# A Strategic Model of Competition among Container Ports in Northeast Asia

December 2006

Yong-An Park
Research Fellow of Korea Maritime Institute

Christopher M. Anderson
Professor of University of Rhode Island

Yong-Seok Choi
Professor of Sunchon National University

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# Abstract

As national economies globalize, demand for intercontinental container shipping services is growing rapidly, providing a potential economic boon for the countries and communities that provide port services. The promise of permanent well-paying jobs at ports, complementary hinterland transportation services, and possible export-related economic development, as well as temporary jobs in port construction, draws many community leaders to propose investing considerable public resources in port development, with the belief that if they build a port there will be shippers to use it. Because successful large, hub ports (planned to accommodate new ultra-large container ships) generate the most economic activity, developers are eager to focus most of their efforts on these investments. While unprecedented recent economic activity in Asia has largely filled available ports, in other parts of the world the race to build has lead to overcapitalization of port resources and significant losses of public funds; the port boom in Asia could lead to similar losses if economic growth slows.

Our broad objective is to assist planners in determining whether they can capture and profitably defend their shipping market share as a hub port, traditional land-sea cargo port, or regional feeder port. While this is a long-term research program, in this short-term project we developed a game theoretic investment model for oligopoly transshipment container market of competitive assets between two ports and apply it by benchmarking possible actions, game parameters and payoffs based on a competition between Busan and Shanghai.

This project draws attention to the importance of understanding that investments to gain market share may be responded to by investments from competing ports. As a result, projections of demand or profits based on an unresponsive competitor, may overstate the potential return from the original investment. This will help Korean ports identify the investments that will be most appealing to customers, and which will help capture market share which can be most easily defended from competitor ports.

We propose to approach our objective through three phases. The first phase focuses on the first two objectives: identifying ports to study and their strategic development opportunities. Phase II is the development of the game theoretic model for an oligopoly transshipment container market. Phase III involves prediction of demand by each port under combinations of future development scenarios, yielding payoffs in the game model, which will be applied to identify likely outcomes of the game as a result of Nash equilibrium.

Given the present circumstance in which Shanghai has invested and Yanghsan is operating, the relevant question is whether Busan should continue with their planned investments.

Busan could have chosen to unilaterally reduce their prices, including the downtown terminals. However, according to Nash Equilibrium outcomes, investments will cost much more than return in benefit for Busan to recapture its market share. To retain some market share they would reduce the price they charge on all the business still using the port. Thus, a price change alone is not a good idea; it would result in too big a reduction in revenues from market share that is not vulnerable to switching over to Shanghai.

Despite this prediction, it is known that Busan has invested heavily in Busan Newport. How should this action be interpreted given the strategies represented in the game? Within the narrow context of this analysis, this would seem to be a mistake since labor costs cannot be driven down as low as Yangshan's, and productivity standards cannot significantly exceed Yangshan.

However, there are important limitations to this analysis that restrict the scope of its conclusions. Specifically, the focus on only the transshipment cargoes originating from northern Chinese ports limit the recommendation to Busan not undertaking massive port expansion in order to defend marginal market share from Shanghai's expansion plans, whether Shanghai's plans were strategically wise or not.

There are other important markets for which Busan might compete with a port that is larger, faster and lower cost than the downtown Busan terminals, yet which might not be as cheap for certain cargoes which have traditionally used Busan. Thus, development efforts, and efforts to study potential future markets, should focus on these other markets, rather than on vulnerable segments of their traditional transshipment market.

When deciding whether, and which, continued investments are most advisable, it is important to be strategic about which markets are being pursued, developed and defended. This analysis suggests that it would be very costly, and not profitable on net, to pursue defense of all transshipment cargoes that have been recently lost to Shanghai's low-cost Yangshan terminal. Rather, development efforts should focus on those markets that yield greater differences in value between the two hub ports, and therefore are less vulnerable to capture by a lower cost port operation in a country with very low labor costs.

The scenarios evaluated here also illustrate potential value to cooperative strategic development. Specifically, they show that an outcome that is sometimes an equilibrium of the port investment game, and a plausible one at that, is a massive joint investment between both ports that has little effect on market share or causes both ports to lose money. This corresponds to the "both ports investing" cell of the game table in the "Reduction in Turnaround Time" game. Cooperative development strategies, in which ports strategically divide transshipment markets by commodity or service, or simply to reduce the pace of port investment to ensure investment does not outstrip market demand, can avoid this situation.

High levels of joint investment would likely expand the overall market, since shipping would be cheaper for cargo routers, who in turn could charge shippers lower rates, reducing the costs associated with foreign production and increasing the quantity of final goods demanded. However, the resulting increase in overall market size is probably small relative to the investments being considered. If market growth is the basis on which speculative investment is undertaken, investment in additional research into the potential for market expansion in response to changes in shipping prices would be advisable.

This analysis is also limited in that it looks only at a portion of the economic benefits ports provide. First, it considers only transshipment business from northern Chinese exports to US and European markets. While this is a large volume and valuable business, it accounts for only about a 1/3rd of Busan's total transshipment volume. Even investments primarily targeted at this market segment may have benefits for other market segments, which are not accounted for in this analysis. This could be a particularly large factor for Shanghai, who may see growth in shipping from South Asia, especially Southern China. Thus, their investment strategy could be targeted at that market, with some associated benefits for their ability to service northern China ports.

Second, this analysis considers only port revenues as a benefit. From a regional economic standpoint, it may be sensible to consider port volume to have a multiplier effect, so that the success of a port does not depend only port revenues exceeding port costs: ports provide jobs and generate a lot of associated economic activity regardless of just how profitable the port is run. However, it is important to have an accurate assessment of the scale of these benefits so the costs associated with port investment, and the additional port benefits received, can be considered; faith that all port investment will yield high returns is a recipe for making unprofitable investments.

A direction for future research is to expand the set of strategies of each port beyond investment or non-investment. In reality, a wide range of strategies might have different effects on different sub-markets targeted by the ports, can be adopted. In addition, each strategy might be adopted at several levels. This may be particularly important as Busan seeks to identify markets that can be easily defended against the low cost of labor at Shanghai.

# Ⅰ. Introduction

## 1. Necessity

As national economies globalize, demand for intercontinental container shipping services is rapidly growing, providing a potential economic boon for the countries and communities that provide port services. The promise of permanent well-paying jobs at ports, in complementary hinterland transportation services, and possible export-related economic development, as well as temporary jobs in port construction, draws many community leaders to propose investing considerable public resources in port development, under the belief that if they build a port, there will be shippers to use it. Because successful large, hub ports (planned to accommodate new ultra-large container ships) generate the most economic activity, they are the focus of most investment efforts. While unprecedented recent economic development in Asia has largely filled available ports, in other parts of the world this race to build has lead to overcapitalization of port resources and significant losses of public funds (e.g., Cyprus); the port boom in Asia could lead to similar losses if economic growth slows.

## 2. Purpose

Our broad objective is to assist planners in determining whether they can capture and profitably defend their shipping market share as a hub port, traditional land-sea cargo port, or regional feeder port. While this is a long-term research program, within this short project, we developed a game theoretic investment model for an oligopoly transshipment container market of competitive assets between two ports and apply it by benchmarking possible actions, game parameters and payoffs based on a competition between Busan and Shanghai. Specifically, we

1) Identify development plans at Busan and Shanghai, and how each plans to defend its existing market share from development by the other port;

2) Develop a game theoretic model of competition between two container ports;

3) Apply the game theoretic model by determining the available development and market defense actions available to each port, and determining the payoffs to each port from each possible combination of actions.

While the resulting model of market entry and demand for port services will aid planners in determining the proper investment scale for new ports in a competitive environment, it may also help them determine whether there are additional gains from cooperative development, and in assessing the effects of service interruptions among existing ports, due to labor disputes, accidents, natural disasters or other events.

## 3. References

Port demand is a topic of broad interest, so it is not surprising that researchers have conducted studies with similar demand estimation methods to those we propose. However, we are aware of no studies that are as broad as ours, looking at more than small regions when considering port demand, or that seek to integrate demand analysis into a game theoretic framework.

There have been a number of (older) qualitative analyses of shipper behavior and route choice, which are useful in identifying key variables. For example Murphy and Daley (1992; 1994) conducted a survey of people at different points in the supply chain, and identified tracking information, loss/damage performance, cost, equipment availability and convenient pickup/delivery as being key variables. While this provides a starting point, all these variables may not remain important when looking only at containerized cargo. Bichou and Gray's (2005) review of terminology also provides a descriptive starting point for model variables.

In contrast to these qualitative studies, statistical analysis of actual port choice data using methods similar to those proposed for Phase I allows researchers to identify not only which factors are (statistically) important, but also to quantify their importance.

Discrete choice techniques were developed by McFadden (1974) to gauge demand for the Bay Area Rapid Transit train network around San Francisco, and popularized for transit demand research by Ben-Akiva and Lehrman (1985). Bierlaire (1998) provides a more recent summary of discrete choice approaches and their applications to transportation behavior analysis and forecasting. Winston (1981) conducted one of the first port choice models, using a multinomial probit analysis to predict the demand for domestic ocean container service. Tsamboulas (2000) uses a combination of statistical methods to correlate behavioral and perceptual factors related to the use of intermodal transportation with the physical and economic criteria to which modal choice approaches are usually confined.

Application of 'discrete choice' models of container transportation is relatively recent. Mainly because of the computational complexity of the problem, as the number of alternatives is relatively large and very detailed data about ports and shipments is required. Veldman and Buckmann (2003) use a logit model to quantify factors affecting cargo routing decisions, including transport cost, transit time, services frequency and indicators of service quality. Based on the estimation, they derived a demand function to be used for port traffic forecasting in four major ports around Rotterdam (Antwerp, Bremen and Hamburg). The estimated demand function was the basis for the economic and financial evaluation of a container port expansion project. However, this study did not consider the global source of the cargo, and it did not take adequate account of the variation of route selection behavior of different commodity types. For international shipping, liner rates will be an important factor in cost, and Brooks and Button (1996) provide a sense of determinants for shipping rates.

For the Asia-pacific region, Tiwari et al (2003) used a nested discrete choice method to analyze shipper's behavior for containerized cargo in China. This study modeled the port and shipping line choice behavior of shippers in China, using a shipper-level database obtained from a 1998 survey of containerized cargo shippers.

The model included 10 shipping line and port combinations as the total choice set, nesting the choice of ports within the choice of Chinese and non-Chinese shipping lines. This study indicated that the most important variables are the location of the port as expressed by sea transportation time and cost, land transportation time and cost, and port characteristics including number of ship calls, total TEU handled, TEUs of cargo per crane, TEUs per berth, usage factors (handling volume per length of quay), number of routes offered, and port loading charges.

Nir, Lin and Liang (2003) use a logit model to capture the distribution of export activity among Taiwan's three ports. They found that generalized measures of travel time and cost to the ports were significant. In contrast to Tiwari, et al., they found service frequency was not a significant factor. While they observed that ports are competitive, in that shippers do not always choose the port closest to them, the analysis does not capture the diversity of those choices.

Malchow and Kanafani use a logit (2001) and nested logit (2004) discrete choice models to analyze the distribution of maritime export shipments among US ports. This study selected four commodity-types (bulk materials, foods, fabrics and manufactured goods) in one month of PIERS data, exported to eight foreign countries, and eight US ports including Charleston, long Beach, Los Angeles, Port of New York, Oakland, Savannah, Seattle, and Tacoma. The variables in this model included both attributes that determine transit time and attributes that affect the total transit cost. In addition to the variables that were significant in other studies, they identified sailing headway (average time between sailings on a route at a particular port), cargo type and the probability of being the last port of call are significant factors in shipper choice.

A significant contribution of our project is that we are considering demand in the context of competition and strategic development. Competitiveness of container ports has been described and measured in a number of ways, including time series analysis, DEA and SFA methods, multi-criteria evaluation, survey of container ship operators and logistics managers, shift-share analysis and diversification indexes such as Herfindahl-Hirschmann. All of these measures are targeted at measuring the relative competitiveness of the port within the study region, which include Asia (Yap and Lam 2006; Ha 2003; Song 2002; Teng, et al. 2004) and Europe (Lambaerde and Verbeke 1989). However, these methods do not consider competitiveness in relation to its financing methods, cost recovery mechanisms, and impact on the port service quality and development. The discussion of these issues is available from Haralambides (2002). He discussed port competition and port overcapacity for different pricing methods under different financing structures, and argues marginal cost pricing is most appropriate to achieve cost recovery and fair competition among ports.

There are a number of analyses development models of competitive port aspects, but they typically consider infrastructure investment to be an exogenous market (rather than endogenous strategic) phenomenon (e.g., Nir, Lin and Liang 2003; Hanelt and Smith 1987). An exception is Zan (1999), who constructed a multi-level market game of port service prices, liner scheduling and pricing, and shipper liner choice. In the leader-follower game developed, the port administrator selects a level of infrastructure and port service prices, the shipper then sets routes, frequencies and transport prices, and shippers then select liners based on time and price. While this model is extremely detailed, and not a pure Stackelberg game as it is described (the players differ in role in the process, and are not simply competitors offering prices on substitute goods), it is one of the few applications of game theory to port service competition.

## 4. Differences from Preceding Study

Ensuring that public investment in port development actually leads to the intended increase in economic activity, and thus business and economic development, requires developing a careful plan for port and hinterland infrastructure. Key to developing that plan is understanding two factors: whether the proposed port has the features and services that will draw shippers to use it rather than other ports in the region, and whether there are actions (e.g., lowering prices or investing in their infrastructure to become more competitive) that incumbent ports can take to defend their market shares. While existing planning methods (focus groups, public meetings, user consultations) are well designed to plan facilities which will appeal to customers, the potential for responsive investment on the part of competitors is frequently not considered in the process, and the extent to which demand can shift is not well understood. Our project will develop a formal theoretical as well as an applied, data-driven model for integrating cargo transportation planning into strategic factors to determine investment in port infrastructure.

## 5. Policy and Expectations

This project will focus attention to the importance of understanding that investments in a port to gain market share may be responded to by investments from competing ports. As a result, projections of demand or profit based on an unresponsive competitor may overstate the potential return to the original investment. This will help Korean ports identify the investments that will be most appealing to customers, and help them capture market share which can be easily defended from competitor ports

# Ⅱ. Methodology

## 1. Task Descriptions

We propose to approach our objectives through three phases. The first phase focuses on the first two objectives, identifying ports to study and their strategic development opportunities. Phase II is development of the game theoretic model. Phase III will involve prediction of demand for each port under combinations of future development scenarios, which will yield payoffs for the game model, which will be applied to identify likely outcomes of the game from Nash equilibrium calculations.

## 2. Methodology

Phase 1: Identify competing ports and their strategic development opportunities. In this phase, we identify a Korean port and a non-Korean competitor port which are competing for container traffic in some segment of the market (e.g., common hinterland or transshipped cargo), and which are actively attempting to expand their market shares within that market segment. Market share expansion could take place through a variety of initiatives, including pricing; physical characteristics (e.g., berth size, channel depth); productivity measures (e.g., crane speed, number of cranes); the transportation infrastructure of the port's hinterland; and commodity-specific variables.

We will consult with industry experts and port officials to identify future development plans, and alternative plans that could be enacted to capture or defend market share.

In selecting Busan and Shanghai as our case study, we put particular emphasis on those ports that are focusing their development efforts on elements that appeal to shippers had been previously measured. We conceptualize our model in terms of a shipper's choice because our interviews with industry and port officials indicate shippers and expediters have considerable control of where shipments are loaded or unloaded, often even changing destination ports while containers are en route to save time. However, we recognize that there is variation in the industry as to who makes the actual routing decision between shippers who choose liners and thus routes, or liners once they have a transportation agreement with a shipper. Since we are modeling actual observed container movements, we are actually modeling the demand functions of whoever is making the choice, so our model will be accurate even if our necessarily concise explanation is oversimplified. While this analysis is part of the larger research program, we do not have resources as part of this project to conduct a new analysis of shipper demand for port services.

Several published studies will provide information on how shippers trade off among ports with different amenity profiles. Veldman and Buckmann (2003) examined preferences of European shippers using revealed preference techniques, and Malchow and Kanafani (2004) conducted a similar study of exporter preferences for US shippers. Murphy et al. (1992) and Murphy and Daley (1994) used survey techniques to gain measures of relative importance of port services. We will use the results of these analyses to determine how demand is likely to respond to different development scenarios, generating payoffs for the game to be applied in Phase III.

Phase II: Developing a model of spatially specific ports includes three elements that are key to understanding competitive investment. First, it is characterized by imperfect competition, where individual ports may cooperate or compete to provide service for a given area. Whether competitive or cooperative outcomes are sustained is of particular interest to port developers in Asia. Second, port competition is spatially dependent, in that investments will generally affect competitors whose hinterlands overlap to a greater extent than more distant competitors. Third, the game is dynamic, in that it is played through time with the option for ports to make investments in different years.

While development of a model incorporating all three elements is beyond the scope of this short project, we anticipate integrating elements from three basic game models to develop a single model that generates a range of predictions consistent with the incentives associated with international container port development and competition. In this project, we abstract from the timing and oligopolisitic pricing issues and focus on returns to strategic investment opportunities available at Busan and Shanghai, given current or advertised prices.

The underlying model of pricing used will be Bertrand price competition (see Sidebar 1) **[where?]**, in which a competing ports' demand curve is substituted for other shipping customers (captured by parameter b). In this model, the imperfect competitors each set their price, anticipating the price that others will set. In Nash equilibrium, each port is maximizing its profit, given the price levels set by the other players.

