

Investing in Port Infrastructure to Lower Trade Costs in East Asia

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Abstract

Emerging economies in East Asia have relied to a great extent over the past decade on export-led growth. We examine in this paper how port infrastructure affects trade and role of transport costs in driving exports and imports for the region. Existing studies use survey indexes to explain transport costs. These do not link investment in port infrastructure to transport costs. Our analysis addresses this issue by including a new index of port capacity. We include in our estimates a variable to represent the congestion of the ports to explain the transport costs. This enables us to inform infrastructure policies by domestic governments and development institutions. We find that the port congestion has significantly increased the transport costs to East Asia from both the United States and Japan. Our analysis suggests that cutting port congestion by 10 percent could cut transport cost in East Asia by up to three percent. This translates into a 0.3 to 0.5 percent across-the-board tariff cut. In addition, our results suggest that trade cost reductions with new investment in port infrastructure in East Asia could translate into higher consumer welfare that would outweigh the cost of investment in new port capacity in the region.

1. Introduction

This paper empirically examines how investment in port facilities affected the trade costs in East Asia. Port infrastructure has played a key role in facilitating trade in the region. However, serious congestion in seaports is evident from data on maritime shipping and trade stat, resulting in the higher trade costs in the region. The scope of the study includes the benefits of the construction of port infrastructure to address traffic congestion in East Asia.

The Important Role of Ocean Ports in the Trade of East Asia

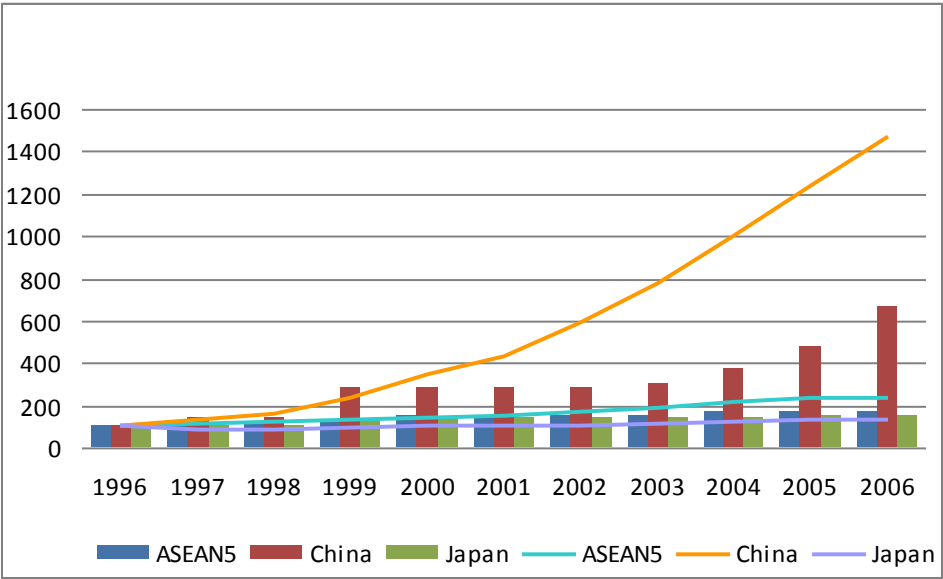
Countries in East Asia need to rely heavily on ocean transportation as the means of international trade. Among the ASEAN5, the peninsular part of Malaysia, Singapore and Thailand are adjacent to each other, but significant amounts of the trade among them must rely on ocean transportation. Indonesia and Philippines are islands countries. If measured by weight, virtually all the traded goods between the ASEAN5 and all of the major trading partners, the United States, Japan and China, need to move through ocean. Road and railway transports between China and some ASEAN5 members contribute to their trade, but they are limited, because major part of their international trade takes place between the industrial center of China, i.e. her coastal provinces, and ASEAN5. Air transport is rapidly increasing and taking substantial shares especially in trade value. The dominant volume of trade of the developing countries still relies on sea transport. For example, the share of air over the total imports of the United States from ASEAN5 countries reached 56.3 percent in value, but only 1.4 percent in weight in 2006.

Reflecting the geographic characteristics noted above, governments in East Asia have historically set a priority on port infrastructure improvements -- in coordination with an export-oriented development strategy. Transport infrastructure has also been a key sector in ODA in East Asia. Shortage in port capacity and quality in the developing countries in this region, however, has risen over the past decade.

Trends in Port Traffic in East Asia: Expanded Capacity but More Congestion

The major ocean ports in East Asian developing countries have suffered from serious congestion with rapid growth in freight demand over the past decade. Bottlenecks arise in spite of continued investments in port improvement, expansion and containerization. Figure 1 illustrates the trends in capacity and throughput in the major container ports in ASEAN5, China and Japan.

Figure 1: Capacity and Throughput in Major Container Ports



(Source) Authors' estimates. *Containerization International Yearbook, Shipping Statistics Yearbook.*

(Note) Index at 1996 =100 . Bar graph denotes the sum of the estimated capacity of the major container ports in the country / region. The numbers of major ports are: 8 in ASEAN5, 8 in China, and 11 in Japan. See Appendix for the detailed methodology of the estimation of the port capacities. Line graphs in the figure denote the sum of the loaded and unloaded containers in TEU.

Port traffic in ASEAN5 has steadily grown, while the Asian economic crisis slowed this trend around 2000. The growth of port traffic throughput, measured as total unloaded and loaded containers in TEU, has consistently exceeded that of the physical capacity of the ports. China has had growth in port traffic, by 30.8 percent annually from 1996 to 2006, much faster than experienced in ASEAN at 9.0 percent. The investment in port infrastructure could not keep pace with the growth of port capacity during the same period, 20.8 and 5.3 percent on annual average respectively. Because of the resulting congestion, vessels needed to wait for embarkation and disembarkation. Ports in Japan, in contrast to the ASEAN5 and China, have had idle capacity. Reflecting the long period of stagnation in the Japanese economy, Japanese trade grew slowly. Substantial public investment in 1999 and 2000, due to the counter-cyclical fiscal policy of the Japanese government, contributed to increases in port capacity. These factors, together with substitution to air transport, have led to idle ports capacity in Japan.

Ports with sufficient capacity, efficient facilities with high technology, and good management contribute to lower transport and trade costs. In addition to the explicit costs from port tariffs and loading / unloading charges, the time costs from congestion and inefficient facilities / management contribute to transport costs. These costs are reflected in freight charges by shipping companies, storage costs, and brokerage fees by port broker incurred by traders. More frequently, these costs are charged to traders in payments to forwarders. Our study examines

whether and to what degree improvement in port infrastructure in East Asia has reduced the total costs of port transportation over the past decade.

2. Port Infrastructure, Transport and Trade Costs: Survey

Trade costs are widely defined as any costs which increase the prices of traded goods during the delivery process from the exporters (or producers) in exporting countries to the final consumers. Developed countries face substantially high international trade costs: estimated about 74 percent in terms of *Ad valorem* tax equivalent¹, including transportation costs, policy barriers, information costs, contract enforcement costs, currency costs, and legal and regulatory costs² (Anderson and van Wincoop (2004)). Poor countries have higher trade costs. The quantity and quality of port infrastructure closely affect transport costs. Expansion of port capacity and improved port facilities can streamline and speed-up embarking and disembarking, loading and unloading process and enable to use more efficient container vessels. This section surveys the existing literatures on the infrastructure and transport costs, focusing on the empirical findings on the ocean ports, in particular.

Limited Availability of Trade Cost Data

The existence of trade costs is a key theoretical assumption of the standard gravity model of trade. Bilateral trade in the gravity model is determined by the magnitude of the economies of

¹ Defined as international trade costs divided by the value of the imported goods in the country of origin.

