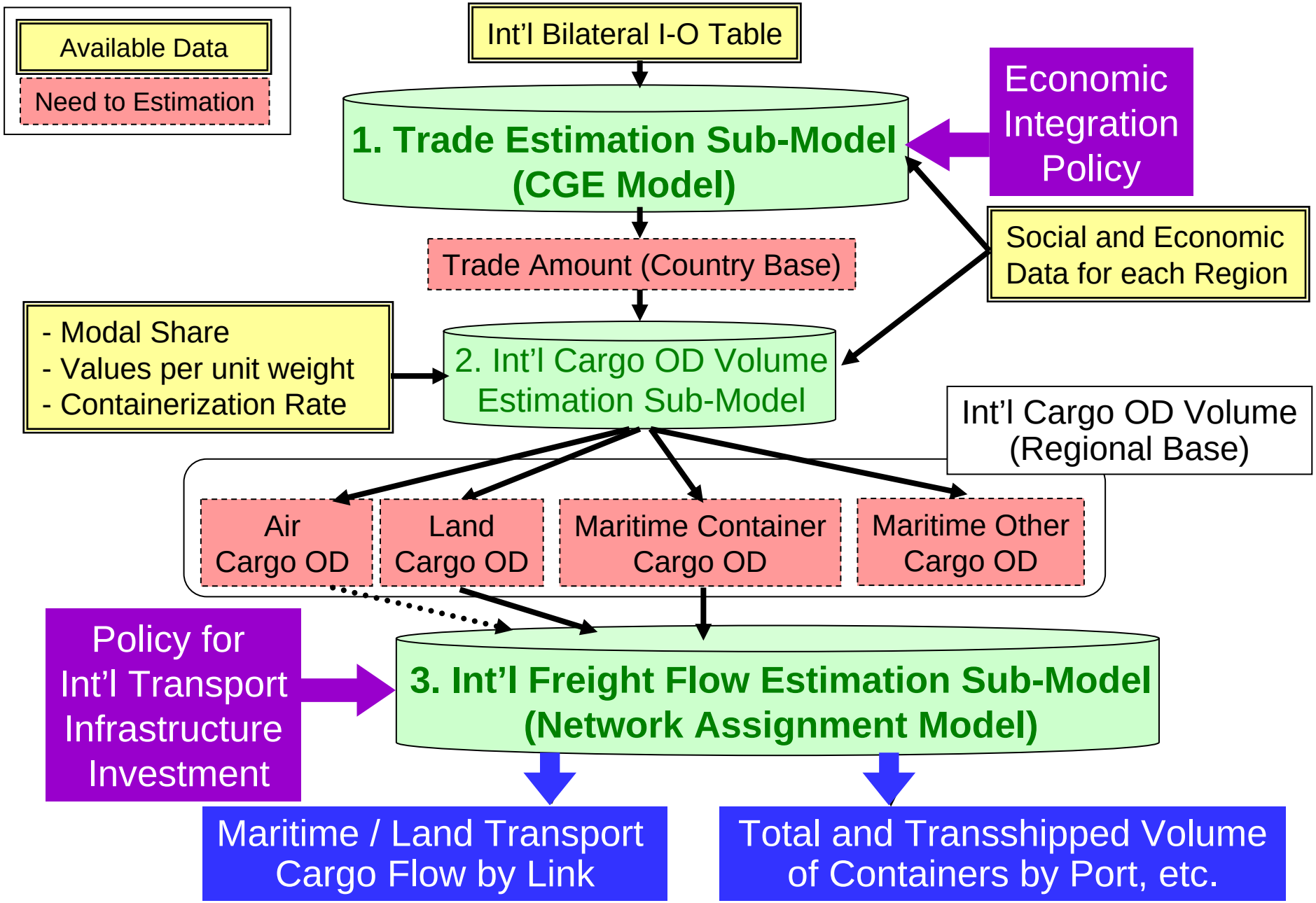
Japan - China - Korea – ASEAN FTA (ASEAN+3)
100% Tariff Reduction Case