Our analysis will look at the competitive Nash equilibrium outcome. In Nash equilibrium, ports will invest heavily to compete with one-another. When a large number of ports are serving the same markets (as could happen in Asian export manufacturing regions, or in the US with the inland Midwestern market which can be served well by many ports), the level of investment could be so high that it cannot be recovered without significant growth in global port demand. This outcome is of particular policy relevance, because there is concern among port experts that many governments are investing in ports with the anticipation of capturing market share, but without adequate consideration for the capacity being developed elsewhere. If the parameters determining returns on investment are such that the competitive equilibrium can lead to losses, then port development is not a responsible use of public monies; improvements require either cooperative investment levels, or not entering into the port services market in the first place. However, outcomes may be improved with cooperation.

Phase III: Applying the game model to determine likely outcomes of port competition. Applying the theoretical model requires identifying each of the three textbook elements of an economic game: a set of players, a set of actions for each player, and the payoffs for each player according to the combination of possible actions of all players.

Each scenario will specify the set of relevant ports (players), and investment alternatives for each port (actions). We will apply the simulation model to determine the demand, and thus some measure of profitability, for each port under each combination of investments. These payoffs will be used within the game, which will allow us to calculate Nash equilibrium levels of investment, and the potential relative gains from coordination of investment in a cooperative outcome for each scenario. These equilibrium outcomes can be used to advise port authorities, as well as local and national governments in selecting a level of port investment that maximizes profits and ensures responsible use of public economic development funds.

The next sections of this report presents data characterizing containerized cargo, the pricing of port services, and development plans at Busan and Shanghai. These data will serve as a basis for the development of our model of port services demand for transshipment services for cargo originating at northern Chinese ports. The following section presents the basic game model in its general form. The final section applies the game model, using data on cargo flows, to examine the strategic opportunities present for both Busan and Shanghai to strategically invest or alter their prices to secure more market share.

# Ⅲ. Review of Asian Port Operations

## 1. Economic Overview

Despite higher oil prices and natural disasters, global economic activity in 2005 was stronger than in previous years. In 2005, global GDP growth was estimated at 4.8% and World Trade growth recorded a 7.3% increase. Growth in China has been rapid, estimated at 9.9% in 2005. The strong growth in China is expected to be maintained in 2006. In 2005, Korean GDP growth is estimated at 4% , 0.6% point lower than growth in 2004. And the Japan economy expansion is well established, growth in Japan is recorded at 2.7%, 0.4% point higher than growth in 2004.

Table III-1 Northeast Asia Economic Outlook Overview

| type | | 2000 | 2003 | 2004 | 2005 | Projections | |
|---|---|---|---|---|---|---|---|
| | | | | | | 2006 | 2007 |
| World | | 4.8 | 4.1 | 5.3 | 4.8 | 4.9 | 4.7 |
| Advanced | | 3.9 | 2 | 3.3 | 2.7 | 3 | 2.8 |
| Northeast. Asia | Japan | 2.9 | 1.8 | 2.3 | 2.7 | 2.8 | 2.1 |
| | Korea | 8.5 | 3.1 | 4.6 | 4 | 5.5 | 4.5 |
| | China | 8.4 | 10 | 10.1 | 9.9 | 9.5 | 9 |

Source : IMF, World Economic Outlook, April, 2006.

## 2. Northeast Asia Container Throughput

### A) World Container Throughput

World container throughput increased to 337 million TEU in 2004 from 231 million TEU in 2000. In Northeast Asia container throughput increased from 63 million TEU in 2000 to 105 million TEU in 2004. The growth of container throughput in Northeast Asia has been rapid, and due to the growth of China volume the region has increased its share of the global market from 27.3% in 2000 to 31.0% in 2004. China's share increased greatly from 17.7 % in 2000 to 22.1% in 2004. Korea's share also increased, but only from 3.9% in 2000 to 4.2% in 2004. Japan`s share decreased from 5.7% in 2000 to 4.7% in 2004 due to economic stagnation.

Table III-2 Korea, China, Japan Container Volume Trend

(thousand TEU, %)

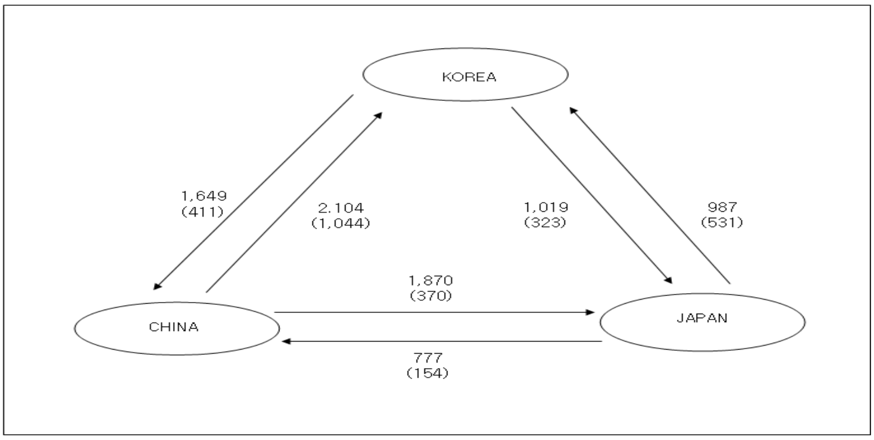
| type | 1990 | | 1995 | | 2000 | | 2004 | |
|---|---|---|---|---|---|---|---|---|
| | Throughput | Share | Throughput | Share | Throughput | Share | Throughput | Share |
| Korea | 2,348 | 2.7 | 4,503 | 3.3 | 9,030 | 3.9 | 14,299 | 4.2 |
| China | 1,204 | 1.4 | 17,232 | 12.6 | 40,984 | 17.7 | 74,540 | 22.1 |
| Japan | 7,966 | 9.3 | 10,604 | 7.7 | 13,130 | 5.7 | 15,937 | 4.7 |
| Sub-total | 11,518 | 13.4 | 32,339 | 23.6 | 63,144 | 27.3 | 104,776 | 31 |
| Others | 74,078 | 86.6 | 104,900 | 76.4 | 168,545 | 72.2 | 232,082 | 69 |
| World | 85,596 | 100 | 132,239 | 100 | 231,689 | 100 | 336,858 | 100 |

### B) Intra Northeast Asia Container Throughput

Since China`s entry to the WTO in 2001, the regional trade volume in Northeast Asia has continuously increased. The growth of the international division of labor and the expansion of regional trade volume require markets in the region to integrate [1]. The container throughput of intra Northeast Asia increased from 7 million TEU in 2003 to 8.4 million TEU in 2004. The container throughput of exports and imports in the intra region route increased from 4.6 million TEU in 2003 to 5.6 million TEU in 2004. The transshipped container volume in the intra-region route increased from 2.4 million TEU 2003 to 2.8 million TEU in 2004.

Figure III-1 Intra Northeast Asia Container Volume Including T/S Volume

(thousand TEU)




Source : Bong-Min Jung et al., Assessment of Comparative Competitiveness and Strategy to heighten the Possibility of Logistics Hub in the Northeast Asia, KMI, 2006.
(The numbers in parenthesis indicate T/S movement at each route.)

1) Ghang Jong-Hee, Baik Jong-Sil, Park Yong-An, Identification of Barriers in Operation and Management of Maritime and Multimodal Transport, KMI, 2001 p. 1.

Table III-3 Intra Northeast Asia Container Volume

| Route | Korea/Japan | | | Korea/China | | | China/Japan | | | Korea/China/Japan | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Ex -Import | T/S | Subtotal | Ex -Import | T/S | Subtotal | Ex -Import | T/S | Subtotal | Ex -Import | T/S | Subtotal |
| 2003 | 1,708 | 686 | 1,764 | 1,932 | 1,354 | 3,285 | 1,633 | 406 | 2,039 | 4,643 | 2,446 | 7,089 |
| 2004 | 1,151 | 854 | 2,006 | 2,298 | 1,455 | 3,753 | 2,123 | 524 | 2,647 | 5,572 | 2,833 | 8,405 |

Source : ibid

(i) Korea-Japan Route

Container throughput on the Korea-Japan route increased from 1.8 million TEU in 2003 to 2 million TEU in 2004. The container volume in 2004 is composed of 0.98 million TEU of Korea inbound volume, including 531,000 TEU of T/S cargo and 1 million TEU of Korea outbound volume, including 323,000 TEU of T/S cargo.

Most export and import container cargo between Korea and Japan is handled at the ports of Busan, Gwangyang, Ulsan, and Masan. In 2004, major calling ports in Japan were Tokyo (17.1% market share), Osaka (12.1%), Yokohama (9.2%), Hakada (7.6%), and Nagoya( 6.5%) Apart from these ports, ships also call at 50 additional regional ports in Japan[2].

Container ships, car ferries and general cargo ships call at the Port of Busan, but only container ships call at the ports of Gwangyang, Ulsan and Masan. Container cargo is comprised of direct trade cargo and transshipment cargo.

Bilateral shipping agreements between Korea and Japan have yet ro conclude, but both parties established the "Korea-Japan Shipping

2) Baik Jong-Sil, Park Yong-An, Ellimination of Barriers in Operation and Management of Maritime and Multimodal Transport in China, Japan, and Korea, KMI, 2002 p. 8.

Working Committee" in 1987.

The "Korea-Japan Shipping Working Committee" has been discussing the entry and management of Korea-Japan trade routes, Japanese lines' entry to Korea-Japan trade routes, safety policy on passenger ships, and current contentious issues. The participation of Japanese lines on Korea-Japan trade routes was limited until 1995, but the market has since opened up to Japanese lines from 1996 [3].

Nowadays, KNFC (Korea Near Sea Federation Council), a loose strategic alliance of Korean container lines plays a vital role in Korea-Japan trade and many foreign container lines also are adding service to Korea-Japan trade routes. The trade volume of Korea-Japan routes has been gradually increasing every year. But the continuous over-capacity of ship space in Korea-Japan trade routes make load factors and freight rates lower, which translates into lower profits for container lines. [4]

Table III-4 Korea-Japan Route Container Volume Throughput

( thousand TEU)

| Year | Korea Inbound | | | Korea Outbound | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Export | T/S | Sub Total | Export | T/S | Sub Total | Export | T/S | Sub Total |
| 2003 | 431 | 420 | 851 | 647 | 266 | 913 | 1,078 | 686 | 1,764 |
| 2004 | 455 | 531 | 987 | 696 | 323 | 1,019 | 1,151 | 854 | 2,005 |

Source : ibid.

3) ibid, p.9.

4) ibid, p.10.

(ii) Korea-China Route

Container throughput on the Korea- China route increased from 3.3 million TEU in 2003 to 3.7 million TEU in 2004. The container volume in 2004 is composed of 1.6 million TEU of Korea inbound volume including 411,000 TEU of T/S cargo and 2.1 million TEU of Korea outbound volume including 1.0 million TEU of T/S cargo.

The largest portion of Korea's export and import container cargo for China is handled at the ports of Busan, Gwangyang, and Incheon. In 2004, major partner ports for the trade between Korea and China are Tianjin (21.5%), Tsingdao (19.1%), Shanghai (18.4%), and Dalian (12.1%).

Major container lines call at the port of Busan and the port of Gwangyang, while car ferries call at the port of Incheon, general cargo ships call at the ports of Busan, Gwangyang and Incheon. Container cargo is divided between direct trade cargo and transshipment cargo according to the way of trade. Direct trade cargo means the import and export container between Korea and China, and transshipment cargo means the cargo going to other countries and the cargo coming from other countries via the airport or the ports of Korea.

Jang Geum Shipping Lines joint venture with Dongnama Shipping Lines in Korea and Sinotrans in China started the trade route between Korea and China in June, 1989. This opening of the route was an important milestone to promote the shipping relations between Korea and China and generated a sharp increase in the volume of container cargo. Bilateral shipping agreements between Korea and China, concluded in May 1993, improved the conditions under which maritime cargo transport operations are carried out between both countries.[5)]

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5) ibid, p.4.

Korea and China agreed that container transport operation was basically a free market. But both parties had agreed to put the same numbers in ships to the Korea-China transport routes.

With regards to access of cross trade routes, the participation of Korea and China in Japanese trade routes became a hot issue. Korea had requested China to join the Japan-China trade route just as China requested Korea to join the Korea-Japan trade route. With respect to the management of Korea-China trade routes, Korea and China had adopted mutual agreement system to deploy additional container ships and to open a new trade route under the principle of fair cargo sharing. Therefore both new entry of Korea-China trade route and free competition between shipping lines are limited. Korea and China have the equivalent market power by deploying the same number of ships.[6)]

Table III-5 Korea-China route Container Throughput

(thousand TEU)

| Year | Korea Inbound | | | Korea Outbound | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Export | T/S | Sub total | Import | T/S | Subtotal | Ex-Im | T/S | Total |
| 2003 | 1,073 | 376 | 1,448 | 859 | 978 | 1,837 | 1,932 | 1,354 | 3,285 |
| 2004 | 1,238 | 411 | 1,649 | 1,060 | 1,044 | 2,104 | 2,298 | 1,455 | 3,753 |

Source : ibid.

(iii) China-Japan Route

Container throughput on the China Japan route increased from 2.0 million TEU in 2003 to 2.6 million TEU in 2004. The container volume in 2004 is composed of 1.87million TEU of Japan inbound volume including 370,000 TEU of T/S cargo and 777,000 TEU of China outbound volume including 154,000 TEU of T/S cargo.

6) ibid, p.4.

The largest portion of China's export and import container cargo for Japan is handled in the port of Shanghai (44.7%), Tsingdao (12.4%), Dalian (12.2%), Tianjin (10.5%).

Table III-6 China-Japan Route Container Throughput

(thousand TEU)

| Year | China Inbound | | | China Outbound | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Export | T/S | Sub total | Import | T/S | Sub total | Ex-Im | T/S | Total |
| 2003 | 495 | 123 | 618 | 1,138 | 283 | 1,421 | 1,633 | 406 | 2,039 |
| 2004 | 623 | 154 | 777 | 1,500 | 370 | 1,870 | 2,123 | 524 | 2,647 |

Source : Korea Shipowners Association
Yellow Sea Liners Committee
T/S volume is estimated by KMI

## 3. Asia Container Port Trends

### A) Korea

Container throughput in the ports of Korea increased from 9.1 million TEU in 2003 to 14.5 million TEU in 2004. The growth of T/S container was higher than those of imports and exports. In 2004, the port of Busan handled 11.5 million TEU, including 4.8 million TEU of T/S container from other countries mainly composed of China, Japan, and other countries. Annual growth rate from 2000 to 2004 at the port of Busan records 19.0% for T/S container, contrary to 0.7% for Korea domestic container. The port of Gwangyang, opened in 1996, handled 1.3 million TEU, including 0.4 million TEU of T/S container. Faced with an increase of container throughput, the Korea government has taken steps to develop Busan New Port, Incheon New Port, and Gwangyang port.

Table III-7 Korea : Container Throughput by Port, 1990-2004

(thousand TEU)

| port/year | 1990 | 1995 | 2000 | 2003 | 2004 |
|---|---|---|---|---|---|
| Busan | 2,384.5 | 4,502.6 | 7,540.4 | 10,408 | 11,492 |
| -Transshipment | n.a. | 859.0 | 2,390.0 | 4,251 | 4,791 |
| Gwangyang | - | - | 642.2 | 1,185 | 1,322 |
| -Transshipment | - | - | 64.1 | 344 | 360 |
| Inchon | ** | 296.0 | 611.3 | 821 | 935 |
| Ulsan | ** | 43.0 | 236.3 | 318 | 303 |
| Masan | ** | 7.0 | 41.8 | 47 | 62 |
| Others | 211.5 | 69.4 | 44.5 | 407 | 409 |
| Total | 2,560.0 | 4,918.0 | 9,116.4 | 13,186 | 14,523 |
| -Transshipment: TEUs | 151.0 | 859.0 | 2,454.1 | 4,598 | 5,158 |
| -Transshipment: % | 5.9 | 17.5 | 26.9 | 34.8 | 35.5 |

Including coastal movement
Source : Korea Container Terminal Authority
Ocenan Shipping Consultants Ltd
MOMAF

### B) China

The China container throughput has increased sharply from 19 million TEU in 2000 to 52.6 million TEU in 2004. The port of Shanghai handled 14.6 million TEU in 2004.

The container throughput of the port of Shenzhen, which is located in the southern region of China, recorded 13.7 million TEU in 2004.

The growth of container throughput in other main ports of China has increased rapidly. In 2004, the port of Tsingdao handled 5.1 million TEU.

The Number of Chinese ports with container throughput exceeding 1 million TEU increased to 8 in 2004, and rose to 9 in 2005.[7] To keep pace with rapid demand growth of China`s foreign trade container

7) Ministry of Communication of the China, The Report on China`s Shipping Development 2005, 2006. p. 2

transport and cargo throughput, the Chinese government developed 920 specialized berths for containers, crude oil, ore and coal, including 188 berths of the 10,000 ton and above class during the period of the "Tenth Five Year Plan."

The construction of the 1st phase project of Yangshan New Port at the Shanghai International Shipping Center was completed in December and went into operation. The completed 1st phase project was composed of the port area, Donghai Bridge and the supporting projects in Luchogang. The port area has five berths of 70,000 to 100,000 tons capable of accommodating the most advanced post-Panama containerships, and a 1600m long front-line with an annual handling capacity of 3 million TEU.[8)]

Table III-8 China : Container Throughput by Port, 1990-2004

(Thousand TEU)

| port/year | 1990 | 1995 | 2000 | 2003 | 2004 |
|---|---|---|---|---|---|
| Shanghai | 456 | 1,526 | 5,613 | 11,283 | 14,557 |
| Shenzhen | n.a. | n.a. | 3,994 | 10,614 | 13,650 |
| Guangzhou | 81 | 220 | 1,430 | 2,762 | 3,308 |
| Tsingdao | 135 | 603 | 1,540 | 4,239 | 5,140 |
| Tianjin | 289 | 702 | 1,708 | 3,015 | 3,814 |
| Dalian | 131 | 374 | 1,011 | 1,670 | 2,211 |
| Xiamen | 30 | 310 | 1,085 | 2,331 | 2,872 |
| Ningbo | 211.5 | 69.4 | 902 | 2,772 | 4,005 |
| China Total* | 1,295 | 4,806 | 19,085 | 41,449 | 52,556 |

* Excluding HK

Source : emap Business Communications, Containerisation International Yearbook

8) ibid. p. 6. p. 7.