² Even the lack of transparency in the trade policies would increase the trade costs because of higher risks in trade, obliging the traders to pay the premium for preventative measures in case the risks realize. See Helbel, Shepherd and Wilson (2008), and Abe and Wilson (2008).

the trading partners and relative bilateral trade costs. A major analytical obstacle to this model is the limitation of official statistics on the trade cost, which prevents the researchers from directly regressing the bilateral trades on the amounts/rates of trade costs in total. As a compromise, proxy variables, such as distance, required time for trade, geographical and policy dummies, and various surveyed indexes, appear in the trade regressions, in addition to published nominal tariff rates. This enables to estimate the effect of the unobservable trade costs, represented by these factors, on the trade. However, to what degree these variables affect trade cost itself and to what degree the trade cost affect affects the bilateral trade remain unclear.

The limitation in availability of the data is also true for the narrowly-defined transport costs between the ports that constitute a part of trade costs. The authorities of most countries only publish the amounts of import on the CIF base, inclusive sum of export prices of the goods and costs for insurance and freight without showing any details. If researchers would like international transport cost data between the ports of trade partners, they must estimate the international transport cost by separating that part from the CIF import prices in most of the countries. Only the United States and New Zealand officially publish shipping / transport cost data based on the declarations from the importers for the taxation purpose³.

Estimating trade costs for empirical analysis is challenging, therefore. An empirical compromise has been the “matching method” which uses ratio of the CIF import value divided by FOB export value between the same trading partners, whereas the former is reported from the importing country and the latter, from the exporting country. Limao and Venables (2001) estimate transport costs, or more precisely the “transport cost factors” by applying the method to the Direction of

³ A other few countries appear to have transport data in cross-section (Hummels and Lugovskyy (2006)).

Trade Statistics (DOT), published by the International Monetary Fund (IMF). The authors use estimated transport cost factors as the dependent variable of the regressions to examine various determinants of transport costs, which include an index of infrastructure level. While they appear to obtain a persuasive result, the matching method should require a careful treatment in use. For instance, Hummels and Lugovskyy (2006) analyzes the accuracy of the method, comparing the estimates with the officially published import charges statistics of the United States and New Zealand, with conclusion that the matching method may generate “noisy” information.

Determinants of Transport Costs

Limao and Venables (2001) estimate determinants of transport costs, in particular those related to infrastructure. Their transport cost factor regression has distance, per capita incomes, geographical factors, such as common barriers and island dummies, and the indexes of the levels of infrastructure of various parties, as explanatory variables. Their infrastructure index consists of four items: (i) length of road, (ii) length of paved road, (iii) length of rail, and (iv) telephone main lines per person. These four items are normalized and averaged to construct the infrastructure index of a country. Due to its main interest in transport costs for the geographically landlocked counties, the study tends to be implicit on the port infrastructure. But the regressions of trade costs and bilateral trade amount both include the dummy variable for inlands, partially controlling the effect of sea transport. According to their findings, sea transport is much cheaper than land transport. In contrast, explicit measures of port infrastructure should be necessary in our study on East Asia where the dominant proportion of the trade in volume is made between sea ports.

Clark, Dollar, and Micco (2004) specifically examine the relationship between port efficiency and maritime transport costs. Instead of using the CIF/FOB matching method, they directly use the “import charges” from the United States trade statistics. The U.S. official statistics record every year the HS 6-digit commodity based, via liners, port-to-port import values, weights and “import charges”, the latter roughly reflecting the transport costs between the ports⁴. They run regression analysis for cross-section data in 1998: the dependent variable is port-to-port via-liner import charge per weight at HS 6-digit commodity level; the independent variables are bilateral (port-to-port) distance, port-to-port via-liner trade value per weight at HS 6-digit level, total import volume from the exporting country, directional imbalance in total trade between the U.S. and the exporting country, containerization ratio of the HS 6-digit based import from the exporting country, and various policy variables, as well as the efficiency indicators of sea ports of exporting countries to the ports of the U.S.⁵

The authors test four different indicators as the proxies of the port efficiency, including: (i) country specific port efficiency index from *The Global Competitiveness Report*⁶; (ii) total square number of largest seaports by country, normalized by the product of exporting country’s population and area; (iii) GDP per capita of the exporting country; and (iv) the same

⁴ According to the official source, the import charge represents the aggregate cost of all freight, insurance, and other charges (excluding U.S. import duties) incurred.

⁵ The amounts of the trade and weight in their regression cover those transported by liners only, not include those by tankers nor tramps. They use an Instrumental Variable technique to control the endogeneity of the variable of total volume, with the instrumental variable of exporting country’s GDP.

⁶ *The Global Competitiveness Reports* of the World Economic Forum publish every year the questionnaire survey results on various items related to the country’s competitiveness, including the port efficiency indicators to measure the quality of infrastructure of ports and airports. The indicators reflect more or less subjective views of the respondent executives in the countries, as they are asked to respond by assigning points on the efficiency in their countries.

infrastructure index as that used by Limao and Venables (2001). Their regression shows that all the four port efficiency indicators have significantly negative coefficients. The improvement in port efficiency leads to reduction of the transport costs. For other variables, the containerization ratio, directional imbalances and total liner import volume have negative coefficients, while distance and weight value have positive ones. The signs of the coefficients agree to the theoretical prediction.

Blonigen and Wilson (2008) adopt an innovative methodology to estimate the efficiency of major ports in the world including the United States. Using the port-to-port, HS 6-digit commodity based import statistics of the United States, this study explored the efficiency of trading partners' ports by estimating the regression of port-to-port import charges on partner's and U.S. port-specific fixed effects, as well as a explanatory variables. Their regression has port-to-port U.S. import charges in HS 6-digit commodity codes, as the dependent variable; and the dummy variables of the partner's and U.S. ports, the distance, weight, value per unit, containerization ratio, trade imbalances and some of the products of the variables, as independent variables. The exporters' port-specific dummy variables in the regression should reflect their fix-effect, i.e. the cost efficiency/inefficiency for each port of the trading partners with the ports in the U.S. Then, they test the estimated port efficiency measures by applying them to the regression of port-to-port bilateral trade gravity model, as an explanatory variable, obtaining a significantly negative coefficient. This confirms that their estimated port efficiency measurements reflect the transport costs, which have an explanatory power on the bilateral trade.

The port efficiency measures by Blonigen and Wilson show that, in East Asia, Japanese ports are generally more efficient. Those in Korea, Taiwan, Singapore and Hong Kong are less efficient.

And those in Southeast Asia and China are the least efficient. However, their ranking of the port efficiency may attract an observation on the nature of the measurement. Some of the most technically advanced ports in East Asia, such as Singapore and Hong Kong come in the middle of the list⁷. As shown in Figure 1, the ports in the developing countries in East Asia chronically congested. The leading ports in the region, such as Singapore and Hong Kong generally charge higher port tariffs, reflecting their market power, high demands and superiority in technology. On the other hands, the ports in Japan that are higher-ranked in efficiency generally maintain idle capacity with smaller demands. As such, the measure of port efficiency appears to strongly reflect not merely the technical efficiency, but the costs in total, including both pecuniary port tariffs and charges and the implicit time costs from the congestion and inefficiency in all the process in the ports. Moreover, the higher demand and technical efficiency may bring about rent on the port tariffs. Reflecting them, the port efficiency measurements by Blonigen and Wilson cover more than “the inherent technical efficiency of a port”, reflecting other non-technical factors to determine the costs around the ports, as also observed by the authors. Our research objective calls for direct measurements to reflect the physical capacity of port infrastructure, instead of adopting their measurement. Notwithstanding, their measurements give good reference with rich information on the cost efficiency of the ports in a wider sense.