Large Effects



Container Volume Change with China	39.7 %
Trade Amount Change with China	36.3 %
Container Volume Change with FTA Countries	28.1 %
Trade Amount Change with FTA Countries	20.4 %
Maritime Container Volume Change	6.5 %
Trade Amount Change	4.1 %
GDP Change	0.1 %

Trade-Freight Integrated Forecasting System




Thank you for your listening!
Port of Sihanoukville

Feature of the Model

The Model can Consider …

- Both Shippers' and Carriers' Behavior
  to Choose their Transport Route
  in order to Minimize the Cost

- Not only International Maritime Transport
  but also Land Transport

Link Cost Function for Carrier Model [1] Cruise Link

Loading & Cruise Link

(1,000 JPY/TEU)

$$CCL_{pqsk} = \frac{Cop_s + Cfix_s}{f_{pq} \cdot cap_s} \cdot l_{pq} + vt_{carr} \cdot \left\{ \frac{l_{pq}}{v_s} + \frac{T \cdot f_{pq} \cdot cap_s}{2(XCL_{pqsk} + XCB_{pqsk})} \right\}$$

Depends on Other Link Flow

Passing & Cruise Link

$$CCB_{pqsk} = \frac{Cop_s + Cfix_s}{f_{pq} \cdot cap_s} \cdot l_{pq} + vt_{carr} \cdot \frac{l_{pq}}{v_s}$$

Interference between link flows

XCL_{psqk}: container flow of the link between ports *p* and *q* in ship-size *s*, carrier group *k* (TEU/year),

XCB_{pqsk}: container flow of the corresponding *Passing & Cruise link* (TEU/year),

l_{pq}: distance (NM), v_s: Speed of ship of size *s* (knot),

cap_s: capacity of ship (TEU/vessel), f_{pq}: load factor of the link,

T: time unit (in this case 1 year = 8,760 hours),

vt_{carr}: time value of the container transported for carriers (1,000 yen/hour/TEU),

Cop_s, *Cfixs* : operation cost and fixed cost of the ship of size *s* (1,000 yen/NM/ vessel)

Link Cost Function of Carrier Model [2] Berthing Link

$$CSB_{psk} = \frac{Cent_{ps}}{\overline{f_{pk}} \cdot cap_s} + vt_{carr} \cdot TW(p,s) \cdot \frac{24}{h_p}$$

Monetary Cost for Entering Port

Waiting Time for Entering Port

Here,

$$TW(p,s) = \gamma_1 \cdot \left(\frac{Tanc_p \cdot \sum_{i=s}^{j} \sum_{k} \left(\frac{XSB_{psk}}{\overline{f_{pk}} \cdot cap_s \cdot T} \right)}{\sum_{i=s}^{j} NB(p,i)} \right)^{\gamma_2}$$

Interference between Shipping Group

When

$$\frac{NSB(p,s)}{NB(p,s)} \geq \frac{NSB(p,s-1)}{NB(p,s-1)}$$

$\underline{Cent}_{ps}$: port charge at port p for vessel category s (1,000 JPY/vessel),
$\overline{f_{pk}}$: average load factor entering port p,
$TW(p, s)$: expected waiting time for mooring at port p for vessel category s,
h_p: average operation time per day (hours/day),
$Tanc_p$: time required for loading, unloading, and transshipment at port p (hours/vessel),
$\gamma 1$, $\gamma 2$: unknown parameters relating to waiting time for mooring ($\gamma 1$, $\gamma 2 > 0$).,
XSB_{psk}: annual flow of the ship-berthing link defined by the carrier group k (TEU/year)

Conclusion and Future Works

Achievement of this Research

- Extension of the MICCS including hinterland transport
  in Southeast Asia with consideration of national border
- Showing some policies on improvement of infrastructure
  at targeted area can be evaluated
  by simulation using the model

Future Works

- Improvement of performance of the model
- Further extension of the model

ex) Hinterland Transport in Northeast Asia, Central Asia and North America

- Including empty containers and
  cargo transported by other modes
  such as air transport and international RORO/ferry