### C) Japan

The container throughput in the ports of Japan narrowly decreased from 15.9 million TEU in 2003 to 15.0 million TEU in 2004. The port busiest port in Japan, Tokyo, handled 3.4 million TEU in 2004.

The port of Kobe which had been a hub of Northeast Asia before the earthquake in 1995 handled 2.2 million TEU in 2004. The port of Osaka handled 2.0 million TEU in 2004. The container throughput of the other ports recorded lower than 2.0 million TEU in 2004. the Japanese government planned to heighten Japanese port` competitiveness by adopting a 24 hour work system, single window service for cargo, reducing port tariff, and a support policy for super hub port development.

Table III-9 Japan : Container Throughput by Port, 1990-2004

(Thousand TEU)

| port/year | 1990 | 1995 | 2000 | 2003 | 2004 |
|---|---|---|---|---|---|
| Tokyo | 1,555 | 2,177 | 2,899 | 3,313 | 3,358 |
| Yokohama | 1,648 | 2,757 | 2,317 | 2,505 | 2,718 |
| Kobe | 2,596 | 1,464 | 2,266 | 2,045 | 2,177 |
| Nagoya | 898 | 1,477 | 1,912 | 2,073 | 2,155 |
| Osaka | 543 | 1,439 | 1,333 | 1,864 | 2,009 |
| Hakata | 153 | 296 | 474 | 567 | 611 |
| Kitakyushu | 256 | 449 | 412 | 448 | 472 |
| Tomakomai | 160 | 234 | 356 | 348 | 356 |
| Shimizu | 164 | 252 | 376 | 345 | 519 |
| Japan Total* | 8,092 | 10,810 | 13,570 | 15,937 | 15,056 |

Source : emap Business Communications, Containerisation International Yearbook

### D) Taiwan

The container throughput of Taiwan ports has marginally increased from 12.0 million TEU in 2003 to 13.0 million TEU in 2004. The port of

TKaoshiung, a hub port in Taiwan, handled 9.7 million TEU in 2004.

In 1995 the Taiwan government promulgated the Regulations allowing those cargoes going to and from ports fo Fuzhou and Xiamen in China to be transshipped via Kaoshiung port. The Taiwan government uses the term "offshore" to avoid the label of direct shipping links, which is officially forbidden in Taiwan law.[9] Taiwan further promoted the Mini Three Links program to provide direct shipping links between its outlaying islands - Kinmen and Matsu and China Xiamen and Fuzhou ports in mainland China. Nevertheless the indirect short sea shipping programs of offshore shipping center and Mini Three Links promoted by Taiwan are not enough to cope with the needs required by the people of both Sudes across the Taiwan strait.[10]

Table III-10 Taiwan : Container Throughput by Port, 1990-2004

(Thousand TEU)

| port/year | 1990 | 1995 | 2000 | 2003 | 2004 |
|---|---|---|---|---|---|
| Kaoshiung | 3,495 | 5,053 | 7,426 | 8,840 | 9,710 |
| -Transshipment | 1,341 | 2,177 | 3,966 | n.a. | n.a. |
| Keelung | 1,841 | 2,165 | 1,955 | 2,001 | 2,070 |
| Taichung | 128 | 447 | 1,130 | 1,246 | n.a. |
| **Taiwan Total*** | **5,463** | **7,665** | **10,510** | **12,087** | **13,025** |
| -Transshipment | 1,449 | 2,370 | 4,340 | n.a. | n.a. |

Source: emap Business Communications, Containerisation International Yearbook

9) Rong-Her Chiu, Current Status of Short Sea Shipping between Mainland China and Taiwan, International Conference on Contemporary Issues of Shipping and Ports in Korea, 2006. P.1.

10) ibid. p. 16.

### E) Southeast Asia

Due to economic growth, the container throughput in the ports of Southeast Asia has increased steadily. The container throughput in the ports of Singapore increased from 18.1 million TEU in 2003 to 20.6 million TEU in 2004. Other countries, Malaysia, Indonesia, Thailand, and Philippines have also shown stable growth in container throughput.

Table III-11 Southeast Asia : Container Throughput by Port, 1990-2004

(Thousand TEU)

| country/year | 1990 | 1995 | 2000 | 2003 | 2004 |
|---|---|---|---|---|---|
| Singapore | 5,130 | 11,850 | 17,040 | 18,100 | 20,600 |
| Malaysia | 900 | 2,110 | 5,300 | 10,210 | 11,260 |
| Indonesia | 920 | 2,670 | 4,640 | 5,180 | 5,600 |
| Thailand | 1,080 | 2,160 | 3,660 | 4,200 | 4,900 |
| Philippines | 1,490 | 2,510 | 3,570 | 3,500 | 3,700 |

Source : emap Business Communications, Containerisation International Yearbook.

# Ⅳ. Identification of Strategic Development

## 1. Quest for the strategy of the opposite port

### A) Korea's Search

In 1985, the Korean government concluded the construction plan for the Gwangyang Container Port and proposed a construction completion date of 2001. The port of Gwangyang was expected to lessen the congestion of the downtown of Busan, to reduce the logistics costs of both imports and exports, and to make both Korean ports more globally competitive.

In 1995, during the construction of the port of Gwangyang, the earthquake at Kobe City in Japan occurred. At that time, the port of Kobe was a hub port in Northeast Asia.

After the Kobe disaster, transshipment cargo in Northeast Asia had shifted mainly to the port of Busan, which a result handled twice the volume of its optimal capacity. To solve congestion problem in the container terminal and sea channel brought on by the container rush, the Korean government developed the Busan New Port Construction Plan as a project to attract private funds.[11)]

In 1996, the Korean government finalized the Basic Construction Plan for Busan New Port, and in 1997 established the Basic Plan of Private Finance Initiative for the Busan New Port.

KMI helped to develop the Basic Construction Plan, and supported the Korean government's decision-making process by forecasting the container volume for the Busan New Port. KMI estimated that the ratio of

11) Busan Port Authority(BPA)

T/S container cargo in Busan New Port would be 30%, realizing the volume of T/S cargo from China and Japan would continue to increase.

In the late 1990s, most of the scholars in Korea insisted that the Chinese port growth was constrained by shallow channel depths, and that it would be very difficult for China to construct channels deeper than 16m to handle 10,000 TEU size container vessels.

Koreans did not consider the Chinese government would decide so quickly to develop the Yangshan New Port construction plan and build so huge a container terminal in such a short period. Although China adopts a socialist-capitalism economic system, the land belongs to the Chinese government. So the government can build in a shorter period of time than other countries due to the social infrastructure not requiring a purchase process for expropriation. In 2001, the Chinese government announced that the port would be completed in 2005. This caused the Korean government to reevaluate the Basic Construction Plan of Korean Port.

### B) China's Search

In 1997, the Shanghai metropolitan government and the Chinese government concluded their basic strategic study on the Yangshan New Port Construction which make Shanghai a logistics hub. Then they proceeded with a feasibility study of the Yangshan New Port. In 2000, the Chinese government requested foreign specialists to consult on the feasibility of the Yangshan New Port development.

Possible negative effects were thought to be increased transfer costs for T/S containers, $13 billion in construction costs, and the destruction of marine habitats.[12] The possibility of mass unemployment in

12) Cho Gye –Seok, Park Yong–An, The visiting Report for the Port of Shanghai,

neighboring ports, such as the port of Ningbo, was also outlined.

Proponents, however, insisted that the Yangshan New Port could handle larger vessels than Shanghai Waigaoqiao Terminal, which can currently handle up to 6,000 TEU container vessels. They also concluded that the maximum size of container vessels in the main trunk route would be 10,000 TEU, that the berth depth of the new port should exceed 16m, enabling it to handle 10,000 TEU vessels, and that the excavation of the Channel of Waigaoqiao Terminal would increase its depth only up to 12.5m.

Having considered the pros and cons of the project, the Chinese government reevaluated the feasibility study of the Yangshan New Port. In 1999 and 2000, Chinese government officials and researchers from the Transportation Planning Institute in China visited the container ports of Busan and Gwangyang in Korea, met with Korean government officials and staff in the Korean container terminals, to gather data on the Korean Port Development Plan strategy. Their major concerns were the commencement time of the Busan New Port and the plans for Korea's new container terminal.

## 2. Development Plan

### A) Busan Situation

#### (i) Existing Port of Busan Container Terminal

The port of Busan is located on the southern tip of the Korean peninsula and fulfills its function as a gateway to link the Pacific ocean with Northeast Asia. It has six existing container terminals in the north

KMI, 2000, 9.

harbor area for a capacity reaching 4.9 million TEU annually.

Table IV-1 Existing Container Terminal of the port of Busan

| type/terminal | Jasungdae | Shinsundae | Gamman | Shin-Gamman | Wuam | Gamchun | Total |
|---|---|---|---|---|---|---|---|
| No.,of Berths | 5 | 4 | 4 | 3 | 3 | 2 | 21 |
| Length | 1,447m | 1,134m | 1,072m | 826m | 500m | 600m | 5,579m |
| Depth | 15m | 14-15m | 15m | 12-15m | 11m | 13m | |
| Quay Crane | 13 | 11 | 14 | 7 | 5 | 4 | 54 |
| Yard Crane | 31 | 32 | 37 | 15 | 13 | 10 | 138 |
| Loading Capacity (10thousand TEU) | 120 | 120 | 120 | 65 | 35 | 34 | 494 |

Source : KCTA(Korea Container Terminal Authority).

(ii) Development Plan of Busan New Port

The Busan New Port is located in the west region of Busan , 40 km from the existing container terminal. The 1st phase opened in December 2005.

Total completion of the Busan New Port is planned for 2011. The Busan New Port includes the north container quay, south container quay, and west container quay (developed in that order). The quay wall length of the berthing facility at Busan New Port will be up to 9.95km, and it will have a total of 30 ship berths to handle a capacity of 8,040,000 TEU annually.[13] The north container quay is currently under construction. Six ship berths are being developed by the Busan New Port Corporation (a consortium of private companies), and four ship berths by government funds, for a total of 13 berths.

13) BPA

Table IV-2 Busan New Port Development Project

(BPA, government, private funds)

| Classification | Total | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|---|---|---|
| Number of Berths | 30 | 3 (opened) | 3 | 1 | 11 | 4 | 3 | 5 |
| -Government | 12 | - | - | 1 | 4 | 4 (private funds) | 3 | - |
| -Private funds | 18 | 3 | 3 | 1 | 7 ("container" complex 4) | - | - | 5 |
| Accumulated number of vessels | 30 | 3 | 6 | 7 | 18 | 22 | 25 | 30 |
| Accumulated loading capacity (10,000TEU) | 804 | 90 | 180 | 191 | 443 | 564 | 654 | 804 |

Source : BPA(Busan Port Authority)

(iii) Rear Logistics Site

The Korean government and BPA are planning to make the Busan New Port a strategic point of logistics in Northeast Asia by securing a logistics site in the rear complex of the port to attract international logistics companies.

The Korean government and BPA co-purchased 1.2 million $m^2$ of the north container quay rear site for logistics, which is estimated to be able to supply 3.07 million $m^2$ of rear logistics complex. BPA has worked to attract logistics companies and establish supporting facilities such as CFS in a 66,116 $m^2$ area created in the 1st phase in preparation for the opening of the new port.

Table IV-3 Development, management, and operation at Busan New Port: rear area

| Classification | Ministry of Maritime Affairs and Fisheries | BPA |
|---|---|---|
| Roles | · Attract investment for logistics complex, and general supervision and support of operation and management systems<br>· Financial incentive for resident companies<br>· Establishment of collaborative and controlling facility | · Investment attraction activities<br>· Appointment and lease to some companies<br>· Maintenance and management of control and public facilities<br>· Management and operation of logistics complex |

Source : BPA

Table IV-4 North Container Quay Rear Site Creation Plan

<Site Creation Plan by Phase >

| Classification | Sub-total | 1st phase | 2nd phase | 3rd phase | 4th phase |
|---|---|---|---|---|---|
| Creation period | 2005~2011 | 2005. 6 | 2006. 12 | 2008. 12 | 2010. 12 |
| Creation area(㎡) | 1,204,209 | 64,992 | 425,651 | 492,825 | 220,741 |
| | (Accumulation) | (64,992) | (490,643) | (983,468) | (1,204,209) |

Source : BPA

(iv) Free Trade Zone

In 2004, the Busan New Port and Busan-Jinhae was announced as a free trade area. Various incentives for Free Trade Zones (FTZ) in Korea such as customs duty exemptions along with tax reduction and lower rent, are given to companies who take up tenancy in the distribution complex in the hinterland of the Busan New Port.10) FTZ will provide highly added value services, such as assembling, freight co-loading, processing, cargo handling and storage. FTZ will enhance the possibility to develop the Busan New Port from a transfer a cargo port into an international distribution base.

Table IV-5 FTZ Designated Area

| Target | Area (㎡) (pyeong) | Target | Area (㎡) (pyeong) |
|---|---|---|---|
| Stage 1 Terminal | 2,093,000 (611,958) | Connection Pier and Multi-purpose Terminal | 140.000 (42,350) |
| Stage 2 Terminal | 698,938 (211,429) | Distribution Site in Northern Hinterland | 1215,300 (367,628) |

Source : BPA

## B) Shanghai Situation

### (i) Port of Shanghai Existing Container Terminal

The port of Shanghai is located at the entrance of the Yangtz River and covers the central and western region of China. It has seven existing container terminals in the Yangtz River Waters, with a capacity which reaches up to 8.5 million TEU annually.

Table IV-6 Existing Container Terminal of the port of Shanghai

| type/terminal | SCT -9 | SCT -10 | SCT -14 | Waigaoqiao | | | | total |
|---|---|---|---|---|---|---|---|---|
| | | | | phase1 | 2/3 | 4 | 5 | |
| No.,of Berths | 3 | 4 | 3 | 3 | 5 | 4 | 4 | 26 |
| Length(m) | 784 | 857 | 640 | 900 | 1,565 | 1,250 | 1,100 | 7,096 |
| Depth(m) | 10.5 | 10.5 | 10.5 | 12 | 13.2 | 13.2 | 13.2 | |
| Quay Crane | 8 | 7 | 5 | 10 | 19 | 14 | 14 | 77 |
| Yard Crane | 22 | 20 | 12 | 30 | 70 | 78 | 78 | 310 |
| loading capacity (10,000TEU) | 80 | 75 | 48 | 120 | 225 | 100 | 200 | 848 |

Source : KCTA

(ii) Yangshan New Port Development and Operation

The 1st phase Container Terminal of the Shao (small) Yangshan Port, which has been predominately driven by the Chinese government, and was opened in 2005. The 1st phase Terminal has 5 berths, with awater depth 16m and a capacity of 2,220,000 TEU/year.

By 2010, 11 berths will be added in the Shao Yangshan area, increasing capacity to 7 million TEU/year. The Ministry of Communication of China plans to develop 30 berths in Shao Yangshan and 20 berths in Da(big) Yangshan by 2020. When the project is completed, Yangshan Port will have 50 berths handling 25 million TEU/year.

Table IV-7 Shanghai Yangshan Port Container Terminal Development Plan

| Area | | Berths | Quay Length(m) | Open in | Remarks |
|---|---|---|---|---|---|
| Shao Yangshan | Phase1 | 5 | 1,600 | 2005 | 2.2 million TEU |
| | Phase 2 | 4 | 1,400 | 2006 | 2 million TEU |
| | Middle Port (Phase 3) | 7 | 2,200 | 1 berths by 2007<br>6 berths by 2010 | |
| | East Port | - | -Exclusively for LNG | | |
| | West Port | - | -Exclusively for Feeder Terminal | | |
| | Sub Total | 30 | 10,000 | 2020 | 13 million TEU |
| Da Yangshan | East Port | | 4,400 | | |
| | West Port | | 6,500 | | |
| | Sub Total | 20 additional berths will be constructed after 202 | | | |

Source : KMI

(iii) Hinterland Logistics Service

As a hinterland logistics base, the Logistics Center in Luchao port area and Linggang New City are constructing a business-support city. The Linggang Industrial Development Zone is also in rapid progress. The Luchao Port Logistics Center, which is connected with Yangshan Port through Donghai Bridge, is being developed as a 1,120,000㎡ facility, incorporating a customs inspection and quarantine area, an auxiliary operation zone which is a logistics center, hazardous materials yard, and supervisory area for logistics.

Table IV-8 Functions of the Luchao Logistics Center

| Classification | Major Functions |
| --- | --- |
| Inspection and Quarantine (610,000m2) | * Customs inspection and quarantine for import/export cargo<br>- custom clearance & quarantine of containers transported by trucks and in the yard |
| Auxiliary Operation Area (450,000m2) | * Supportive area for the operation of Yangshan Terminal<br>- Temporary retaining, CFS service, retaining empty container, container repair , etc. |
| Hazardous Material Yard(60,000m$^2$) | * Inspection and piling of hazardous material containers |

Source : KMI

(iv) Management, Operation, and Customs Clearance Systems

The 1st phase Terminal of Yangshan Port is operated by Shanghai Shendong International Container Terminal Company (SSICT), which is a subsidiary of SIPG (Shanghai International Port Group).[14]

14) Park Yong-An, Chun Hyung-Jin, Study on Effective Means for Shipping and Transportation Companies to Advance into the Chinese and Japanese Market, KMI,

SSICT is a joint venture of SIPG and SPCC (Shanghai Port Container Company) with an equity ratio of 49% and 51% by SIPG and SPCC, respectively. SIPG handles management, operation and marketing, SSICT takes charge of loading/unloading and logistics-related services.