Summary on the Estimated Elasticities of Transport Cost per Weight

The estimated values of the elasticities of the determinant factors of transport costs in various literatures tend to converge within the consistent ranges. The elasticities reviewed below are

⁷ For example, Singapore continues to take the top in the ranking of port infrastructure quality index in *The Global Competitiveness Report*.

converted to the elasticities of transport cost per weight with respect to the various independent variables, obtained from log-linear regressions. The summary below only refers to ocean transport, except mentioned otherwise.

- *Port-to-port distance*: around 0.14 to 0.21 for regressions on the disaggregated commodities base data. Only Limao and Venebles (2001), which uses the aggregated import charge data from matching method inclusive both ocean and land transportation, reports larger numbers: around 0.21 to 0.38. The larger numbers may reflect: (i) the higher cost land transportation; and (ii) the composition change effect that the longer distance results in comparative advantage in ocean shipping against the air, leading to higher value per weight ratio⁸ and more expensive transport cost per weight.
- *Value per weight*: around 0.53 to 0.63. The elasticity is less than one, implying that the *Ad valorem* transport cost decreases as the value per weight of the same commodity rises⁹. Within the same highly disaggregated category of commodity, transport cost takes smaller share in the sales price for the more expensive, luxurious goods.
- *Containerization ratio* (percent change of transport cost per weight with respect to the percent point change of containerization ratio): around -0.038 to -0.081.
- *Various Indicators for Port Infrastructure*: significantly contributing to the reduction in transport costs. One point rise in Port Efficiency in the GCR index¹⁰ corresponds to 4.3 percent reduction in *Ad valorem* transport cost. An increase in the number of major ports from 3 to 4 in a country corresponds to 0.7 percent reduction in *Ad valorem* transport cost. An upgrade of the *infrastructure index*, consisting of paved road, railroads and telephone

⁸ See Harrigan (2005) for the discussion on the comparative advantages between air and ocean shipping.

⁹ The elasticity of *Ad valorem* transport cost with respect to value per weight equals to the elasticity of transport cost per weight with respect to value per weight minus one.

¹⁰ The full mark of the index is 7.

lines also reduces the ocean transport cost, while the index is a proxy of the port infrastructure.

Ad valorem Transport Costs in East Asia

The conclusion of this section outlines international transport costs in East Asia draw on data from the United States and Japan since 2000. As noted above, U.S. official statistics report import charges aggregated at the detailed HS commodity classification. In addition, Japan, another major importer for the developing countries in East Asia, publishes official Balance of Payment (BOP) Statistics which include import amount on the FOB base¹¹. Subtracting the FOB import in the BOP statistics from the CIF import in the customs statistics gives the estimate of transport cost of Japan. The authorities in Japan, Ministry of Finance and the Bank of Japan, publish the data disaggregated by the exporting partners, but not in commodity subdivision. In the compilation of the official statistics, the authorities in Japan estimate the freight and insurance cost for the import from each country first, and then calculates the FOB imports by subtracting it from the reported customs values. With the ministerial ordinance, Japanese sea transport enterprises must report their revenues to the authorities, including import sea freight fare from the importers in Japan. Dividing the total amount of freight fare by the share of import sea cargo carried by the Japanese enterprises in the official maritime statistics, the authorities estimate the total amount of freight costs. This calculation is made on the exporter country-specific and modal-specific (liners, tramps and tankers) base, adding them up to country specific freight payments in total (Bank of Japan (2005)).

¹¹ Japan is one of the few countries which publish the FOB base import data in conformity with the *Balance of Payments Manual* of the IMF.

Table 1 summarizes the *ad valorem* ratio of import charges over the amount of imports from selected East Asian countries in the United States and Japan, averaged for 1996-2000 and 2001-2006. Note that the data cover all the modals of the imports, including air, ocean and land shipments.

Table 1: *Ad valorem* Rates of Import Charge

(Unit: percent)

	<i>Japan</i>		<i>United States</i>	
	1996-2000	2001-2006	1996-2000	2001-2006
<i>Indonesia</i>	7.34	7.13	7.12	7.68
<i>Malaysia</i>	11.10	11.54	2.93	2.93
<i>Philippines</i>	15.69	17.64	3.57	4.37
<i>Singapore</i>	7.34	6.81	1.68	1.80
<i>Thailand</i>	14.30	15.94	4.81	5.82
<i>Viet Nam</i>	12.83	11.23	7.33	8.28
<i>China</i>	7.65	9.29	6.46	6.72
<i>Korea</i>	10.91	14.27	3.36	3.79
<i>Hong Kong</i>	28.29	na	4.08	4.69
<i>Taiwan</i>	16.11	21.32	3.92	4.32
<i>Canada</i>	7.41	7.48	1.79	1.49
<i>Australia</i>	8.18	6.54	6.13	4.78
<i>New Zealand</i>	9.35	11.81	9.36	7.36
<i>Japan</i>	--	--	2.53	2.67
<i>United States</i>	13.43	13.89	--	--

(Source) Japan: Customs Office, Bank of Japan, US: Department of Commerce

(Note) 1. The rates are defined as: (Import Charge) / (Import in FOB/Custom Value) * 100.

2. The Bank of Japan reported negative imports from Hong Kong for 2003-2006, and the figures are omitted in this table.

Table 1 suggests that *Ad valorem* transport costs are generally higher than nominal tariff rates both in the United States and Japan. The simple average rates of nominal tariff of the United States and Japan are only 3.5 and 5.6 percent in 2006, respectively, according to World Trade Organization Home Page. This underscores the relative importance of the trade facilitation to reduce such costs in the transportation sectors to promote the international trade. A tendency also appears that the rates of Japan are generally higher than those of the U.S. This will be explained in the next section by the formal analysis.

3. Determinants of Transport Costs: Empirical Analysis

We conduct a formal regression analysis on transport costs in East Asia, using available data on transport costs, taken as import charges, of the United States and Japan. The existing studies used survey indexes to explain transport costs, failing to link the physical port investment to transport costs. Instead, we have estimated an index of physical capacity of ports, shown above, and include in the regression the explanatory variable representing the congestion in the transport cost model to measure their effects. This enables us to directly assess the infrastructure policies by domestic governments and ODAs. This section discusses the specification of the regression and the infrastructure indicators, and examines the results.

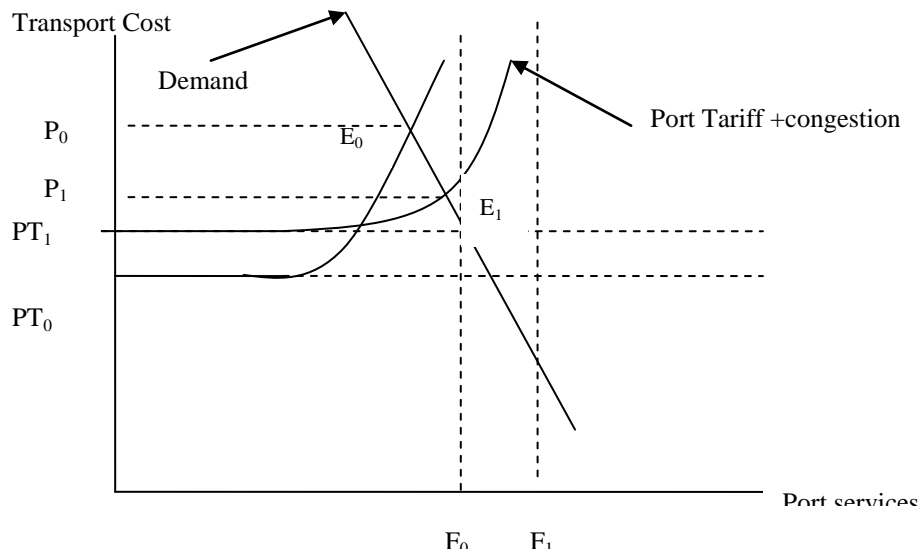
Port-related Costs reflected in Import Charges

International transport costs between ports, defined by CIF minus FOB values, include only freight and insurance costs. But import charge statistics may cover the costs of services associated with transport: for example fees paid to port and storage brokers and freight

forwarders. The comprehensive port efficiency indexes of Blonigen and Wilson, covering transport cost are estimated from the import charge statistics. If ports are congested not only do freight and insurance costs increase¹², but also miscellaneous costs to traders, such as idle time at ports¹³, around the ports may further accumulate. Our empirical interest exists in the effect of expansion of physical port capacity which would reduce such costs.

Figure 2 illustrates a simple partial equilibrium framework of supply and demand of the port services.

Figure 2: Market for Port Services: Illustration



(Note) P: Transport cost. PT: Port tariff. F: Full capacity of the port

¹² Costs for the freight companies may increase, due to longer waiting time for disembarkation and loading, and the increased uncertainty of the waste of time. These increased costs should pass on to the users.

¹³ See Simeon, et.al (2008).

The downward-sloping demand curve in the figure represents the demand for port services¹⁴, which is in turn derived from the demands for the imports and exports of the goods through the ports of the country. The steep slope of the curve reflects somewhat inelastic derived demand. The supply curve of the port service represents the supply price from the port authorities to the users, i.e. the port tariffs and loading/unloading charges (PT), and the cost incurred because of the congestion / inefficiency in the port ($P - PT$). At the time 0, the equilibrium in the market is at E_0 . With the lower full capacity of the port at F_0 , the congestion cost is larger ($P_0 - PT_0$), in spite of the smaller port tariff at PT_0 . If the port authority invests to expand the port capacity and upgrade port facilities, together with the new technology and management embodied and associated with the investment, the full capacity of the port increases to F_1 . The port tariff (horizontal) part of the supply curve may shift upward to recover the construction costs¹⁵, but the upward-sloping part of the supply curve, representing congestion, shifts rightward and downward. At the new equilibrium E_1 , both increase in the port tariff/charges and decrease in congestion costs take place. Only when the latter surpasses the former, this framework can consistently explain the negative coefficients of the port congestion.

Specifications and Data of the Trade Cost Regression: the U.S. Data

With the reference of the simple model illustrated above, we adopt the following specification for the regression model of the U.S. import charges per weight (equation (1)), which are similar

¹⁴ The users include the shipping companies, forwarders, and ultimately the traders of the goods. Due to our additional assumption of non-existence of rents by the shipping companies, the costs for the port service fully pass through to the importers without any mark-ups.

¹⁵ The port authority may take rent, in addition to the capital cost, due to the superior services created from the investment.

to Clerk, Dollar and Micco (2004). The source of the data is *U.S. Imports of Merchandise*, DVDs, unless mentioned otherwise. The estimation period is from 2001 to 2006, when the trade rapidly increased after the Economic Crisis and the congestion in the ports materialized.

$$\ln\left(\frac{TC_{ikt}}{Wgt_{ikt}}\right) = \alpha_0 + \sum_k \alpha_{1k} + \sum_t \alpha_{2t} + \alpha_3 \ln(dist_{it}) + \alpha_4 \ln\left(\frac{Value_{ikt}}{Wgt_{ikt}}\right) + \alpha_5 \ln(Wgt_{ikt}) + \alpha_6 Cnt_{it} + \alpha_7 PIndex_{it} + \varepsilon_{ikt} \dots \dots \dots (1)$$

where: TC_{ikt} : the amount of the import charge for the imports of the United States via vessels from country i for commodity k at 6-digit level, at the year t .

$dist_{it}$: bilateral distance between country i and the United States. The distance is calculated as the weighted average of the port-to-port liner distances between major ports in country i and Seattle, Los Angeles and New York, using the actual flows of container cargos in 1998 and 2003 as the weight (Shibasaki et. al. (2004)¹⁶). The distance estimated for 1998 is applied to the observations for 2001 and 2002, and that for 2003 is applied to those thereafter.

Wgt_{ikt} : the weight of the imports of the United States via vessels from country i for commodity k at 6-digit level, at the year t .

$Value_{ikt}$: the import customs value of the United States via vessels from country i for commodity k at 6-digit level, at the year t .

Cnt_{it} : the ratio of containerization, as the import weights via containerized vessels divided by those via all the vessels from country i at the year t .

¹⁶ The authors appreciate the kind provision of the data in the electronic form from Dr. Shibasaki.

$PIndex_{it}$: the indexes representing the efficiency / capacity of the ports of the exporter country i at the year t . Our primary indicator for the regression is the port congestion index, defined as the sum of the loaded and unloaded containers in TEU at the major container ports in the country i in the year t , divided by the sum of the estimated full physical capacity of the major container ports in the country i in the year t .¹⁷ This indicator reflects the ratio of utilization of the ports. The higher value of this index means the higher possibility of physical congestion in the ports. Accordingly, this index represents the supply curve drawn in Figure 2. For comparison purpose, we also test the port infrastructure quality index in *Global Competitiveness Reports (GCR)* and water transportation index in *The World Competitiveness Yearbook* of IMD (WCY).

α_{1k} : the dummy variables for controlling the commodity-specific fixed effects.

a_{2t} : the time dummy variables.

i : the exporting countries / regions in Asia Pacific region, consisting of each of ASEAN5 (Indonesia, Malaysia, Philippines, Singapore and Thailand), China, Japan, Korea, Hong Kong, Taiwan, Viet Nam, Australia and New Zealand.

Commodity-specific fixed effects and uniform time-varying factors across the country and commodity are assumed to exist in the regression. For the latter, time dummy variables enter the regression as explanatory variables, absorbing all the time-varying factors, such as changes in fuel prices and technological progress across the sectors and countries. All the independent variables appear to be exogenous, and we do not resort to the instrumental variable method, as is the case in the most of the existing studies.

¹⁷ See Appendix A for the detailed methodology of the estimation of the port capacities.

Results of the Trade Cost Regressions of the U.S.

Table 2 below summarizes the results of the regression. As the observations represent the detailed subdivision of the commodities, the estimated parameters do not reflect the variation of composition of the imported commodities among the exporting countries. With the time dummies in place, the regression reflects only the cross-sectional variation. The commodity specific effects are also controlled by the fixed effects. The variables of distance, value/weight and weight take the form in log, giving their elasticities. The containerization and port congestion indexes are in the form of ratio, and their estimated parameters represent the percentage change of import charge / weight, with respect to a point change in the indexes. Because of the lack of data on Viet Nam, the third specification uses fewer observations.

Table 2: Determinants of Trade Cost per Weight from Asia-Pacific Countries to the U.S.

<i>dependent variable: import charge / weight</i>			
<i>at 6-digits commodity level (log)</i>			
	(1)	(2)	(3)
<i>distance (log)</i>	0.2470 (10.84)***	0.0835 (3.61)***	0.2105 (9.39)***
<i>value/weight (log)</i>	0.4873 (161.78)***	0.4909 (163.62)***	0.4908 (159.49)***
<i>weight (log)</i>	-0.0294 (-32.32)***	-0.0346 (-37.56)***	-0.0320 (-33.66)***
<i>containerization (share)</i>	-0.0281 (-15.25)***	0.0169 (10.96)***	0.0212 (12.71)***
<i>port congestion (index)</i>	0.0737 (18.45)***		
<i>Port Infrastructure Quality (GCR) (index = 1 - 7)</i>		-0.0747 (-33.95)***	
<i>Water Transportation (WCY) (Index = 1 - 10)</i>			-0.0517 (-28.00)***
<i>Numbers of Observations</i>	151249	151249	145600
<i>R²</i>	0.4057	0.4102	0.4111

(Source) Authors' estimates, using *U.S.A. Merchandise Imports DVDs*.