Table IV-9 Yangshan Port Terminal Operation System: 1st phase

| Company | Responsibilities |
|---|---|
| SIPG | - Establishment of operation strategy for Yangshan Port<br>- Management/operation including entrance/ departure, berth arrangement, etc.<br>- Marketing and liner management |
| SSICT | - Unloading and logistics related services<br>- Other terminal related matters<br>- Collecting and analyzing of statistics data |

In order to strengthen the T/S functions, SIPG established the Transshipment Management Center, which will integrate and manage T/S cargoes in the Yangshan New Port. Furthermore, SIPG and the Shanghai Customs Authority are jointly working on an improved customs clearance system. A separate customs office was established for the Yangshan New Port which would clear cargo with a single declaration and inspection on the basis of enhanced information systems.

(v) Free Trade Zone [15)]

In June 2005, China`s First free trade zone was established in Yangshan, with the consent of the State Council. Yangshan Bonded Port

2005. pp., 66~67.

15) Ministry of Communication of the China, The Report on China`s Shipping Development 2005, 2006. p. 79. p. 48.

Area consists of Small(Shao) Yangshan's port area, East Sea Bridge, and designated land area near the bridge, with a total planned area of 8.14 square kilometers. Yangshan Bonded Port Area enjoys preferential taxation and foreign exchange policies for both a bonded zone and an export-processing zone. Foreign cargo entering the Area does not have to pay customs duties.

# Ⅴ. Competition Strategy

## 1. Competition among T/S container ports in Northeast Asia

Hub ports are defined as having specific characteristics: centrality and intermediacy(UNCTAD, 1990)[16]. Centrality refers to the port's location relative to hinterland markets. The port of Rotterdam and the port of LA are representatives of centrality.

Intermediacy refers to the location of the port relative to smaller source ports and final destination markets with goods that can be transshipped.

A hub port is located on the main trunk line. In Northeast Asia, the main trunk line is thought to contain the Port of Singapore, the Port of Hong Kong, the Port of Shanghai, and the Port of Busan. A hub port should also be able to receive the largest vessels. In the near future, the capacity of container vessels will grow to 10,000~12,000 TEU.

As the shipping companies optimize the operation of larger vessels in order to call at fewer ports, the hub ports try to collect T/S cargos from neighboring countries.

The port of Busan has collected T/S cargo from China and Japan. Since the Yangshan New Port and other China hub ports have tried to collect more T/S cargo from the Northern China region and the regional port in Japan, the port of Busan is faced with a decreasing growth rate ratio of T/S cargo from other countries.

16) UNCTAD, Development & Improvement of Ports – The Establishment of Transshipment Facilities in Developing Countries, TD/B/C.4/AC.7/10., 1990, August. 20

## 2. T/S Container Volume Forecast

### A) China Container Cargo

In 2005, the Global Logistics Research Institute(GLORI) in Korea has estimated that container volume of China will grow from 62 million TEU in 2003 to 144 million TEU in 2011 and to 369 million TEU in 2020. The capacity of Chinese ports will increase to 79 million TEU in 2011 from 53 million TEU in 2003. In 2011, the difference between supply and demand will reach 65 million TEU.

Table Ⅴ-1 China Container Throughput Forecast

(thousand TEU)

| History | | Forecast | | | |
|---|---|---|---|---|---|
| 1992 | 2003 | 2006 | 2011 | 2015 | 2020 |
| 9,983 | 161,957 | 85,194 | 144,352 | 219,136 | 369,257 |

Source : GLORI, 2005.

Table Ⅴ-2 China Container Demand / Capacity Forecast

(thousand TEU)

| type | 2003 | 2004 | 2005 | 2006 | 2010 | 2011 |
|---|---|---|---|---|---|---|
| Capacity | 61,957 | 68,897 | 76,613 | 85,194 | 130,266 | 144,856 |
| Demand | 53,468 | 59,613 | 64,169 | 67,769 | 76,704 | 78,905 |
| Balance | -8,489 | -9,284 | -12,444 | -17,425 | -53,562 | -65,447 |
| | (13.7) | (13.5) | (16.2) | (20.5) | (41.1) | (45.3) |

Source : Ocean Shipping Consultants, World Containerport Outlook to 2015, 2003.
GLORI, 2005.

### B) Japan

GLORI estimated that the container volume for Japan will grow to 19 million TEU in 2011 and to 28 million TEU in 2020, from 13 million TEU in 2002. GLORI also pointed out the possibility of a decrease in T/S container volume from Japan in Korea ports, as Japanese ports have been trying to reform and rationalize its logistics system to reduce port costs.

Korean shipping companies have lead the coastal shipping network at Japanese regional ports. They have connected the Japan regional ports with the Korean ports at Busan and Gwangyang.

Table Ⅴ-3 Japan Container Throughput Forecast

(thousand TEU)

| History | | Forecast | | | |
|---|---|---|---|---|---|
| 1992 | 2002 | 2006 | 2011 | 2015 | 2020 |
| 8,965 | 13,410 | 15,915 | 19,537 | 22,923 | 27,896 |

GLORI, 2005.

### C) T/S container cargo from China and Japan

GLORI forecasted the T/S container volume for Korean ports through regression models, by adopting these independent variables: Chinese exports and imports volume; the sum of Korean, Chinese, and Japanese ex-imports volume; time, the sum of Chinese, Japanese and American ex-imports; and the sum of Chinese and Japanese ex-imports.

GLORI calculated five such forecasts and averaged these five forecasts to select an average as the optimum value. As a result, the T/S container volume of Korean ports was estimated at 11 million TEU in 2011 and 21 million TEU in 2020 from 4.6 million TEU in 2003.

According to GLORI, the T/S container volume of China and Japan is estimated at 32.6 million TEU in 2011 and 79 million TEU in 2020. The Korean ports transshippment volume of China and Japan was calculated to be 10 million TEU in 2011 and 19 million TEU in 2020.

Table Ⅴ- 4 Korea Port T/S container volume (2011~2020)

(Thousand TEU)

| Year | 2011 | 2015 | 2016 | 2020 | Annual growth rate(%) | |
|---|---|---|---|---|---|---|
| | | | | | '11~'15 | '15~'20 |
| volume | 10,855 | 15,090 | 16,255 | 21,344 | 8.6 | 7.2 |

GLORI, 2005

Table Ⅴ-5 Northeast Asia T/S Container Forecast

(10 Thousand TEU, %)

| China & Japan T/s container volume | | History | | Forecast | | | |
|---|---|---|---|---|---|---|---|
| | | 1995 | 2001 | 2006 | 2012 | 2015 | 2020 |
| | | 498 | 1,376 | 2,012 | 3,262 | 4,817 | 7,903 |
| Korea port T/S container | Total | 14 | 421 | 644 | 1,121 | 1,509 | 2,134 |
| | T/S of China and Japan | 77 | 379 | (580) | (1,009) | (1,358) | (1,921) |
| | Share | 15.5 | 27.5 | (28.8) | (30.9) | (28.2) | (24.3) |

GLORI, 2005

## 3. Busan and Shanghai Port Strategy

### A) Port of Busan

The growth of Chinese ports is impressive. While the rate of growth at the port of Busan has been decreasing, Chinese ports are threatening Korean ports with increased throughput speed and a sharp rise in traffic. The rapid growth of the port of Shanghai, in particular, is a direct threat to Busan's ambition to become the main hub port of Northeast Asia. The growth of container volume in China ports has been fuelled by the decision of many multinational companies to relocate production of a whole range of consumer goods from their domestic plants, mainly in USA and Europe, to China where production costs are much cheaper.[17)]

In 1997, Shanghai had a mediocre harbor ranked at around 10th in the world. It rose to 6th in container cargo handling by 2000, and replaced Busan as 3rd in container cargo handling volume in 2004. Presently, Shanghai is competing with Hong Kong and Singapore, the 1st and 2nd container ports, respectively. Shanghai is poised to become the hub port of the world, not just the hub of Northeast Asia.

The port of Busan has been trying to heighten its competitiveness by reducing port tariffs, reforming cargo handling systems, and establishing a logistics complex and FTZ areas.

(i) Transshipment Entrance Fee Exemptions

Since October 2003, entrance fees for transshipments in Korean ports have been completely exempt. MOMAF (Ministry of Maritime Affairs & Fisheries) announced that entrance fees for transshipments, which had been reduced by 50%, would be exempted by 100%. Furthermore, marketing activities targeting foreign liners was developed and a volume incentive system was introduced.[18)]

Total exemption of entrance fees for transshipment, which was an exceptional measure succeeding the 50% reduction implemented July 2003, was intended to maintain the appeal of Busan Port in the face of possible bad weather and labor strikes by inland transporters.

The exemption of the $2.20 for 1 TEU entrance fee could reduce the $2,200 fee for a vessel carrying 1,000 TEU. Based on the total

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17) Jane R.C. Boys, Contaierisation International, March, 2003. p.89.

18) Korea Container Terminal Authority, Container Information, 2003. 12

transshipment cargoes in Busan in 2002, $4.6 million could be exempted.

In 2003, coastal container transportation which had prohibited foreign flag ships was allowed temporarily in the route between Busan-Gwangyang. Though limited, the permission of coastal transportation of foreign flag ships is intended to enhance the benefits of calling at Korean ports for foreign carriers by utilizing Busan and Gwangyang as one port and greatly extending the flexibility of fleet operation. The permission includes a carrier's alliance cargo as well as its own cargo.

(ii) Labor Supply Reform

In 2004, Busan Port Labor Unions made a resolution for 24(hour) x 7(day) labor supply, which will enhance the competitiveness of the port in addition to the launch of the Busan Port Authority.

Since 2003, the Union had been supplying loading/unloading labor service to provisionally recover the damage caused by the Typhoon Maemi. The resolution, agreed upon in the representative conference, enables shipping with shorter waiting times regardless of time of port entrance, as is the case in advanced foreign ports[19].

(iii) Volume Incentive System

In December 2003, the Minister of MOMAF announced that a Volume Incentive system would be enforced in Busan and Gwangyang Ports in order to attract transshipment cargoes.[20]

Due to the decrease of the vessels calling at Korean ports , caused by

19) Korea Container Terminal Authority, Container Information, 2004. 3

20) Korea Container Terminal Authority, Container Information, 2004. 3

the increase of foreign flag vessels using Chinese ports and direct lines to China, which is rapidly growing, a sense of crisis prevails in the Korean harbor industry. The volume incentive system could be an opportunity for the Korean harbor industry to grow by providing foreign flag ships with an unexpected favor.

Basically, the volume incentive system exempts liners carrying large volumes of cargo from port dues. According to the system, 10~50% of the transshipment fee is deducted when transshipping 200,000 TEU or greater cargoes are handled annually in Busan or Gwangyang ports, or when the transportation volume is increased by more than 20% compared with the previous year. The discount rate of port dues is decided by the cargo volume, number of vessels and tonnage.

The volume incentive system was in force at Busan until December 2006,[21] and will remain in Gwangyang until December 2007.[22] Extension of the period will be decided later according to the trend of transportation volume.

### B) Port of Shanghai

Through the construction of the Yangshan New Port, the port of Shanghai could resolve insufficient capacity and limited draught of the Waigaoqiao container terminal.

The 1st phase of the Yangshan New Port comprises five berths , providing 1,600m quay line, and adds 2.2 million TEU in annual capacity.[23]

To diminish additional transit cost from the Yangshan New Port to the

21) MOMAF

22) KCTA

23) e-map, Contaierisation International, March, 2005.

Waigaoqiao container terminal which have played the role of the center for inland waterway shipping and coastal shipping in China, the Ministry of Communication (MOC) raised the port tariff at the Waigaoqiao container terminal, but MOC dropped the port tariff at the Yangshan New Port.

Yet the share of T/S container volume in the port of Shanghai was about 2% in 2004, much lower than in the port of Busan. To attract T/S cargo, the port of Shanghai has been trying to improve competitiveness by discounting port tariff in the Yangshan New Port, by establishing a logistics complex and logistics Free Trade Zone in the hinterland, and by improving customs clearance procedure and cargo handling system.

(i) Transshipment Cargo Fees Cut

In June 2006, Shanghai International Port Group (SIPG) cut the transshipment cargo fee by 22% for international and coastal cargoes and by up to 53% for cargoes from Yangtz Valley[24].

The spokesman for SIPG said in an interview that the new transshipment cargo fees will be readjusted to $25/TEU and $37/FEU for international, coastal, and Yangtze River cargoes. In addition to this price decrease, the loading and unloading charges for international cargoes transported between the Waigiaoqiao and Yangshan Container Terminal barge shuttle service will be lowered. At present, the cargoes from Yangtze River to be exported to Yangshan Terminal are transported on small barges of 100~200 TEU and then transshipped to a larger barge at Waigiaoqiao or Luchao Port.

With the exemption of loading/unloading fees of the shuttle barges for the cargoes in the Yangshan New Port, the transportation fees of the

24) Korea Container Terminal Authority, Container Information, 2006. 6

shuttle between the two sections will be reduced from $44 and $77, to $19 and $34 per TEU and FEU, respectively. The cargo owners will be able to reduce their fees by 30%.

SPIG said that these measures are aimed at attracting liner calls at the Yangshan Port, which is 32km away from Shanghai, and reducing the transportation cost of using Yangshan Terminal. The Yangshan Terminal, which opened on Dec. 15, 2005, has handled 1,060,000 TEU (including 247,000 TEU of transshipment) for the past 150 days.

table Ⅴ-6 Container Throughput at Shanghai Port

| type | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|
| Imports | 2,661 | 3,054 | 4,141 | 5,445 | 6,997 |
| Exports | 2,951 | 3,286 | 4,471 | 5,838 | 7,558 |
| Total | 5,612 | 6,340 | 8,612 | 11,283 | 14,554 |

Source : emap Business Communications , Containerisation International, March, 2005.

(ii) Volume Incentive System

The port of Shanghai utilizes a Volume Incentive System for shipping companies when the transportation volume is increased by more than 20% compared with the previous year. Annually the discount rate of stevedoring charge is decided by the cargo volume, and the sharing of shipping company in the port

# VI. Port Competition Game Model

## 1. Introduction

We developed a model based on the competition between Busan and Shanghai, with a particular emphasis on the transshipment cargoes being exported from China, Korea and south Asia to markets in the east for which Busan New Port and Shanghai's Yangshan Terminal are competing. This simple two-port starting point will allow us to develop models and apply them to a tractable scenario that is relatively easy to think about, before scaling up to the far more complicated multi-port case that describes Northeast Asian port competition.

A game theoretic approach was adopted because the payoff that a port receives from investing in new port facilities depends on the investments made by competing ports: an investment is likely to yield more cargo if competing ports do not invest, as cargo will leave the outdated, less efficient facility for the newer, more efficient one. Thus, in deciding whether to invest (or the extent of investment), it is important for a port to take into consideration the strategic investment opportunities of its competitors.

Competing ports may have limited investment opportunities, which makes their market shares vulnerable to poaching through investment; or they may have investment opportunities that make it easy for them to defend their market share.

In this game, there are two players, Busan and Shanghai ports. Each port must decide whether to make an investment in some infrastructure that will make it more appealing to certain types of cargo, and thus more profitable. The normal table representation of this game is:

| | | *Shanghai Port* | |
|---|---|---|---|
| | | **Invest** | **Do Not Invest** |
| *Busan Port* | **Invest** | $\Pi_{B(I,I)-CB}, \Pi_{S(I,I)-CS}$ | $\Pi_{B(I,N)-CB}, \Pi_{S(I,N)}$ |
| | **Do Not Invest** | $\Pi_{B(N,I)}, \Pi_{S(N,I)-CS}$ | $\Pi_{B(N,N)}, \Pi_{S(N,N)}$ |

The table represents the payoffs that are received by each player, the Busan (row) player first, and the Shanghai (column) player second in each cell. The symbol Pi(si,sj) captures the payoffs, or profit, of port i, not including investment costs which result from the combination of investment decisions by the two ports, si $\in$ {Invest, Not invest}. Investment costs, Ci, are expressed separately to identify their explicit decisions.

The profits represented in the table arise from the market for container transshipment services based on the nature of competition between the two ports. Economic theory presents three ways to think about how prices, which in turn determine quantities provided at each port and hence profits, are determined. First, prices could be determined through a competitive market. Second, prices could be determined through a cooperative or tacit collusive arrangement between the ports designed to divide market share in a way that maintained high prices and profits. Third, prices could be determined through imperfect competition.

In all market structures, the people who make cargo routing decisions will choose the route, including the hub port, which is most appealing by taking into account such factors as liner and port charges, shipping time and reliability of the route. Since time and uncertainty can be reduced with additional money, we will refer to the most appealing option as the one of least cost. Pricing in port competition is most likely a combination of perfect competition and oligopolistic imperfect competition. Each port has strong market power over geographically proximate shipping. However, for transshipment in Northeast Asia in particular, there are a large number of competitors, so the extent of local market power is limited, and the most desired market share is region-wide. Thus, pricing policy should be evaluated on a regional basis.

We are suggesting thinking about pricing in an imperfect competition framework that allows each port's demand for respond to other ports' prices differently, based on each port's mixture of local cargo and the availability of substitutes. One way to do this is to represent the profits in the table as the Nash equilibrium profits of a Bertrand pricing game. That is, after the firms have made their investment decisions and built their infrastructure, they are going to set prices to compete with one-another as Bertrand competitors. In this game, their respective demand curves are represented by:

qB(pB,pS); = a - pB + b(sB,sS) pS

qS(pS,pB); = a - pS + b(sS,sB) pB

These demand equations faced by each firm capture the effect that pricing and appeal of a port's competitors have on its demand. Raising a port's own price drives customers to the competition, increases in the competition's price drive customers back.

The function b(sB,sS) plays a key role in this game, as it captures how the quantity demanded at one port responds to the price of its competitor. In economic terms, this is a demand elasticity. Thus, in the port competition model, it captures differences in location, differences in appeal, and differences in infrastructure; because it is based on differences, it changes with investment on the part of both ports.