(Note) 1. Estimation period is from 2001 to 2006.

2. t-values in parentheses. *** significant at 1% , ** at 5%, * at 10%.

3. *GCR*: Global Competitiveness Report, *WCY*: World Competitiveness Yearbook.

4. For a reference purpose, the port congestion index in the regression is multiplied by a factor of 5000. This does not affect the significance of the estimates.

The first specification, using our port congestion index, takes the values of parameters on distance, value/weight, weight and containerization ratio generally within the comparable range to the existing empirical studies.

Our port congestion index takes a significantly positive coefficient. This is the expected result by our partial equilibrium framework, illustrated in Figure 2 above. The estimated value implies that the expansion of port capacity by 19 percent in China, which is the annual average growth rate of the estimated port capacity from 2001 to 2006, would *ceteris paribus* reduce the international transport cost, measured by import charge, by 2 percent.

The other two indicators of port performance reflect opinion survey results. The *GCR* port infrastructure quality index reflects the responses on what degree port facilities and inland waterways in a country are developed, and the *WCY* water transportation index reflects the responses on to what degree water transportation (harbor, canals, etc.) meets business requirements. These indicators reflect the perceptions of the respondent executives in a particular country and generally cover a wider range of the scope than simply physical congestion of ports. Both of these indicators have significantly negative coefficients in the second and third

specification of the regression, as expected. The estimated parameter on the *GCR* index, -0.074, is about double to that estimated by Clark, Dollar and Micco, -0.043, while there is difference in the *GCR* indexes with the latter being a discontinued index of the “port efficiency”.

A one point increase in the port infrastructure quality index of the *GCR* would reduce transport cost by 7.4 percent. However, no country/region in our Asia Pacific sample could achieve the improvement as large as one point in this index between 2001 and 2006. The third specification using water transportation index of *WCY* results in similar estimates.

Comparison and Correlations between the Indexes on Ports

The three indicators on ports used above should reflect information overlapping each other. Table 3 shows the correlations between the three indicators and the port efficiency measures by Blonigen and Wilson (2008)¹⁸ from 2001 to 2006.

Table 3: Correlations between the Indexes on Ports

	<i>Port Congestion</i>	<i>Port Infrastructure</i>	<i>Sea Transportation</i>	<i>Port Efficiency</i>
<i>Port Congestion</i>	1.00	--	--	--
<i>Port Infrastructure (GCR)</i>	-0.16	1.00	--	--
<i>Sea Transportation (WCY)</i>	0.02	0.92	1.00	--
<i>Port Efficiency (BW)</i>	0.29	-0.63	-0.47	1.00

(Source) Port Congestion: Authors’ calculation based on *Containerization Yearbooks*. Port Infrastructure: *Global Competitiveness Report*. Sea Transportation: *World Competitiveness Yearbook*. Port Efficiency: Blonigen and Wilson (2008).

¹⁸ The journal article only puts a table showing a measurement averaged throughout the years from 1991 to 2003 on each foreign port. We take simple averages of ports in a country to obtain the index of the country, and assume the port efficiency measurements do not change over time from 2001 to 2006 to calculate the correlations in Table 5.

Our port congestion index partially correlates to the port efficiency measurement by Blonigen and Wilson. No significant correlation, however, is found with the indexes from *GCR* and *WCY*. Our port congestion index represents narrowly-defined physical congestion / utilization of ports and possibly some rents from the higher demands and technical efficiency. The other two indexes reflect survey opinions that reflect much a much wider scope and perceptions. Our index does correlate to the port efficiency index by Blonigen and Wilson which is supposed to cover all port-related costs incurred by transporters, because it is the value of the port-specific fixed effects. The indexes from *GCR* and *WCY* also correlate to the port efficiency index, showing that both of the indexes also contain information on the costs on ports.

If the port efficiency measurement of Blonigen and Wilson is regressed on our port congestion index, time dummies and constant, the estimated coefficient of our index is 0.049, significant at the 1 percent level. The regression can explain around 15 percent of the total sum of the squares. For the same example above, the expansion of port capacity by 18 percent for China in 2006 will brings about the fall in the port efficiency measurement by 1.3 percent. Because the port efficiency index is measured in terms of fixed effects in the regression of import charges, its fall by 1.3 percent just means the fall in import charges by the same percentage. The estimated results regression (1) implies that the same shock will bring about the fall in import charge by 2 percent. These comparable results from the two difference approaches reinforce the plausibility of our estimates.

Specifications and Data of the Trade Cost Regression: the Japanese Data

The same theoretical formulation as above can be applied to estimate the impacts of the port infrastructure improvement to trade costs by using the Japanese data. However, the constraint of the data in Japan to only the aggregated country level without the commodity and modal subdivision requires to the imposition of the various controls in regression. The estimation period covers from 1996 to 2006. The adopted specification for the regression is as follows in equation (2):

$$\ln\left(\frac{TC_{it}}{Wgt_{it}}\right) = \beta_0 + \sum_t \beta_{1t} + \beta_2 \ln dist_{it} + \beta_3 \ln\left(\frac{Value_{it}}{Wgt_{it}}\right) + \beta_4 \ln dist_{it} \ln\left(\frac{Value_{it}}{Wgt_{it}}\right) + \beta_5 \left(\frac{AirValue_{it}}{Value_{it}}\right) + \beta_6 \frac{Wgttnk_{ik}}{Wgt_{it}} + \beta_7 PIndex_{it} + \beta_8 HKdummy + \mu_{ikt} \dots \dots \dots (2)$$

where: TC_{ikt} : the amount of the transport costs imported by Japan, estimated by imports in CIF value subtracted by imports in FOB value.

$dist_{it}$: bilateral distance between country i and Japan. The same method as the U.S. data is applied to adjust the distance in 1998 and 2003. The distance estimated for 1998 is applied to the observations from 1996 to 2002, and that for 2003 is applied to those thereafter.

Wgt_{it} : the weight of the imports of Japan from country i , including both the shipments via vessels and air, at the year t .

$Value_{it}$: the import customs value in FOB value of Japan from country i at the year t .

$Airvalue_{it}$: the import customs value in FOB value of Japan via air shipping from country i at the year t . This divided by $Value$ makes the ratio of air shipment in value to be used to control the air shipments.

$Wgttnk_{it}$: the weight of the imports of Japan from country i with the HS codes from 25 to 27 at the year t . The range of the code covers stones, cement plaster, ores, slag, mineral fuel, oil, and so on. These bulky goods are normally transported by tankers or tramps. This divided by Wgt makes the ratio of bulky goods shipments in weight to be used to control the bulky goods shipments.

$PIndex_{it}$: the indexes representing the efficiency of the ports of the exporter country i at the year t . We use our port congestion index, the infrastructure index in GCR , and the water transportation index in WCY . In addition, the port efficiency measurements by Blonigen and Wilson is used in this regression of Japanese data to test this measurements estimated from the U.S. data.

β_{It} : the time dummy variables to control the effects of time-varying factors throughout the countries, such as the fuel prices, exchange rates and overall technological progress.

β_{st} : the dummy variables for controlling the extraordinarily large trade costs estimated for the data in Hong Kong from 2003 to 2006.

i : the importing country/region to Japan, including each country of ASEAN5, China, Korea, Hong Kong, Taiwan, Viet Nam, United States, Canada, Australia and New Zealand.