We are currently evaluating parameterized functional forms of the b(sB,sS) function for use in this model. We want a functional form which has sensible properties for port competition, including:

a). Decreasing in own investment, so that a port's own investment distinguishes its product in the market (by being faster, more efficient, more reliable, etc.), making it less sensitive to others' prices

b). Conversely, increasing in competitors' investment

c). Range that includes zero (isolated markets), where a port's demand is not affected by the price of the other port

The functional form will also include parameters scaling the firms' respective investments, so the effects of investment may be better calibrated to the geographic markets from which the cargoes being studied are drawn.

## 2. Game Solutions

Once we have selected a functional form for b(sB,sS), the game will be solved backward in two steps, beginning with the pricing game.

a). For the four possible combinations of investing and not investing on the part of the two players, we will solve the Bertrand competition game to fill in the values for ?B and ?S above.

b). We will then solve the investment game in the table based on the Nash equilibrium.

The idea behind this backward induction solution is that firms will need to consider their ability to compete in the pricing market in order to evaluate their return on investment ifrom the game. In the Nash equilibrium, each port is giving its best response, given what the other port has chosen. Therefore, this game will help identify likely actions on the part of the competitor port, and the best response to it.

With a large number of ports, the solution converges rather quickly to the competitive outcome. Thus, the case of competition between Busan and Shanghai can be analyzed with a Bertrand model, which would provide an optimistic estimate of the two ports' profits because the competitive contribution of other ports in the region are not factored in, or a competitive model, which would provide a conservative estimate because it may not fully capture the ports' ability to exercise local and regional market power and charge higher prices.

# VII. Applying the Game Model

## 1. Approach

Applying the full two-stage Bertrand competition model requires very complete information about profit functions, or other objective functions of each player.

Such information is usually proprietary, and even data that would allow inferences to be drawn about what profits might be is particularly challenging to locate with regard to Chinese ports, because in many cases it is not recorded by the Chinese authorities. Thus, to develop a game based analysis of Busan and Shanghai port development policies, we abstract from the "pricing game", focusing instead on strategy in the "development game" given observed or projected prices; we can do this because Shanghai's development is already underway, and new prices are posted. Thus, we can evaluate possible pricing and development policies in Busan.

Applying the "pricing game" requires filling in the profit values of the game table based on the quantity of services demanded at each port and on the observed price differences. To determine how demand changes based on the difference in cargo routers' costs for using each port, we construct an estimate of the demand curve

for export transshipment services at Busan. To do this, we estimate the number of containers to be shipped from important northern Chinese ports to key world markets, dividing the estimated volumes into different world markets. We then determine the shipping times along each Chinese source port-foreign world port route through either Shanghai or Busan. The volume along each route can then be associated with the hub port that it can travel through faster. The time difference indicates a strength of preference, which can be converted to a monetary value using a willingness to more pay per hour for faster shipping time. Ports can then determine how much business will switch ports in response to differences in costs other than time, such as port charges or transshipment turnaround time. This can be used to estimate the demand at each port in response to investments that affect port charges or turnaround time.

The next section explains the data and method used to construct the demand estimates.

## 2. Data Used

### A) Shipping Times

The first step in determining demand at each port is calculating which port has a travel time advantage on which international routes. This largely reflects which route is shorter in nautical miles, but there are a number of factors that may not be included in mileage measures of travel times. First, currents can affect the speed of ships traveling between ports so that two trips of the same physical distance may take considerably different times. Second, certain ports, especially congested ports, may delay vessels and force them to wait for hours, or even a couple days. These factors, which may vary by terminal within a given port, are not captured by distances alone.

To addresses these concerns, we use liner's scheduled sailing times between ports, where possible. The distance and scheduled travel hours between the northern Chinese ports of interest and the hub ports are presented in the following table.

Table Ⅶ-1 Travel times & distances between northern Chinese ports and hub ports

| Chinese Port | Shanghai | | Busan | |
|---|---|---|---|---|
| | Distance (NM) | Travel time (Hour) | Distance (NM) | Travel time (Hour) |
| Dalian | 528 | 28 | 559 | 28 |
| Tianjin (Xingang) | 679 | 30 | 711 | 36 |
| Qingdao | 351 | 21 | 501 | 24 |
| Yantai | 490 | 23 | 521 | 23 |
| Weihai | 448 | 21 | 480 | 24 |
| Lianyungang | 309 | 15 | 514 | 34 |
| Ningbo | 132 | 5 | 517 | 37 |

1) Reasonable travel time data was not available for all port pairs, so travel times presented in red [which are???] were estimated based on dividing distance by average speed (from other 4 ports on similar routes)

We obtained vessel travel time in hours between port pairs from the web sites of Maersk and Hanjin shipping lines. For each pair of ports, we identified a vessel that served those two ports. Then if possible, we sought nonstop service, but vessels serving northern Chinese ports were running regular circle routes. For these services, we subtracted time vessels were scheduled to spend in each port. While this means that travel times may not reflect times along the most direct routes, they are nonetheless reflective of the shipping times between ports of interest.

By this measure, most Chinese ports have similar travel times to Busan and Shanghai. For routes in which this method yielded meaningless values, or meaningless differences, (due to hourly data being available on only circuitous routes), we adjusted times to reflect published day schedules.

TableⅦ-2 shows the distance and scheduled shipping times between the hub ports under consideration to major world ports.

TableⅦ-2 Travel times & distances between hub ports and foreign destination ports

| Port | Country | Shanghai | | Busan | |
|---|---|---|---|---|---|
| | | Distance | Travel time (Hour) | Distance | Travel time (Hour) |
| | | (NM) | | | |
| Los Angeles | USA | 5700 | 255 | 5241 | 240 |
| Long Beach | USA | 5705 | 245 | 5245 | 218 |
| New York | USA | 10568 | 514 | 10108 | 494 |
| Seattle/Tacoma | USA | 5080 | 223 | 4620 | 198 |
| Vancouver | Canada | 5091 | 256 | 4631 | 231 |
| Felixstowe | United Kingdom | 10385 | 459 | 10675 | 475 |
| Rotterdam | Netherlands | 10464 | 453 | 10754 | 469 |
| Hamburg | Germany | 10718 | 477 | 11008 | 493 |
| Antwerp | Belgium | 10459 | 496 | 10749 | 501 |
| Le Havre | France | 10264 | 504 | 10554 | 520 |
| Kobe | Japan | 762 | 39 | 359 | 33 |
| Tokyo | Japan | 1049 | 69 | 665 | 50 |
| Hong Kong | China | 868 | 19 | 1159 | 20 |
| Singapore | Singapore | 2196 | 93 | 2486 | 112 |
| Kaohsiung | China, Taiwan | 639 | 26 | 921 | 45 |

1) Travel times in red [???] are from non-stop routes; travel times in blue [???] have been adjusted to reflect published daily schedules (in contrast to available hourly schedules)

Although travel times to the two hub ports are similar from most northern Chinese ports, there are some differences to world ports. Busan's proximity to the eastbound main trunk route gives it an advantage to North American ports, while Shanghai is closer to the Suez Canal route to European markets.

TableⅦ-3 shows Busan's shipping time differences associated with the each route; positive numbers can be served more quickly through Busan and negative numbers can be served more quickly through Shanghai. In general, Busan can serve the North American and Japanese markets faster, and Shanghai can serve the European markets faster, reflecting the geographic advantage of each port.

Busan and Shanghai can add to, or subtract from, their natural appeal by changing factors in their services. First, Table VII-3 shows only travel times, and does not include transshipment turnaround times. Thus, travel time differences can be increased or reduced if one hub port transships faster than the other. Second, cargo routers may be willing to trade off additional shipping time for lower port fees, or pay a higher rate to accelerate shipping. Therefore, hub ports can also affect demand for their services by changing prices[25]. While the value of time varies by shipment, precise data on shipments is not available, so we use an average rate of $25 per TEU per hour of shipping saved[26].

Thus, for each route, we calculate the difference in money or equivalent costs that is required for cargo routers on that route to prefer one port over the other.

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25) There may also be differences in freight charges associated with each route

26) $25 per TEU per hour is based on a preliminary analysis of cargo router preferences for US imports from all over the world.

Table Ⅶ-3 Estimated differences in vessel travel times (Busan-Shanghai) Chinese cargo ports destined for each foreign port

| type | | Foreign Destination | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | LA | LB | NY | SEA | Vancouver | Felixstowe | Rotterdam | Hamburg | Antwerp | LeHavre | Kobe | Tokyo |
| Chinese Origin | Dalian | 15 | 27 | 20 | 25 | 25 | -16 | -16 | -16 | -5 | -16 | 6 | 19 |
| | Tianjin | 9 | 21 | 14 | 19 | 19 | -22 | -22 | -22 | -11 | -22 | 0 | 13 |
| | Tsingdao | 13 | 25 | 18 | 23 | 23 | -18 | -18 | -18 | -7 | -18 | 4 | 17 |
| | Yantai | 15 | 27 | 20 | 25 | 25 | -16 | -16 | -16 | -5 | -16 | 6 | 19 |
| | Weihai | 12 | 24 | 17 | 22 | 22 | -19 | -19 | -19 | -8 | -19 | 3 | 16 |
| | Lianyugang | -4 | 8 | 1 | 6 | 6 | -35 | -35 | -35 | -24 | -35 | -13 | 0 |
| | Shanghai | -8 | 4 | -3 | 2 | 2 | -39 | -39 | -39 | -28 | -39 | -17 | -4 |
| | Ningbo | -17 | -5 | -12 | -7 | -7 | -48 | -48 | -48 | -37 | -48 | -26 | -13 |

1) The Shanghai-LA cell is calculated on the travel times of Shanghai-Busan voyage time, 23 hours and Busan-LA voyage time, 240 hours

### B) Transshipment Volumes

Having established the travel times along each route, the next step in determining demand is establishing the volume of transshipped TEUs along each route. This is an extremely challenging task, because no central data collecting agency has information on the number of containers on each route. That is, no one collects the number of containers originating at each northern Chinese port, how those are distributed between the hubs, and how many containers from each hub are delivered to which world destinations.

Korean Customs tracks the origins and destinations of cargo shipped through Korea, but they do not have information on cargo not shipped through Korea, which is key to understanding the full extent of the market. To construct estimates of the volume along each route, we use a series of strong assumptions to leverage the available data. Where possible, we used 2004 data, which is the most recent year widely available.

Since Korean Customs data is the only data available on the number of transshipped containers originating at each northern Chinese port, we scale the number of transshipped containers originating at each northern Chinese port and transshipment moves in Busan by the ratio of the total number of transshipment through Shanghai (6,242,000)[27] to the total number of transshipment moves in Busan (4,762,000) to obtain the total size of the market, the total number of containers to be transshipped through either of the hub ports.

This is probably not an accurate assumption, because cargo ports will disproportionately select the hub port that is closer to them based on route over which they ship most of their cargo. However, we do not have this data.

Table VII-4 presents these estimates. The Trans in Pusan column comes from Korean Customs data for all ports except Yantai and Weihai, which are estimates from pooled data. The right-hand column shows the scaled numbers, which we take as the total size of the market from each Chinese port.

Transshipped in Busan is based on Korean Customs data and scaled transshipped containers can is multiplying this by the ratio of transshipping activity at Shanghai to that of Busan.

27) Drewry Shipping Consultants Ltd., The Drewry Annual Container Market Review and Forecast 2005/06, 2005. p. 32.

Table Ⅶ-4 Estimated 2004 containers (000s) transshipped from each northern Chinese ports

| type | Total Throughput | Trans. In Pusan | Scaled Transhp Containers |
|---|---|---|---|
| Dalian | 2651 | 133.2 | 307.798 |
| Tianjin | 4801 | 194.2 | 448.756 |
| Quingdao | 6307 | 190.2 | 439.513 |
| Yantai | 500 | 9.8 | 22.586 |
| Weihai | 500 | 9.8 | 22.586 |
| Lianyugang | 1010 | 11.4 | 26.343 |
| Shanghai | 18084 | 149 | 344.308 |
| Ningbo | 5191 | 65.7 | 151.819 |

Having established the quantity of transshipped containers leaving each Chinese port, it is necessary to determine how each origin port's total is divided among the world ports of interest. Unfortunately, even the Korean Customs data available to us does not indicate, for that subset, how each origin port's data is distributed among individual destination ports. Hence, strong assumptions are again required to make use of available data.

Thus, we assume that the same percentage of transshipped cargo from each Chinese port goes to each foreign port. However, the foreign destination ports do not report separately transshipped and direct shipped containers. Hence, we assume that all foreign ports receive the same percentage of their Chinese imports through transshipment.

Thus, the portion of transshipped containers originating in Dalian and going to Los Angles, for instance, is the number of transshipped containers exported from Dalian (first row) multiplied by the ratio of the total number of TEUs imported from China at Los Angeles to the total number of TEUs imported from China at all the world ports listed. Given the major world ports being considered, and that direct service is available for all of them, this is a plausible assumption in the absence of better data. Import TEU data for US ports was obtained from PIERS and is not a constructed estimate.

Information for Vancouver, Tokyo and Kobe was obtained from the ports' web sites. In some cases, ports report only total TEUs and import volume by country in tons; in this case, it is assumed that the TEUs from China is the same fraction of total TEUs as Chinese-origin tonnage is to total tonnage. Felixstowe and Le Havre data are from Drewry Consultants, and Rotterdam, Hamburg and Antwerp are from intermodal.org.

Table VII-5 shows the resulting estimated volumes along each route, especially the number of boxes moved. In conventional accounting of transshipment TEU volume, boxes are counted twice, once for unloading the feeder vessel, and once for loading the export vessel. While our volume estimates may be lower than other published numbers due to data problems and the limited scope of our analysis, each container is counted twice in official port productivity numbers.

Table Ⅶ-5 Estimated 2004 transshipped originating at each Chinese port

(thousand TEU)

| | | Foreign Destination | | | | |
|---|---|---|---|---|---|---|
| | | LA | LB | NY | SEATAC | Vancouver |
| Est. China Imports (000TEUs) | | 2251 | 2202 | 616 | 843 | 424 |
| % Share | | 17.93% | 17.54% | 4.90% | 6.72% | 3.38% |
| Chinese Origin | Dalian | 55.191 | 53.985 | 15.097 | 20.673 | 10.392 |
| | Tianjin | 80.466 | 78.708 | 22.011 | 30.141 | 15.151 |
| | Tsingdao | 78.809 | 77.086 | 21.558 | 29.520 | 14.839 |
| | Yantai | 4.050 | 3.961 | 1.108 | 1.517 | 0.763 |
| | Weihai | 4.050 | 3.961 | 1.108 | 1.517 | 0.763 |
| | Lianyugang | 4.724 | 4.620 | 1.292 | 1.769 | 0.889 |
| | Shanghai | 61.738 | 60.388 | 16.888 | 23.126 | 11.625 |
| | Ningbo | 27.223 | 26.628 | 7.447 | 10.197 | 5.126 |
| Total | | 316.251 | 309.338 | 86.510 | 118.461 | 59.547 |

| | Foreign Destination | | | | | | |
|---|---|---|---|---|---|---|---|
| | Felixstowe | Rotterdam | Hamburg | Antwerp | LeHavre | Kobe | Tokyo |
| | 1040 | 797 | 2195 | 445 | 330 | 483 | 928 |
| | 8.29% | 6.35% | 17.49% | 3.54% | 2.63% | 3.84% | 7.39% |
| Dalian | 25.502 | 19.543 | 53.823 | 10.907 | 8.102 | 11.833 | 22.750 |
| Tianjin | 37.180 | 28.493 | 78.472 | 15.902 | 11.812 | 17.252 | 33.169 |
| Tsingdao | 36.414 | 27.906 | 76.855 | 15.574 | 11.569 | 16.897 | 32.485 |
| Yantai | 1.871 | 1.434 | 3.950 | 0.800 | 0.594 | 0.868 | 1.669 |
| Weihai | 1.871 | 1.434 | 3.950 | 0.800 | 0.594 | 0.868 | 1.669 |
| Lianyugang | 2.183 | 1.673 | 4.606 | 0.933 | 0.693 | 1.013 | 1.947 |
| Shanghai | 28.526 | 21.861 | 60.207 | 12.201 | 9.063 | 13.237 | 25.449 |
| Ningbo | 12.578 | 9.639 | 26.548 | 5.380 | 3.996 | 5.837 | 11.221 |
| Total | 146.126 | 111.983 | 308.411 | 62.497 | 46.423 | 67.804 | 130.360 |

The information in Tables 2 and 4 can be combined to associate a volume of transshipment business with each port: if the value in a cell in Table 2 is positive, indicating shipping through Busan is faster, the value in the corresponding cell of Table 4 can be expected to travel to Busan, other things equal, because it is faster to use.

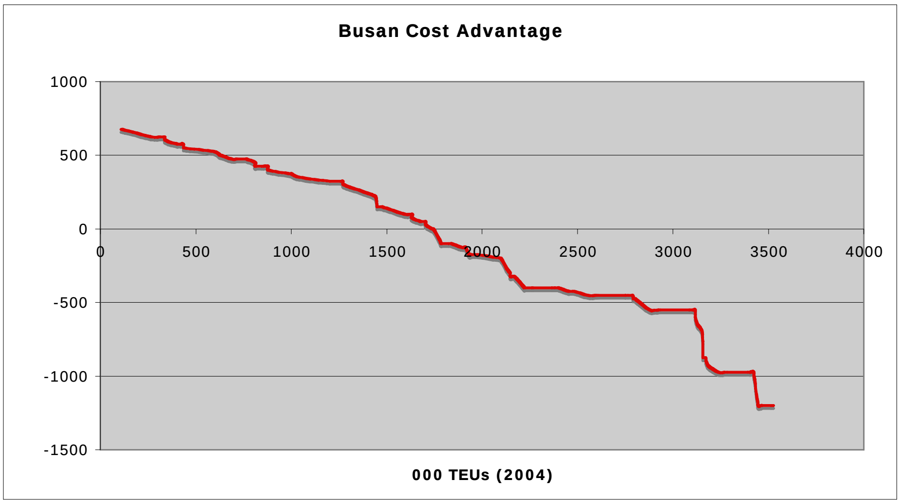
## 3. Market Vulnerability

Having collected data on travel times and route volumes, the first exercise is to examine the sensitivity of demand for Pusan port services based on the geography of the markets.

Because Busan is closer to the main eastbound trunk line than Shanghai, it has a natural advantage in getting products from northern Chinese ports to US markets faster than Shanghai, which is out of the way. The time difference associated with shipment through Busan, relative to shipment through Shanghai, can be used to indicate this advantage, and therefore the strength of preference a shipper from a northern Chinese port to a given destination port.

FigureⅦ-1 below shows the number of TEUs for which Busan has a natural price advantage at each level. For example, the graph shows that there are about 500 TEUs of transshipment volume for which Busan has a natural cost advantage of over $500 per TEU. This represents a sort of natural demand curve, reflecting the per-TEU reservation prices at which cargo routers would switch from one port to the other. Busan's overall natural geographic advantage is expressed by most of the TEU volume producing a positive cost advantage for Busan. Here, the zero line represents where there is no cost advantage for one port or the other, and hence volume above the zero line represents business for Busan and volume below the line represents business for Shanghai. If the only difference between the ports is the speed of getting goods to market, we could expect Busan to handle about 1,724,000 of the 3,527,000 transshipment container moves (48.9% market share) transshipped from northern Chinese ports in 2004.

**Figure Ⅶ-1** Cost advantage arising from Busan's location




However, Busan has two causes for concern from this graph. Since this graph shows only cost-equivalent advantage arising from lower travel times through Busan, it must be adjusted for other cost factors, such as port charges and the turnaround time of transshipped cargo. If Busan is cheaper to use (considering both port charges and turnaround time), then the horizontal line representing no cost advantage for either port moves down. This would reflect that Busan's lower cost was able to attract some cargo from Shanghai for which Shanghai had a natural advantage, but nevertheless found Busan to be a better deal due to lower port charges or faster turnaround time.

Based on this logic, TEUs that are relatively close to the zero line are vulnerable to be attracted to the other port, and TEUs that are relatively far from the zero line are relatively secure business, because the natural cost advantage is so great.

Recent trends give the advantage in faster operations and lower charges to Shanghai, which leads to the first source of concern. The region of the demand curve just above the zero line is relatively flat, indicating that Shanghai can capture a large number of TEUs from Busan by creating a relatively small difference in port charges or turnaround time. Specifically, if it is $100/TEU cheaper to use Shanghai (considering both lower port fees and faster handling times), more than 140,000 TEUs for which Busan has a natural cost advantage of less than $100 will switch to Shanghai; if it is $500 cheaper to use Shanghai, 1,114,000 TEUs for which Busan has a natural advantage will find Shanghai cheaper to use. Thus, Busan's market share is relatively vulnerable to increases in efficiency or reduced costs at Shanghai.

The second source of concern is the steepness of the demand curve below the zero line means Shanghai's natural market share is not similarly vulnerable; capturing a significant number of TEUs for which Shanghai has a natural advantage would require creating very significant price and turnaround time advantages for Busan. For example, making Busan $100/TEU cheaper than Shanghai would capture only about 94,000 TEUs, about two-thirds the volume Shanghai could capture with a similar price difference. However, for larger price differences, it Shanghai and Busan are on more equal footing: making Busan $300/TEU cheaper would capture only 404,000 TEUs from Shanghai, while a similar price difference in favor of Shanghai would capture 464,000 TEUs from Busan.

Together, these factors mean that Shanghai approaches investment to make their operations modestly faster and lower cost thinking they will be able to capture significant market share from Busan.  But Busan must approach their investment considering themselves as primarily defending marginal market share, as very significant cost reductions would be necessary to attract meaningful business from Shanghai.

## 4. Estimating Demand Changes: Price & Turnaround Time

To facilitate application of the demand to scenarios arising from port investment, we have constructed a spreadsheet based on the data and estimates described above that allow a user to enter different turnaround times and price charges at Shanghai and Busan to obtain the resulting allocation of transshipped TEUs and revenues for each port.

TableⅦ-6  Scenario Builder Example: demand prediction workbook

| | | | |
|---|---|---|---|
| Scenario Builder | | | |
| | Change parameters in colored cells<br>to predict total TEUs through each port,<br>breakdown along routes, and revenues | | |
| Parameters | | | |
| | Variance | 0.001 | Sets responsiveness of shipping to cost differences; 0 is unresponsive (random) |
| | Cost/Hour | $25.00 | Cargo routers' willingness to pay per hour of faster shipping.  Baseline 25USD |

**Scenario**

**1) Turnaround Time**

| Turnaround Time | | | | |
|---|---|---|---|---|
| port | | Time | | |
| | | normal | optimal | |
| Busan | | 55.4 | 37.8 | 3 Quay cranes/berth |
| Shanghai | | 37.7 | 32.7 | 3.6 Quay cranes/berth |
| Busan Advantage | time | -17.7 | | |
| | cost equivalent | -442.5US$ | | |

**2) Cost**

| cost | |
|---|---|
| Busan | 156.8 |
| Shanghai | 72.1 |
| Busan Advantage | -84.7US$ |

Table VII-6 shows the primary scenario entry interface of the Scenario Builder section of the worksheet. The worksheet has two parameters. The willingness to pay per hour of shipping parameter represents the cargo router's willingness to pay for a 1-hour faster shipping route; it has a baseline value of $25 USD. The other parameter is more subtle. It captures the sensitivity of shippers to the differences in costs; it is used to compute a probability that each TEU along that route is shipped to the preferred port, with the probability increasing in the differences in costs. The parameter is the value λ in the expression,

$$\frac{\exp(\lambda \Delta C)}{1+\exp(\lambda \Delta C)}$$

where △C is the difference in costs. Over a large number of containers, the probability can be interpreted as a proportion of those containers that go to the less expensive port.

Larger positive values of the parameter correspond to greater sensitivity to price differences; a value of 0 means total insensitivity, or half of containers on each route will go through each hub. A baseline value of 0.001 seems reasonable.

After selecting appropriate values for the parameters, the scenarios can be developed by selecting different transshipment turnaround times and per-move transshipment service prices. The corresponding values can be entered into the colored cells. The worksheet then uses our travel time and volume estimates to predict demand at each port, and the associated revenues from transshipment, at each hub port.

## 5. Game Model Application

We can use this demand prediction tool to generate payoffs (in TEUs or revenue) based on different investment and development scenarios being considered by both ports. The best response to one-another's proposed strategies can be identified, and equilibrium concepts applied to predict likely investment choices by each side. In this section, we demonstrate the use of this tool, and apply it to assess recent investments at Shanghai-Yangshan, and identify whether what scale of response from Busan is reasonable.

*Scenario 1*: Investment in Reduced Turnaround Times

Suppose that both ports make an investment that would reduce turnaround time by an average of 8 hours, at an average annualized cost of C. This investment might be the purchase of additional cranes or dockside equipment to accelerate transshipment container handling. At the status quo, which is representative of Fall 2006 charges, we can consider Shanghai to have an average turnaround time of 37.7 hours and port transshipment fees of $72.10, whereas Busan [28] would have a turnaround time of 55.4 hours and transshipment fees of $156.80.[29] If neither port invests in a turnaround time reduction, Busan handles 1.285 million TEUs and collects $100.7 million in handling charges, and Shanghai handles 2.243 million TEUs and collects $80.9 million in handling charges.[30] The TEUs and corresponding revenues with a variance parameter of 0.001, are shown in the table below.

---

28) The charge for Busan is an average accounting for a mixture of 20-foot and 40-foot containers (loading and unloading is $57.90/TEU and $82.60/FEU), and of same-terminal transshipments and other-terminal transshipments, which must incur a $30-50 shuttle charge to move between terminals (57.8% of cargo in 2004; shuttle charges between Busan's Newport and the downtown terminal are higher $50-80, but that was not a factor in our 2004 data).

29) The freight charges used are based on 2006 published rates. This captures the competition between the ports at an awkward time, since they are still operating primarily out of the downtown terminals, while Shanghai's Yanghsan terminal is serving cargo at a lower rate; possible cost savings which would allow Busan to lower their rates at Busan Newport are not captured here.

30) Note that revenues are not profits. Shanghai may or may not be more profitable than Busan in this case, based on their respective costs.

| | | Shanghai Port | |
|---|---|---|---|
| | | Invest | Do Not Invest |
| Busan Port | Invest | 1.285, 2.243<br>$100.7-C, $80.9-C | 1.442, 2.085<br>$113.1-C, $75.2 |
| | Do Not Invest | 1.134, 2.393<br>$88.9, $86.3-C | 1.285, 2.243<br>$100.7, $80.9 |

Since it is only the differences in service times that matter in this model,[31] this case illustrates the dilemma faced by port developers: if both ports invest (upper left cell); their volumes and revenues do not change relative to both not investing (lower right cell), but they have both paid the additional amount C; they have invested and received no net benefit.

Consider how this situation might arise. Busan observes that if they invest and Shanghai does not, they can raise their revenues to $113.1 million, thus if C is less than the additional profit (113.1-100.7=12.4 million), they will find it is independently profitable in the case when Shanghai does not invest. In the case when Shanghai does invest, it is also Busan's best response to invest when C is less than 100.7-88.9=$11.8 million.

Hence, if C is less than $11.8 million, investing is Busan's best

31) Since faster service times decrease the cost of shipping (shipped capital is tied up in transit for less time), it is actually likely that total market volume will increase in this case. Since this model predicts only the allocation of the 2004 TEUs among ports, this market expansion is not taken into consideration.

response, regardless of what Shanghai does; if C is greater than $12.4 million, not investing is Busan's best response regardless of what Shanghai does; and if C is between $11.8 and $12.4 million, investing is Busan's best response only if Shanghai does not invest.

From Shanghai's perspective, if they invest and Busan does not, they can raise their revenues from 80.9 to 86.3 million. So if C is less than $5.4 million, they will want to be the only investor.[32] However, if Busan invests, Shanghai can also improve their revenues from 75.2 to 80.9-C, so they will want to invest if C is less than $5.7 million.

Hence, if C is less than $5.4 million, Shanghai's best response is to invest regardless of what Busan does; if C is greater than $5.7 million, Shanghai should not invest regardless of what Busan does; and if C is between 5.4 and 5.7 million, investment will be their best response only if Busan invests.

In deciding whether to invest, each port can use the Nash equilibrium to figure out the likely choices of its competitor. Suppose C is the same for each port, and greater than $12.4 million. In this case, it is Busan's best response to not invest, regardless of what Shanghai does. Similarly, it is Shanghai's best response to not invest, regardless of what Busan does. Hence, both ports will not invest, and neither can do better by changing their strategy, so each not investing is a Nash equilibrium.

Suppose instead that C is between $11.8 and $12.4 million. In this case, investment is the best response for Busan only if Shanghai does not invest. However, Busan can see that it is Shanghai's best response not to invest regardless of what Busan does in this price range, so it can

32) When Shanghai invests alone, they capture about the same number of TEUs as does Busan when they invest alone, 159,000 compared to 157,000 for Busan. Note that Shanghai's return from capturing additional market share is nevertheless less than half that of Busan because their port charges are so much lower.

predict that Shanghai will not invest. Busan's best response to Shanghai's non-investment is to invest. Thus, in this case, Busan will invest and Shanghai will not invest, and neither port can be better off by changing its strategy unilaterally, so this is a Nash equilibrium.

The same logic applies when C is between $5.7 and $11.8 million, as it remains a dominant strategy for Shanghai to not invest, and a dominant strategy for Busan to invest.

In the case where C is between $5.4 and $5.7 million, it becomes a best response for Shanghai to invest only if Busan invests. Shanghai can use the game table to figure out whether it is likely that Busan does not invest. They can see that it is the best response for Busan to invest, because it is the best response for Busan to invest at C less than $11.8 million, regardless of what Shanghai does. Thus, Shanghai will deduce that Busan will invest, to which their best response is to invest in this range of C. Hence, Busan will invest and Shanghai will invest, and neither party will be able to improve upon their payoff by unilaterally changing their strategy, a Nash equilibrium.

The case where C is below $5.7 million is perhaps the most strategically interesting, because it illustrates a strategic pitfall to investment and competition. In this case, it is the best response for both ports to invest regardless of what the other does, so it is a Nash equilibrium for both ports to invest. However, all the investment has accomplished is a reduction in service times. Because the same reduction took place at both ports, the distribution of TEUs, and hence revenue, is that same as in the case where neither port invested. That is, both ports spent money, yet neither improved its market share.

This strategic pitfall can lead ports to dissipate their profits in a competitive arms race; cooperation in development can help avoid this costly situation.

This analysis followed the simple case where C was the same for both ports. In reality, it my be cheaper for Shanghai to operate the additional cranes because their labor costs are lower. In this case, there would be a separate C for each port, and they would act as explained here, comparing Busan's C to the $12.4 and $11.8 million thresholds, and Shanghai's to the $5.7 and $5.4 million thresholds.

*Scenario 2*: Gantry Cranes Investment- Normal Case

The previous scenario was constructed to illustrate the pitfalls of offsetting investments, and not based on any actual known investment opportunities. However, information on productivity at the two ports can be used to assess the specific effect of adding additional gantry cranes to each vessel, a measure on which the ports currently differ.

The next two sections evaluate the strategic considerations associated with this investment under two different assumptions about the long-run productivity at each port.

At present, Busan uses 3 cranes per berth, but Shanghai uses an average of 3.6 cranes per berth, leading to a faster turnaround time. This section evaluates whether Busan would benefit from investing in additional gantry cranes to raise their cranes per berth level to Shanghai's level, and the extent to which this investment could be offset by a corresponding investment from Shanghai to reestablish their turnaround time advantage.

The status quo turnaround times are shown in Table VII-7. Productivity measures indicate Busan is able to move 23.45 box moves per hour with 3 gantry cranes, and Shanghai is able to do 34.46 box moves per hour with 3.6 gantry cranes. Given a shipment of 300 twenty-foot boxes and 350 forty-foot boxes, each unloaded from a feeder vessel and loaded on a mainline vessel, the respective status quo turnaround times are 55.4 hours for Busan and 37.7 hours for Shanghai. Note that these numbers do not take into account the frequency of mainline vessel service, which would affect dwell time and therefore the expected turnaround time; we assume that these are the same between ports, as on many routes the two ports are served by the same vessels running the same routes.

TableⅦ-7 Normal status-quo turnaround times

| type | | | Turnaround Time | |
|---|---|---|---|---|
| | | | Busan (G/C:3) 23.45 van/hour | Shanghai (G/C:3.6) 34.46 van/hour |
| Unloading | TEU | 300van | 12.8 | 8.7 |
| | FEU | 350van | 14.9 | 10.2 |
| Loading | TEU | 300van | 12.8 | 8.7 |
| | FEU | 350van | 14.9 | 10.1 |
| TOTAL | TEU | 2000 | 55.4 | 37.7 |

At status quo pricing of $72.10 in transshipment fees at Shanghai and $156.80 at Busan, the difference in cost-equivalent per-TEU is $527.20, a considerable value which may explain why Busan has been losing market share to Shanghai since Shanghai's investments in increased productivity. Suppose that at an average annualized cost of C, each port has the ability to assign and average of 0.6 more gantry cranes to each vessel and increase the productivity proportionately. This would correspond to 28.14 box moves per hour with 3.6 cranes for Busan, yielding a turnaround time of 46.2 hours; and 40.20 box moves per hour with 4.2 cranes for Shanghai, yielding a turnaround time of 32.3 hours. The game will indicate whether it is strategically sensible for Busan to invest in increasing the number of gantry cranes per ship, and then whether the effects of that investment would be offset by a strategic investment by Shanghai.

The TEUs and corresponding revenues, with a variance parameter of 0.001, are shown in the table below.

| type | | *Shanghai Port* | |
|---|---|---|---|
| | | Invest | Do Not Invest |
| *Busan Port* | Invest | 1.359, 2.169<br>$106.5−C, $78.2−C | 1.466, 2.061<br>$115.0−C, $74. |
| | Do Not Invest | 1.182, 2.345<br>$92.7, $84.5−C | 1.285, 2.243<br>$100.7, $80. |

The status quo values are in the lower right cell, corresponding to no further investment on the part of either port. The model predicts that Busan will handle 1,285,000 TEUs to Shanghai's 2,243,000 on the routes being evaluated (36.4% market share). Shifts in cargo during 2005, after the opening of Yangshan terminal, indicate a reduction in market share for Busan. This leads to a predicted $100.7million in revenues for Busan, and $80.9 million for Shanghai.

Busan observes that if they invest and Shanghai does not, they can raise their revenues to $115.0 million, thus if C is less than the additional profit (115.0-100.7=14.3 million), they will find it is independently profitable in the case when Shanghai does not invest. In the case when Shanghai does invest, it is also Busan's best response to invest when C is less than 106.5-92.7=$13.8 million. Hence, if C is less than 13.8 million, investing is Busan's best response, regardless of what Shanghai does; if C is greater than 14.3 million, not investing is Busan's best response regardless of what Shanghai does; and if C is between 13.8 and 14.3 million, investing is Busan's best response only if Shanghai does not invest.

From Shanghai's perspective, if they invest and Busan does not, they can raise their revenues from 80.9 to 84.5 million, so if C is less than $3.6 million, they will want to be the only investor. However, if Busan invests, Shanghai can also improve their revenues from 74.3 to 78.2-C, so they will want to invest if C is less than $3.9 million. Hence, if C is less than $3.6 million, Shanghai's best response is to invest regardless of what Busan does; if C is greater than $3.9 million, Shanghai should not invest regardless of what Busan does; and if C is between $3.6 and $3.9 million, investment will be their best response, only if Busan invests.