As indicated above, we control shipments via air; and those of bulky commodities of HS#25-27, to single out the effects of the improvement of ocean container port capacities. The interaction variable, distance in log times value per weight in log, is included in the regressors to control the special geographical feature in Japanese imports, namely, the remote countries across the Pacific

Ocean, such as Australia and Canada, are rich in natural resources and materials, and tend to export the bulky goods via cheaper transportation¹⁹.

Results of the Trade Cost Regressions of Japan

Table 4 below summarizes the result of the regression (2). The four columns in the table correspond to the uses of each indicator on ports. The estimation periods in some cases differ from the others, due to the availability of the indicators. The estimated parameters in regression (2) have a different implication from those of the U.S. These parameters measure the effects from the difference across the countries and years in the composition of the traded commodities, as well as those from the difference in the various factors across the countries and years for each commodity. In contrast, the regressions on the U.S. data on these parameters measure the latter, only. In coherence with this, the dependent variable, trade cost per weight, covers all the imports, inclusive of those via vessel and air.

Table 4: Determinants of Trade Cost per Weight from Asia-Pacific Countries to Japan

¹⁹ We have also tested the containerization ratio both in values and weights, but they do not have significant coefficients in most of the specifications.

<i>dependent variable: (imports CIF - imports FOB) / weight in total imports from the country (log)</i>				
	(1)	(2)	(3)	(4)
<i>distance (log)</i>	0.2850 (1.25)	0.8114 (2.21)**	1.0075 (3.05)***	0.4602 (2.04)***
<i>value/weight (log)</i>	1.6799 (4.32)***	2.6419 (4.44)***	2.8732 (5.39)***	1.9797 (5.21)***
<i>distance (log) * (value / weight) (log)</i>	-0.0835 (-1.73)*	-0.1900 (-2.57)**	-0.2231 (-3.37)***	-0.1278 (-2.66)***
<i>air shipment share</i>	1.3533 (7.43)***	1.5265 (6.25)***	1.5595 (6.62)***	1.6731 (8.46)***
<i>HS25-27 share</i>	-0.4155 (-2.30)**	-0.2691 (-1.23)	-0.3932 (-1.88)***	-0.6320 (-3.29)***
<i>port congestion (index)</i>	0.0737 (1.90)**			
<i>Port Infrastructure Quality (GCR) (index = 1 - 7)</i>		-0.0518 (-1.61)*		
<i>Water Transportation (WCY) (Index = 1 - 10)</i>			-0.0760 (-2.82)***	
<i>Port Efficiency (BW)</i>				0.9277 (3.38)***
<i>Numbers of Observations</i>	153	83	103	153
<i>Estimation period</i>	1996 -2006	2001-2006	1999-2006	1996 -2006
<i>R²</i>	0.9693	0.976	0.9722	0.971

(Source) Authors' estimates, using *Balance of Payments, Customs Statistics* of Japan.

(Note) 1. t-values in parentheses. *** significant at 1% , ** at 5%, * at 10%.

2. GCR: Global Competitiveness Report, WCY: World Competitiveness Yearbook. BW: Blonigen and Wilson (2008).

3. For a reference purpose, the port congestion index in the regression is multiplied by a factor of 5000 .

This does not affect the significance of the estimates.

The variables generally take the expected signs, while insignificant parameters result in some cases. The coefficients on distance take the larger values, compared to the estimated in the existing studies at around 0.1 to 0.4. However, the interaction term may adjust it. The average values of the value/weight variable (in log) of the trading partners to Japan are 4.3 for ASEAN5,

4.8 for China, 4.6 for Korea and 4.8 for the United States, but only 3.6 for Canada and 2.3 for Australia. Taking the values of the interaction terms in calculation, the elasticity of the distance is almost zero for the neighboring countries to Japan, but 0.1 to 0.4 for Canada and Australia, being in the remote location.

The value/weight variable takes the coefficients larger than one. However, as discussed above, the estimated parameters reflect the variation of the compositions of commodities and modals across the countries. Again, taking the interaction term into consideration, with the average value of the distance variable in log around 7.7, the elasticity of the value/weight would be around one on average, and certainly less than one for the remote countries. A percentage point increase in the shares of air shipments in value increase the total trade cost by 1.4 – 1.7 percent, reflecting higher freight charge by air. A percentage point increase in the share of the specific bulky goods with HS 25-27 in volume decrease the total trade cost by 0.3 – 0.6 percent, reflecting lower charges for the modals to transport these goods, normally tankers and tramps²⁰. In sum, controlling the difference in composition of commodities appears to work well, if not perfectly.

The estimated coefficients on the indicators on ports in the Japanese trade cost regression take the expected signs. Their values resemble those obtained from the regression using the U.S. data. However, the estimated coefficients here represent the impacts on total transport costs including those both via vessel and air. If the factors represented by the port indicators affect the air transport costs to lesser degree than ocean transport costs, the estimated coefficients of the port

²⁰ The ocean shipments costs considerably vary among the modals: the freight charges per ton for Japanese imports are 9,785 yen for liner, 1,872 yen for trampers, and 1,308 yen for tankers (*Maritime Affairs Report 2004* by Ministry of Land, Infrastructure and Transport of Japan).

indicators here should be naturally smaller than those on the U.S. The coefficient of our port congestion index takes exactly the same number as the U.S. regression. If we assume no impact of the port congestion on the air transport costs, one percentage reduction in our index is estimated bring about a 0.10 percent reduction in the ocean transport cost.²¹ The indexes of port infrastructure quality of *GCR* and sea transportation of *WCY* result in a bit smaller than the U.S. regression. Port efficiency by Blonigen and Wilson takes a bit less than one. Overall, the estimated coefficients on the port indicators for Japan are consistent with those in the U.S. regression, except for our port congestion index with a somewhat stronger impact on total transport costs.

Table 1 in the former section shows that *Ad valorem* trade costs are generally higher in Japan than the U.S., except for the imports from Indonesia and Australia. Due to the difference of the compositions of the imported commodity and modal aggregation in the data, we cannot directly compare the regressions between the U.S. and Japan. However, the comparison of the values of the explanatory variables in the regressions may give several possible explanations. For example, for the *Ad valorem* trade costs between the export and import of the pair of the United States and Japan in 2001-2006, their average difference is 1.65 in terms of natural logarithm. The air shipment ratio recorded 0.5118 for the import of Japan from the U.S., but only 0.2405 for that of the U.S. from Japan. This large gap should contribute about 0.4 ($= (0.5118 - 0.2405) \times 1.3533$) to the difference in trade cost. In addition, the value / weight ratios in log are 4.845 and 4.486 for

²¹ The port congestion index is considered here as a real functioning variable, not a proxy of general infrastructure level. This prorating calculation is based on the following data: (i) the value of air shipments takes a 38 percent share in the total imports of Japan; and (ii) the *Ad valorem* trade costs for air and ocean shipping are 3 percent and 5 percent, respectively, in U.S. imports data.

the U.S. and Japan, respectively²². As the elasticity of this ratio, after reflecting the interaction term, is around one, this factor would also contribute about 0.4 ($= (4.845 - 4.486) \times 1$) to the difference. This observation suggests that about 0.8 ($= 0.4 + 0.4$), about the half of the difference in *Ad valorem* trade cost should be attributed to the difference in transportation modals and composition of imported commodities and their prices. The remaining difference, mainly coming from the difference in the parameters, may be probably due to the preference of Japanese importers to the speed and quality of the transportation, provided by liners, airs and container cargos, for the higher-priced goods.

4. Benefits of Port Infrastructure Improvement in East Asia

What are the benefits from the Port Construction?

With a considerable surge in demand for exports and imports, port authorities in the developing countries in East Asia rapidly expanded the capacity of their container ports in the 2000s. However, serious congestion remains. Our regression analysis suggests that the expansion of port infrastructure would *ceteris paribus* reduce the import charges / trade costs, ultimately paid by the importers. In turn, reduction in the transport costs may lead to an expansion of trade through the ports. The consumer surplus for the importers should increase.

The partial equilibrium framework illustrated in Figure 2 above helps consider what happens to the welfare of the port users and port authorities. In the diagram, the increase in welfare is brought about by the decline of the port-related total transport cost from P_0 to P_1 . The decline in

²² The measurement units are adjusted to yen per metric ton.

the costs for port services is to pass through to the reduced charges of the international transportation services, such as forwarders, to the traders, which are recorded by the import charge statistics as import charges.

A hypothetical policy simulation can assess the net benefit of port capacity expansion in East Asia in terms of percentage change in trade costs. In our partial equilibrium framework, the net welfare gain due to the expansion of the port capacity equals to the sum of: (i) the increase in consumer surplus (the trapezium $P_0 P_1 E_1 E_0$) and (ii) increase in the profits of port authorities, namely, port tariff revenue net of the marginal capital and operation costs from the expansion.

The increase in consumer surplus can be estimated by means of the transport cost regressions undertaken above. The policy assumptions on the capacity expansion of the ports will imply the target point change of our port congestion index. Multiplying these point changes with the estimated coefficient of the index, around 0.0737, gives the estimates of percent changes of transport costs. As actual transport costs are largely unobservable, except for U.S. and Japan, the amount of gain in consumer surplus can only be measured in terms of these percentage changes in transport costs²³. This correspond to a rectangular, instead of trapezium $P_0 P_1 E_1 E_0$, ignoring the small remaining triangle, giving an acceptable approximation. One should note that the consumer surplus in the framework, as well as the estimated gains in the consumer surplus, is affected by the costs caused by the congestion and port tariffs and other charges²⁴.

²³ However, we may obtain a rough idea of the consumer surplus, if we assume some plausible number as Ad valorem tax-equivalent transport costs on import prices, for example, at 30 percent.

²⁴ The shipping companies and forwarders are assumed to pass on all the costs in ports to the importers, which are recorded as the import charges in the official statistics.

As for the increase in the profits of port authorities, we adopt a compromising assumption that the net profit is zero. This means that “exact” cost recovery applies. This compromise is the lack of systematic, consistent and comprehensive data, to estimate the increase in nominal revenues from port tariffs and other charges, and that of the capital costs for construction and upgrade of the port infrastructure to expand their capacity. The financial management of the ports authorities in East Asian developing countries appears to perform very well, evidenced by their aggressive expansion plans²⁵. More than full cost recovery without government subsidy has appeared to prevail. In this situation, the exact cost recovery may be acceptable, as a modest assumption.

The Baseline Policy Scenario and its Impacts on Transport Cost

We set a policy scenario on the expansion of the capacity of the major ports in the developing countries in East Asia. Table 5 below shows the impacts on the transport costs for the import of the countries under our baseline scenario. Our policy scenario is such that the port capacity in the developing countries in East Asia is invariably expanded by 10 percent.

Table 5: Impacts of Port Capacity Expansion on Transport Cost: Baseline Scenario

²⁵ For example, an expansion plan of Honk Kong assumes the financial rate of return at as high as 14 percent.

	<i>Transport Cost of Imports (%)</i>		
	<i>Total</i>	<i>Unloading</i>	<i>Loading</i>
<i>Indonesia</i>	-1.38	-0.76	-0.62
<i>Malaysia</i>	-1.32	-0.82	-0.50
<i>Philippines</i>	-2.47	-2.07	-0.41
<i>Singapore</i>	-1.76	-1.39	-0.37
<i>Thailand</i>	-1.37	-1.05	-0.32
<i>China</i>	-1.40	-1.20	-0.20
<i>Japan</i>	-0.42	–	-0.42
<i>Korea</i>	-0.24	–	-0.24
<i>Hong Kong</i>	-2.66	-1.91	-0.75
<i>Taiwan</i>	-1.27	-0.97	-0.29
<i>Viet Nam</i>	-1.65	-0.82	-0.82

(Source) Authors' estimate. The Baseline Scenario assumes the expansion of port capacity by 10 percent for the developing economies in East Asia.

Under the scenario, highly congested ports, such as those in Philippines, Honk Kong and Singapore, will find considerable improvement. The third and fourth columns show the simulated impacts on the transport costs on imports of the economies in the table. This estimate assumes that all the economies take transport cost function invariably taking the following form:

$$\begin{aligned} \ln TradeCost_{ij} &= \ln(Freight_{ij} + Insurance_{ij} + others_{ij}) = f(\dots) + port\ cost_i + port\ cost_j \\ &= g(\dots) + \gamma_1 PIndex_i + \gamma_2 PIndex_j \end{aligned} \quad \dots (4)$$

Where $f(\dots)$ and $g(\dots)$ represent functions, taking the explanatory variables in regression (2) and (3), except for the $PIndex$. Subscripts i and j denote the exporting and importing countries.

The specification (4) generalizes the stipulation of (2) and (3) by including the costs incurred to the traders both in exporting and importing ports (i.e. variables $portcost_i$ and $portcost_j$, or $PIndex_i$ and $PIndex_j$, more specifically). We have added somewhat bold assumption that γ_1 and γ_2 take the same value that is equal to what is estimated in regression (2) and (3). The numbers in the

second column represent the impacts on the transport costs for import of the countries in terms of the percentage change, consisting of the cost-reducing effects in both from (i) their own ports for unloading (the third column) and (ii) the ports of their trade partners for loading (forth column).

The estimated reduction in the transport costs of imports ranges from one half to nearly three percent. The impact is significant. For example, one may recall that the leaders of Asia-Pacific Economic Cooperation in 2001 committed to implementing the APEC Trade Facilitation Principles (Shanghai Accord) with a view to reducing trade transaction cost by five percent by 2006²⁶. The transaction cost defined in the Accord covers the wider scope of trade cost than the narrowly-defined international transport cost, but the latter represents a significant proportion of the former, around one third²⁷. The estimated impacts of the Baseline Scenario would enable several APEC members to meet even one sixth of the target of the Accord .

Moreover, if we assume that the international transport costs are 20 percent *Ad valorem* tax-equivalent on import prices for all the countries at the modest side, the cost reduction effect is from 0.3 to 0.5 percent of the import prices among the developing economies in East Asia. This cost reduction effect is equivalent to the across-the-board tariff reduction, covering all the

²⁶ The Accord include a text as follows: Leaders instruct Ministers to identify, by Ministerial Meeting in 2002, concrete actions and measures to implement the APEC Trade Facilitation Principles by 2006 in close partnership with the private sector. The objective is to realize a significant reduction in the transaction costs by 5% across the APEC region over the next 5 years.

²⁷ Anderson and van Wincoop (2004) illustrates that the representative international trade costs for industrialized countries is 74 percent in terms of *Ad Valorem* tax equivalent. This number breaks down, as 21 percent of transportation costs, and 44 percent of border-related trade barriers. The transaction costs defined in the Accord may cover the first break-down and some of the second and the third. With this, the transportation costs are around one third of the international transaction costs in total.

imported commodities. As the Baseline Scenario can be realistically achieved, port investment provides an effective tool for trade facilitation.

5. Implications

The analysis in this paper suggests the following conclusions. First, port congestion for trading partners in East Asia has significantly increased transport costs for imports from both the United States and Japan. An increase in exports played an important role for these economies to achieve the post-crisis recovery in the 1990s, however infrastructure bottlenecks posed a serious obstacle to recovery in 2000s.