In deciding whether to invest, each port can use Nash equilibrium to figure out the likely choices of its competitor. Suppose C is the same for each port, and greater than $14.3 million. In this case, it is Busan's best response to not invest, regardless of what Shanghai does, and it is Shanghai's best response to not invest regardless of what Busan does. Hence, both ports will not invest, and neither can do better by changing their strategy, so each not investing is a Nash equilibrium.

Suppose instead that C is between $13.8 and $14.3 million. In this case, investment is a best response for Busan only if Shanghai does not invest. However, Busan can see that it is Shanghai's best response not to invest regardless of what Busan does in this price range, so it can predict that Shanghai will not invest. Busan's best response to Shanghai's non-investment is to invest. Thus, in this case, Busan will invest and Shanghai will not invest, and neither port can be better off by changing its strategy unilaterally, so this is a Nash equilibrium.

The same logic applies when C is between $3.9 and $13.8 million, as it remains a dominant strategy for Shanghai to not invest, and a dominant strategy for Busan to invest.

In the case where C is between $3.6 and $3.9 million, it becomes a best response for Shanghai to invest only if Busan does. Shanghai can use the game table to figure out whether it is likely that Busan will not invest. They can see that it is a best response for Busan to invest, because it is a best response for Busan to invest if C is less than $13.8 million, regardless of what Shanghai does. Thus, Shanghai will deduce that Busan will invest, to which their best response is to invest in this range of C. Hence, both ports will invest, and neither will be able to improve upon their payoff by unilaterally changing their strategy, a Nash equilibrium.

While not as stark as the 8-hour reduction example above, there is still potential for investment on the part of both ports to make one-another worse off. If they are facing differing C's, it can be worth it for Shanghai to invest up to $3.9 million to defend only $2.7 million in revenues, and for Busan to invest up to $14.3 million to defend only $5.8 million in revenues. Thus, we see the competitive arms race of infrastructure investment potentially dissipating profits for both ports in this normal investment case.

*Scenario 3:* Gantry Crane Investment: Optimal Case

While the analysis above is based on current productivity measures, as crews adapt to new technology at both ports, it is possible that productivity will improve without additional infrastructure investments. A reasonable limit to this learning process may be captured by the maximum throughput possible predicted by queuing theory. The game above can be recalculated with optimal turnaround times to provide insight into whether investment is an equilibrium alternative for either port in the future.

TableⅦ-8 Optimal turnaround times predicted by queuing theory

| type | | | Turnaround Time | |
|---|---|---|---|---|
| | | | Busan (G/C :3) 34.4van/hour | Shanghai (G/C:3.6) 39.7van/hour |
| Unloading | TEU | 300van | 8.7 | 7.6 |
| | FEU | 350van | 10.2 | 8.8 |
| Loading | TEU | 300van | 8.7 | 7.6 |
| | FEU | 350van | 10.2 | 8.8 |
| TOTAL | TEU | 2000 | 37.8 | 32.7 |

Suppose that at an average annualized cost of C, each port has the ability to assign and average of 0.6 more gantry cranes to each vessel and increase their productivity proportionately. This would correspond to 41.28 box moves per hour with 3.6 cranes for Busan, yielding a turnaround time of 31.5 hours; and 46.32 box moves per hour with 4.2 cranes for Shanghai, yielding a turnaround time of 28.1 hours. The game will indicate whether it is strategically sensible for Busan to invest in increasing the number of gantry cranes per ship when operating at optimal efficiency, and then whether the effects of that investment would be offset by a strategic investment by Shanghai.

The TEUs and corresponding revenues, with a variance parameter of 0.001, are shown in the table below.

| type | | Shanghai Port | |
|---|---|---|---|
| | | Invest | Do Not Invest |
| Busan Port | Invest | 1.570, 1.958<br>$123.1-C, $70.6-C | 1.664, 1.863<br>$130.5-C, $67.2 |
| | Do Not Invest | 1.442, 2.085<br>$113.1, $75.2-C | 1.535, 1.992<br>$120.4, $71.8 |

The status quo values are in the lower right cell, corresponding to no further investment on the part of either port. The model predicts that Busan will handle 1,535,000 TEUs to Shanghai's 1,922,000 TEUs on the routes being evaluated (43.5% market share). Busan's market share is higher than in the scenario above because their normal operating is further above their optimal than is Shanghai's. This leads to a predicted $120.4 million in revenues for Busan, and $71.8 million for Shanghai.

When both ports are operating at optimal efficiency, Busan observes that if they invest and Shanghai does not, they can raise their revenues to $130.5 million, thus if C is less than the additional profit (130.5-120.4=10.1 million), they will find it is independently profitable in the case when Shanghai does not invest. In the case when Shanghai does invest, it is also Busan's best response to invest when C is less than 123.1-113.1=$10.0 million. Hence, if C is less than 10.0 million, investing is Busan's best response, regardless of what Shanghai does; if C is greater than 10.1 million, not investing is Busan's best response, regardless of what Shanghai does; and if C is between 10.0 and 10.1 million, investing is Busan's best response, only if Shanghai does not invest.

From Shanghai's perspective, if they invest and Busan does not, they can raise their revenues from 71.8 million to 75.2 million, so if C is less than $3.4 million, they will want to be the only investor. However, if Busan invests, Shanghai can also improve their revenues from 67.2 to 70.6-C, so they will want to invest if C is less than $3.4 million. Hence, if C is less than $3.4 million, Shanghai's best response is to invest regardless of what Busan does; and if C is greater than $3.4 million, Shanghai should not invest regardless of what Busan does.

In deciding whether to invest, each port can use the Nash equilibrium to figure out the likely choices of its competitor. Suppose C is the same for each port, and greater than $10.1 million. In this case, it is Busan's best response to not invest, regardless of what Shanghai does, and it is Shanghai's best response to not invest regardless of what Busan does. Hence, both ports will not invest, and neither can do better by changing their strategy, so each not investing is a Nash equilibrium.

Suppose instead that C is between $10.0 and $10.1 million. In this case, investment is a best response for Busan only if Shanghai does not invest. However, Busan can see that it is Shanghai's best response not to invest regardless of what Busan does in this price range, so it can predict that Shanghai will not invest. Busan's best response to Shanghai's non-investment is to invest. Thus, in this case, Busan will invest and Shanghai will not invest, and neither port can be better off by changing its strategy unilaterally, so this is a Nash equilibrium.

The same logic applies when C is between \$3.4 and \$10.0 million, as it remains a dominant strategy for Shanghai to not invest, and a dominant strategy for Busan to invest.

In the case where C is below \$3.4 million, it becomes the best response for Shanghai to invest regardless of what Busan does. In this range, Busan will invest, and neither party will be able to improve upon their payoff by unilaterally changing their strategy, a Nash equilibrium.

*Scenario 4:* Investment at Yanghsan and Busan Newport

At the end of 2005, Shanghai welcomed the first ships to its new deepwater terminal at Yanghsan. This island terminal represented an investment of billions of dollars, made in anticipation of continued rapid growth of the South and East Asian container trade, and capturing transshipment market share from Busan, the other large transshipment hub in the region.

In anticipation of the same developments, Busan is investing heavily in Busan New Port, a large deepwater terminal facility with easy access to a hinterland business and logistics park. A few berths opened to limited traffic in 2006, but significant capacity is due to open over the next few years.

We can use this framework to identify whether Shanghai's investment was to their strategic benefit, to identify whether Busan's planned development is the best response, and whether the equilibrium is beneficial to one or both ports. Or like the scenario above, it is such that one or both ports would like to avoid.

Prior to the development of Yangshan, Shanghais' Waigaoqiao terminal was more expensive and less efficient than the new one. Suppose that without the Yangshan development, Shanghai terminal charges are comparable to current ones at Waigaoqiao, $144.10 per transshipment move, and suppose that its turnaround time was limited to 55 hours.

Suppose the Yangshan terminal reduces turnaround time to 37.7 hours, and costs to $72.10. Further, suppose that Busan's investment in Busan New Port reduces costs from $156.80 to $125, and average turnaround time from 55.4 hours to 40 hours[33]. This yields the following game payoff table, assuming a variance parameter of 0.001.

| | | Shanghai Port | |
|---|---|---|---|
| | | Invest | Do Not Invest |
| Busan Port | Invest | 1.618, 1.909<br>\$101.2-$C_b$, \$68.8-$C_s$ | 2.033, 1.494<br>\$127.1-$C_b$, \$107.7 |
| | Do Not Invest | 1.285, 2.243<br>\$100.7, \$80.9-$C_s$ | 1.691, 1.837<br>\$132.6, \$132.3 |

Here, Cb and Cs are the respective net costs of the new terminal projects at Busan and Shanghai. To be comparable with the annual revenues presented, these costs include both annualized capital investment and operating costs for the new facility.

The first thing to notice is that Shanghai's investment yields lower revenues at Shanghai. This is because they halved their port fee, and while they are attracting 400,000 more TEUs after investment, they are having to lower the rate charged on the 1.837 million they were already

33) We do not have data on what Busan Newport's pricing or productivity will be. The assumed prices are comparable to the downtown terminals' loading and unloading prices, but subtract the shuttle fee which may not be required at the new port.

attracting. However, this does not mean they are losing money (though they may be), because if their investment significantly reduced their costs, the marginal TEU may actually be more profitable for them. In this case Cs will capture the difference in operating costs.

If Shanghai is the only port making an investment, they see a reduction in revenue from $132.3 million to $80.9 million. Strategically, this could mean several things. First, it could mean this simple game, which examines only a subset of the market does not capture all of the benefits Shanghai perceived when they decided to undertake their new terminal development. Second, it could mean they anticipated sufficient growth in shipments and that they will, in the end, capture more revenue. Third, they could be playing a more sophisticated strategic game than we've captured here, and trying to construct a barrier to entry by building excess capacity which serves as a credible threat that if another port attempted to enter the market, they could engage in predatory pricing and ensure that potential entrants could not gain market share.[34] It seems likely that Shanghai's plan involves a combination of these motives.

Given the present circumstance in which Shanghai has invested and

34) There are several examples of this in corporate economic history. During the 1970"s in the United States, Alcoa, the world's largest aluminum company, proposed to build a plant with a capacity five times the then-current world demand for aluminum. One many experts thought they could not operate profitably. While the scale of this plant did not seem to make business sense, its strategic advantage was the threat it posed to potential entrants: if any other company proposed a plant, Alcoa would start production at this plant and drive down the price of aluminum so much that the competitor could not possibly make a profit. Alcoa's proposal was blocked after a federal court found it to be anti-competitive. The Standard Oil Company of the 1890s dominated the US oil market using similar tactics, before US antitrust law was developed. In the absence of international anti-trust law, there may be little potential competitors could do to respond effectively to Shanghai's investment in capacity designed to discourage entrants.

Yanghsan is operating, the relevant question is whether Busan should continue their investment. Busan is faced with a choice between investing to defend some of their market share and making 101.2- Cb, or not investing and making 100.7, a difference of only $0.5 million in annual revenues lost on 333,000 TEUs this export trade from northern Chinese ports. This suggests that if responding to Shanghai's development to defend their current market share will have an annualized net cost greater than $0.5 million, then it is not a good investment of Korea's resources. That is, recapturing that market share will cost more than it returns in benefits.

Even if Busan chooses not to invest, this is not a Nash equilibrium outcome of this game: Shanghai appears to have lost money by investing, and would prefer to not have invested, or at least not have lowered their prices so dramatically, which is what causes the drop in relative revenue, despite an increase in TEUs. This would be a disequilibrium outcome of the game, but one in which Busan can still make the choice that is best for them.

This suggests that one response Busan made was likely a correct one with respect to this segment of the market. Busan could have chosen to reduce their prices, even at the downtown terminals, to retain some market share. But in so doing, they would reduce the price they charge on all the business still using the port. The structure of the demand curve in Figure 1 (pg. ?) suggests that small changes in handling (less than $100 per TEU) might have little effect, though larger changes arising from combinations of price reductions and faster times might have greater effect. Thus, a price change alone is not a good idea as it would result in too big a reduction in revenues from market share that is not vulnerable to switching to Shanghai.

Despite this prediction, it is known that Busan has invested heavily in Busan Newport. How should this action be interpreted given the strategies represented in this game? Within the narrow context of this analysis, this would seem to be a mistake, since costs cannot be driven as low as Yangshan's due to higher labor cost, and productivity standards cannot be significantly exceeded. (However, the analysis of the optimal productivity scenario above suggests that with experience on the new equipment at Busan Newport, productivity may increase and thus expand the value of the investment somewhat.)

However, there are important limitations to this analysis that restrict the scope of its conclusions. Specifically, the focus on only the transshipment cargoes originating from northern China ports limit the recommendation to Busan that it should not undertake massive port expansion in order to defend marginal market share from Shanghai's expansion plans, whether Shanghai's plans were strategically wise or not.

There are other important markets for which Busan might compete with a port that is larger, faster and lower cost than the downtown Busan terminals, yet which might not be as cheap for certain cargoes which have traditionally used Busan. Thus, development efforts, and efforts to study potential future markets, should focus on these other markets, rather than on some vulnerable segments of their traditional transshipment market.

This analysis has shown that, while there are about half a million TEUs that are vulnerable to capture by a Shanghai port that is a couple hundred dollars cheaper per TEU, there are also a much larger number of TEUs that gain much more value from using Busan over Shanghai. One implication of the downward sloping demand curve in Figure 1 (pg.

?) is that Busan's best investments are those for which they have the greatest natural cost advantage over Shanghai. Future market development can focus on developing these markets.

First, Busan has a natural geographic advantage shipping from China's northernmost ports, and to the west coast of the US. The port might work with liners to schedule services that ensure these routes ran as quickly, cheaply and frequently has possible.

Second, given Yangshan's distance from land, and the time associated with crossing the congested cargo bridge, Busan could consider focusing on cargos requiring logistics and value added services, which can be provided much more quickly in the Busan hinterland business park.

# Ⅷ. Conclusion

When deciding whether, and which, continued investments are most advisable, it is important to be strategic about which markets are being pursued, developed and defended. This analysis suggests that it would be very costly, and unprofitable on net, to pursue defense of all transshipment cargoes that have been recently lost to Shanghai's low-cost Yangshan terminal. Rather, development efforts should focus on those markets that yield greater differences in value between the two hub ports, and therefore are less vulnerable to capture by a lower cost port operation in a country with very low labor costs.

The scenarios evaluated here also illustrate potential value to cooperative strategic development. Specifically, they show an outcome that is sometimes an equilibrium of the port investment game, and a plausible one at that, is a massive joint investment that has little effect on market share and causes both ports to lose money. This corresponds to the "both ports investing cell" of the game table in the "Reduction in Turnaround Time" game. Cooperative development strategies, in which ports strategically divide transshipment markets by commodity or service, or simply to reduce the pace of port investment to ensure investment does not outstrip market demand, can avoid this situation.

High levels of joint investment would slightly expand the overall market, since shipping would be cheaper for cargo routers, who in turn could charge shippers lower rates, reducing the costs associated with foreign production and increasing the quantity of final goods demanded. However, the resulting increase in overall market size is probably small relative to the investments being considered. If market growth is the basis on which speculative investment is undertaken, investment in additional research into the potential for market expansion in response to changes in shipping prices would be advisable.

One caveat to this analysis is that it treats demand as continuous, predicting when individual containers would switch hub ports. In fact, individual shippers tend to use certain services for all their cargo on similar routes, and thus cargo may not move as smoothly between hub ports when it becomes more cost effective to use one hub port than another for a subset of the shippers' cargo. This may either understate or overstate the responsiveness of hub port demand.

Our approach is also limited in that it treats demand as homogeneous. In fact, cargoes of different values or commodities may have different degrees of urgency, which mean that some have a willingness to pay values much less than $25/hour in transit, and others have values that are much more. Thus, not all shippers may be willing to pay for faster service, which will affect demand and hub port use patterns.

This analysis also does not take into account shipping schedules, when in fact they are a significant component in turnaround times at hub ports. The model conceptualizes turnaround time as an average, and lets it vary continuously with investment. One way to think about marginal changes is improvements in operating efficiency arising from infrastructure investment. However, going from two main trunk services a week to three results in a very significant change in average turnaround time, reducing average dwelling at the hub from 1.75 days to 1.17 days, a difference of 14 hours (or a cost equivalent of $350). Thus, service schedules can also affect turnaround time in a significant way. This could be problematic for the model if cargo routers attempt to time the connections, switching between hub ports based on which has the shorter expected turnaround time for the next trunk line vessel, rather than average turnaround time.

Liner schedules can have a broader impact. If a liner's business through a hub drops below a threshold level, they may discontinue hub service there altogether, which may lead to migration of a substantial portion of the liner's business away from that hub in one move, rather than the continuous cost-based movement built into the model. This implies the model is probably most appropriate for small-scale changes in cost structures.

Liner behavior can also have an impact. While this analysis presumes liners run primarily direct routes from Busan or Shanghai to a foreign destination port, many mainline vessels in fact call at both Busan and Shanghai; often, they call at Shanghai then Busan on the way to Japan and North America; and Busan then Shanghai on the way to South Asia and Europe. When both ports are called, the differences in port productivity and shipping time will arise not in faster delivery times, but rather in increased time to prepare a shipment before loading of the feeder service: if Busan is loaded after Shanghai on North American routes, then shippers get an extra day to assemble cargo before shipping.

This analysis is also limited in that it looks only at a portion of economic benefits a port provides. First, it considers only transshipment business from northern Chinese exports to US and European markets. While this is a large volume and valuable business, it accounts for only about a 1/3rd of Busan's total transshipment volume. Even investments primarily targeted at this market segment may have benefits for other market segments, which are not accounted for in this analysis. This could be a particularly large factor for Shanghai, who may see growth in shipping from South Asia, especially Southern China. Thus, their investment strategy could be targeted at that market, with some associated benefits for their ability to service northern Chinese ports.