Second, the expansion of the port capacity under our baseline scenario, which is rather modest, to expand the port physical capacity by 10 percent suggests that transport costs in East Asia could decline by one-half to three percent. If transport costs constitute about 20 percent *Ad valorem* tax-equivalent on the import price, the effect is about a 0.3 to 0.5 percent across-the-board cut in tariffs. As this is a recovery of pure loss and technological progress, the welfare gains could be substantial. Third, port authorities in the region could achieve full cost recovery, evidenced by their aggressive investment to expand capacity. Although based on anecdotal evidence, trade cost reductions could far outweigh the cost for physical expansion of the ports in the developing economies in the region.

We may draw four implications from the analysis. First, port infrastructure improvement could provide very good opportunity for trade liberalization and facilitation for the region. In particular, the economies of Singapore and Hong Kong, where tariff rates are virtually zero, will be able to

proceed with further trade liberalization and facilitation by expanding and improving their port facilities. Second, as port infrastructure projects are economically viable long-term investments, private-sector participation in the projects could be a major vehicle for finance, such as through Private Public Partnership. Third, active investment in the region could bolster economic recovery over time in East Asia. Since the investment in port infrastructure can be justified and viable to reduce the bottleneck even in the period of recession, this will provide a useful tool for the governments in the developing economies both in the macroeconomic demand and supply terms. Forth, the nature of the effect of port infrastructure improvements is equivalent to across-the-board uniform tariff reductions. As such, importing countries would suffer less from trade diversion and port investment may face less serious resistance in a public policy context.

(References)

Abe, K. and Wilson, J. S. (2008), *Journal of International Economic Studies*

Anderson, J. and van Wincoop (2004) "Trade Costs," *Journal of Economic Literature*, vol.XLII, pp.691-751.

Bank of Japan (2005) "Revision of Compilation Methodology for Balance of Payment Statistics on Sea Freight Fares and Freight Insurance Premiums," at the home page of the Bank of Japan.

Blonigen, B. and Wilson, W. (2008) "Port Efficiency and Trade Flows," *Review of International Economies*, vol.16(1), pp.21-36.

Clark, X., Dollar, D. and Micco, A. (2004) "Port Efficiency, Maritime Transport Costs and Bilateral Trade," *NBER Working Paper Series*, No. 10353.

Simeon, D, Freund, C. and Pham, C. S. (2008) "Trading on Time," *Review of Economic Studies*.

Helbel, M., Sheperd B. and Wilson, J. (2007) *Transparency and Trade Facilitation in the Asia Pacific: Estimating the Gains from Reform*, Asia Pacific Economic Cooperation and the World Bank.

Hummels, D. (2007) "Transportation Costs and International Trade in the Second Era of Globalization," *Journal of Economic Perspectives*, vol.21 (3), pp.131-154.

Hummels, D. and Lugovskyy, V. (2006) "Are Matched Partner Trade Statistics a Usable Measure of Transportation Costs?" *Review of International Economics*, vol.14 (1), pp.69-86.

Limao, N. and Venables, A.J. (2001) "Infrastructure, Geographical Disadvantage, Transport Cost, and Trade," *The World Bank Economic Review*, vol.15 (3), pp.451-479.

Appendix: Construction of Port Congestion Index

The index to compile is aimed to examining the effect of the physical investment of the ocean container-specialized port facilities on the trade costs. As stipulated in the fourth section in the main text, the capacity of the port directly affects the costs for its services in two aspects: the first is through the port tariffs and other charges for the unloading and loading services, and the second is the time costs due to the congestion. The expansion of the port capacity is accompanied by higher tariffs and charges, but lower degrees of congestion and waiting time for the movement of goods.

We have compiled an index of port turnover , defined as the sum of the loaded and unloaded containers in TEU (Twenty-foot Equivalent Unit) at the major container ports in the country i in the year t , divided by the sum of the estimated capacity of the major container ports in the country i in the year t . Table below summarizes the ports referred to in the compilation of the index, together with the actual throughput and estimated port capacity of each port, and estimated port congestion turnover index for the country/economy. The numerator of the congestion index reflects the actual throughput of the major ports reported in the issues of *Containerization Yearbook*. The same reference is used to estimate the capacity.

The estimate of the port capacity builds on only the physical magnitude. We put the following assumption on the full physical capacity of the port, based on the numbers and depths of the berths: The berths with 14 meters or deeper in depth can accommodate the vessel with 6000 TEU. The vessels use up 250 meters of the berth. The births with 13 meters in depth can accommodate the vessels with 3250 TEU, using up 200 meters of the berth. Those with 12 meters in depth, the

vessels with 1750 TEU, using up 150 meters of berth. Those with less than 10 meters in depth, 500 TEU, using 100 meters and less of berth. Combination of various sizes of vessels are applied to maximize the estimated capacity the port can accommodate at once.

Table: Throughput, Port Capacity and Congestion Index of Major Ports in East Asia

<i>Country/Economy</i>	<i>Port Name</i>	<i>Throughput in 2006 (A)</i>	<i>Port Capacity in 2006 (B)</i>	<i>Tureturnover in 2006 (=A/B)</i>	<i>Tureturnover in 2003 (=A/B)</i>
<i>Indonesia</i>	<i>Tanjong Priok</i>	3280	56	56.7	67.2
	<i>Tangjong Perak</i>	1798	34		
<i>Malaysia</i>	<i>Port Klang</i>	5946	124	61.2	60.6
	<i>Tangjong Pelepas</i>	4480	47		
<i>Philippines</i>	<i>Manila</i>	2853	19	154.2	137.9
<i>Singapore</i>	<i>Singapore</i>	22780	220	103.4	83.9
<i>Thlailand</i>	<i>Bangkok</i>	1535	18	78.3	67.5
	<i>Leamchabang</i>	3984	53		
<i>China</i>	<i>Dallian</i>	3120	54	89.5	105.1
	<i>Guangzhou</i>	6403	114		
	<i>Ningbo</i>	6827	56		
	<i>Qingdao</i>	7608	90		
	<i>Shanghai</i>	21280	121		
	<i>Shenzhen</i>	17881	312		
	<i>Tianjin</i>	5788	51		
	<i>Xiamen</i>	3867	17		
<i>Japan</i>	<i>Chiba</i>	48	2	32.8	31.7
	<i>Hakata</i>	705	18		
	<i>Hiroshima</i>	205	8		
	<i>Kawasaki</i>	46	9		
	<i>Kitakyushu</i>	511	21		
	<i>Kobe</i>	2390	103		
	<i>Nagoya</i>	2632	62		
	<i>Osaka</i>	2237	74		
	<i>Shimizu</i>	564	26		
	<i>Tokyo</i>	3498	68		
	<i>Yokohama</i>	2793	87		
<i>Korea</i>	<i>Busan</i>	11933	203	57.3	81.9
	<i>Inchon</i>	1215	27		
<i>Hong Kong</i>	<i>Hong Kong</i>	22893	161	142.6	174.0
<i>Taiwan</i>	<i>Kaoshiung</i>	9569	132	61.5	57.7
	<i>Keelung</i>	2113	34		
	<i>Taichung</i>	1204	44		
<i>Viet Nam</i>	<i>Danan g</i>	36	3	72.7	234.4
	<i>Haiphong</i>	614	3		
	<i>Hochiminh</i>	2023	32		

(Note) Throughput and Capacity is in 1,000 TEU in a year.

The index is in terms of ratio The higher the ratio is, the more the costs of congestion are, and the more changes to force the traders the waste of time. The index builds on the major ports in East Asia, which conduct most of the international trade. In this sense, this index should not regarded as proxy.