Second, this analysis considers only port revenues as a benefit. From a regional economic standpoint, it may be sensible to consider port volume as having a multiplier effect, so that the success of a port does not depend only port revenues exceeding port costs: ports provide jobs and generate a lot of associated economic activity regardless of just how profitable a port runs. However, it is important to have an accurate assessment of the scale of these benefits so the costs associated with port investment, and the additional port benefits received, can be considered; faith that all port investment will yield high returns is a recipe for replicating unprofitable investments.

A direction for future research is to expand the set of strategies of each port beyond investment or non-investment. In reality, a wide range of strategies, that might have different effects on different submarkets targeted by the ports, can be adopted. In addition, each strategy might be adopted at several levels. This may be particularly important as Busan seeks to identify markets that can be easily defended against low cost labor at Shanghai. As better data can be assembled, it may be worth considering application of the model separately to four different markets:

1.Cargo that simply needs transshipment (sealed container from feeder to main trunk vessel)
2.Cargo that needs consolidation
3.Cargo that needs packaging or other finishing services
4.Cargo that needs assembly

The ports can compete within each of these four markets, or they can specialize in some areas but not others.

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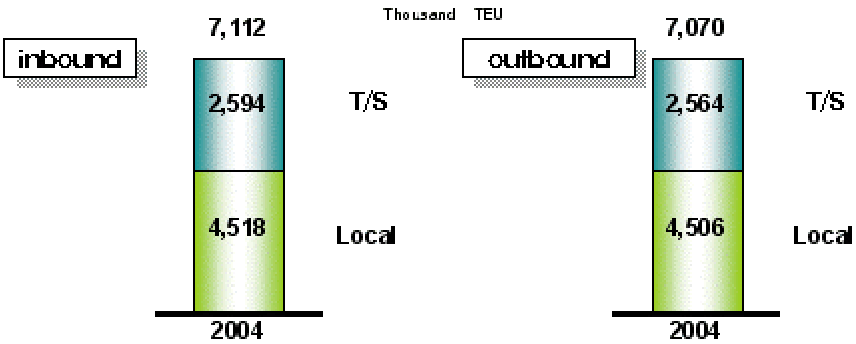
Appendix 1:

# T/S Container of Neighboring Countries in Korean ports

## 1) T/S Container of Korea Port




<Table> Korea China route Container Throughput by Korea Port(2004)

Thousand TEU

| type | Korea Inbound | | | Korea Outbound | | Total | Total |
|---|---|---|---|---|---|---|---|
| | Import | T/S | Sub total | Export | T/S | Sub total | |
| Busan | 591 | 946 | 1,538 | 664 | 355 | 1,019 | 2,557 |
| Gwangyang | 100 | 96 | 196 | 166 | 55 | 221 | 417 |
| Incheon | 231 | 2 | 233 | 218 | 0 | 218 | 451 |
| Pyengtaek | 89 | 0 | 89 | 91 | 0 | 91 | 180 |
| Ulsan | 26 | 0 | 26 | 70 | 0 | 70 | 96 |
| Kunsan | 16 | 0 | 16 | 23 | – | 23 | 40 |
| Masan | 6 | – | 6 | 6 | – | 6 | 12 |
| 합계 | 1,060 | 1,044 | 2,104 | 1,238 | 411 | 1,649 | 3,753 |

Source : ibid

<Table> Korea China route Container Throughput by China Port(2004)

(Thousand TEU)

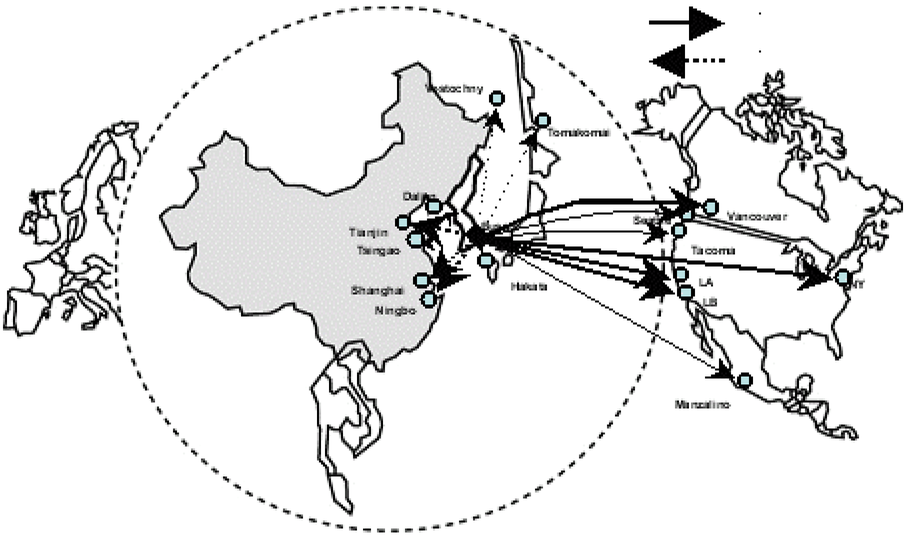
| type | Korea Inbound | | | Korea Outbound Total | | | Total |
|---|---|---|---|---|---|---|---|
| | Import | T/S | Sub total | Export | T/S | Sub total | |
| Shanghai | 263 | 168 | 431 | 309 | 75 | 384 | 815 |
| Tianjin | 148 | 276 | 424 | 179 | 99 | 278 | 702 |
| Qingdao | 171 | 234 | 405 | 202 | 55 | 257 | 662 |
| Dalian | 69 | 137 | 206 | 99 | 67 | 165 | 371 |
| Ningbo | 57 | 66 | 124 | 89 | 55 | 144 | 268 |
| Shenzhen | 53 | 68 | 121 | 70 | 14 | 83 | 205 |
| Xiamen | 41 | 19 | 60 | 23 | 12 | 35 | 95 |
| Weihai | 44 | 0 | 44 | 46 | 0 | 47 | 91 |
| Lianyungang | 22 | 11 | 34 | 29 | 3 | 32 | 65 |
| Yantai | 26 | 4 | 30 | 27 | 5 | 33 | 63 |
| Dandong | 20 | 6 | 26 | 20 | 0 | 20 | 47 |
| Nanjing | 13 | 6 | 20 | 20 | 1 | 21 | 41 |
| Shidao | 15 | 0 | 15 | 16 | 0 | 16 | 31 |
| LONG YAN | 12 | 0 | 12 | 12 | 0 | 12 | 24 |
| Shantou | 11 | 1 | 12 | 11 | 0 | 11 | 23 |
| Zhangjiagang | 11 | 0 | 11 | 8 | 1 | 9 | 20 |
| Yingkou | 9 | 0 | 9 | 9 | 1 | 10 | 19 |
| Rizhao | 8 | 1 | 9 | 10 | 0 | 10 | 19 |
| Guangzhou | 4 | 2 | 6 | 6 | 0 | 7 | 13 |
| Fuzhou | 5 | 2 | 7 | 4 | 1 | 5 | 12 |
| Others | 57 | 40 | 97 | 49 | 19 | 68 | 166 |
| Total | 1,060 | 1,044 | 2,104 | 1,238 | 411 | 1,649 | 3,753 |

Source : ibid

## 2) Busan Port

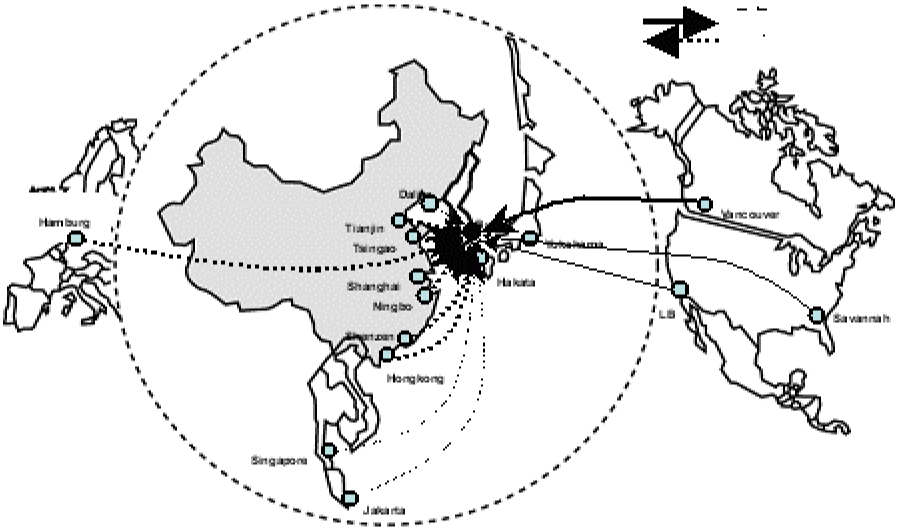
### (1) Busan T/S Container Volume

<Table> Busan T/S Container Volume (thousand TEU, 2004) : Outbound(export)




| port | throughput |
|---|---|
| LB | 143 thousand TEU |
| LA | 117 |
| NY | 97 |
| Tianjin | 96 |
| Vancouver | 93 |
| Hakata(Japan) | 65 |
| Seattle | 58 |
| Manzallino | 58 |
| Tomakomai(Japan) | 57 |
| Ningbo | 53 |
| Takota | 53 |
| Qingdao | 52 |
| Dalian | 51 |
| Shanghai | 49 |
| Vostochny | 41 |

Source : ibid




| port | throughput |
|---|---|
| Tianjin | 268 |
| Qingdao | 190 |
| Shanghai | 149 |
| Hamburg | 140 |
| Dalian | 134 |
| Ningbo | 66 |
| Savanna | 51 |
| HK | 50 |
| Shenzen | 49 |
| Hakata(Japan) | 47 |
| LB | 43 |
| Yokohama | 40 |
| Singapore | 39 |
| Vancouver | 39 |
| Jakarta | 38 |

Source : ibid Source : ibid

(2) Busan China T/S Container Volume(2004) thousand TEU

| Port/type | Korea Inbound | | | Korea Outbound Total | | | Total |
|---|---|---|---|---|---|---|---|
| | Import | T/S | Sub total | Export | T/S | Sub Total | |
| Tianjin | 81 | 268 | 349 | 96 | 96 | 192 | 542 |
| Shanghai | 173 | 149 | 322 | 157 | 49 | 207 | 528 |
| Qingdao | 85 | 190 | 275 | 106 | 52 | 158 | 433 |
| Dalian | 34 | 134 | 168 | 62 | 51 | 113 | 281 |
| Ningbo | 42 | 66 | 108 | 52 | 53 | 105 | 213 |
| Shenzhen | 16 | 49 | 65 | 45 | 13 | 57 | 122 |
| Xiamen | 34 | 17 | 51 | 19 | 9 | 29 | 79 |
| Lianyungang | 22 | 11 | 33 | 28 | 3 | 31 | 64 |
| Nanjing | 13 | 6 | 19 | 18 | 1 | 19 | 38 |
| Zhangjiagang | 10 | 0 | 11 | 7 | 1 | 8 | 19 |
| Yantai | 4 | 4 | 7 | 4 | 5 | 10 | 17 |
| Dandong | 5 | 5 | 10 | 4 | 0 | 4 | 15 |
| Weihai | 5 | 0 | 5 | 8 | 0 | 8 | 13 |
| Shantou | 3 | 1 | 4 | 6 | 0 | 7 | 11 |
| Rizhao | 4 | 1 | 5 | 6 | 0 | 6 | 11 |
| Fuzhou | 5 | 2 | 6 | 3 | 1 | 4 | 10 |
| Guangzhou | 3 | 2 | 5 | 2 | 0 | 2 | 7 |
| Changchun | 0 | 5 | 5 | 1 | 1 | 2 | 6 |
| Shidao | 2 | 0 | 2 | 3 | 0 | 3 | 6 |
| Wenzhou | 2 | 0 | 2 | 2 | 0 | 3 | 5 |
| Others | 50 | 35 | 55 | 34 | 18 | 52 | 137 |
| Total | 591 | 946 | 1,538 | 664 | 355 | 1,019 | 2,557 |

Source : ibid

(3) Busan China Tianjin Import T/S Container Volume(2004)

i. <Table> China Tianjin-> Busan ---> Other Countries (thousand Revenue tonnage)

| Commodities | import(T/S) | Share(%) |
|---|---|---|
| Textiles and its Articles | 3,882 | 60.9 |
| Plastic | 457 | 7.2 |
| Machinery and Mechanical Appliances | 414 | 6.5 |
| Product of the milling industry | 319 | 5.0 |
| Electric equipment and its parts | 290 | 4.6 |
| Animal & Vegetables fats & oils | 258 | 4.1 |
| Products of the Chemicals | 182 | 2.9 |
| Vehicles & its equipment | 114 | 1.8 |
| Prepared Foodstuffs | 60 | 0.9 |
| Fertilizers | 52 | 0.8 |
| Base Metal & its Articles | 48 | 0.8 |
| Fish & Crustaceans | 38 | 0.6 |
| Iron & Steel | 24 | 0.4 |
| Articles of leather | 1 | 0.0 |
| Others? | 230 | 3.6 |
| Total | 6,371 | 100.0 |

## ii. Textiles and its Articles

| Country | Port | (thousand RT) | share(%) |
|---|---|---|---|
| USA | Long Beach | 509 | 13.1 |
| | Los Angeles | 297 | 7.7 |
| | New York | 253 | 6.5 |
| | Savannah | 129 | 3.3 |
| | Tacoma | 71 | 1.8 |
| | Seattle | 69 | 1.8 |
| | Oakland | 43 | 1.1 |
| | Others | 105 | 2.7 |
| | sub total | 1,476 | 38.0 |
| CANADA | Vancouver | 225 | 5.8 |
| | Halifax | 22 | 0.6 |
| | Toronto | 8 | 0.2 |
| | Others | 5 | 0.1 |
| | sub total | 260 | 6.7 |
| Mexico | Manzanillo | 67 | 1.7 |
| Ausralia | Melbourne | 30 | 0.8 |
| | Sydney | 21 | 0.5 |
| | Brisbane | 8 | 0.2 |
| | Others | 0 | 0.0 |
| | sub total | 59 | 1.5 |
| Indonesia | Jakarta | 35 | 0.9 |
| | Surabaya | 6 | 0.2 |
| | Others | 0 | 0.0 |
| | sub total | 41 | 1.1 |
| Netherland | | 41 | 1.0 |
| Germany | | 35 | 0.9 |
| Japan | | 33 | 0.8 |
| HK | | 32 | 0.8 |
| Chile | | 27 | 0.7 |
| Others | | 1,811 | 46.7 |
| Total | | 3,882 | 100.0 |

Source : ibid

## Appendix 2:

# Free Trade Zone Tenant Company Benefits

Domestic and overseas companies taking up tenancy in the hinterland of the Busan New Port will receive various benefits specified in the Regulations of Free Trade Zone. In particular, foreign investment companies will benefit from privileged treatments in taxation and rent.

| Classification | Content | |
|---|---|---|
| Direct Tax Reduction | Target of Reduction | - Foreign manufacturing company with investment of 10 million dollars or more |
| | | - Foreign distribution company with investment of 5 million dollars -or more |
| | Details of Reduction | - Corporation tax, income tax, -acquisition tax, registration tax, property tax and aggregate -land tax exempted by 100% for 3 years and by 50% for 2 years thereon (Article 9 of Foreign Investment Promotion Act and Article 121-2 of-Special Tax Treatment Control Act) |
| Exemption and Return of Indirect Tax | - Exemption of duties on foreign goods carried into FTZ by tenant company | |
| | - Zero tax rate of VAT applied to transactions of domestic goods within FTZ by tenancy companies | |
| | - Exemption of provisional import surtax, liquor tax, excise tax, transportation tax, special tax for rural development and education tax (Article 45 of Act on Free Trade Zone) | |
| Rent | - Application of preferential rent (foreign investment companies engaged in distribution industries specified in Regulations of Free Trade Zone) (Article 17 of Act on Free Trade Zone) | |
| | - Busan Gamcheon Site: App. 5,950 won per ---annum/ pyeong | |
| | - Hinterland of Pusan Newport: App. 1,586 won ---per annum/ pyeong | |
| | - Hinterland of Gwangyang Port: App. 1,190 won ---per annum/ pyeong | |
| Simplifying Declaration Procedures for Distribution Activities | - Minimizing procedures of declaration in customs office for various value-added distribution activities carried out within FTZ, such as transfer of goods between registered companies, consumption and utilization of foreign goods and repair operation, etc. | |

* Having been designated both as free trade zone and free economic zone, --the distribution complex of Pusan Newport is entitled to various benefits --or supports specified in the Regulations of Free Economic Zone.
Source : BPA

# Appendix 3:

# Comparison of Major Asia Port Tariffs

Thousand US Dollar

| Dues | Busan | Gwangyang? | Shanghai | Singapore | HK | Kaoshiung |
|---|---|---|---|---|---|---|
| tonnage dues? | − | − | 12.2 | 0.6 | − | 1.3 |
| port dues? | 9.0 | − | 5.5 | 4.0 | 2.2 | 1.2 |
| berh hire | 2.4 | − | 0.9 | 7.4 | 2.2 | 3.5 |
| wharfage? | 8.8 | − | 9.5 | − | − | 40.3 |
| port construction fee | − | − | 11.6 | − | − | − |
| pilot charge | 2.1 | 3.2 | 6.0 | 0.5 | 2.5 | 3.5 |
| towage charge | 2.6 | 1.9 | 6.7 | 1.6 | 2.3 | 2.1 |
| stevedoring charge | 89.7 | 66.3 | 110.9 | 172.1 | 427.9 | 130.1 |
| trucking | − | − | − | 65.0 | − | − |
| tally? | 7.2 | 7.2 | 5.7 | 0.2 | − | 6.5 |
| hatch cover | 0.5 | 0.5 | 0.1 | − | − | − |
| lashing? | 9.5 | 10.1 | − | 2.8 | − | − |
| line handling charge | ?0.3 | 0.4 | 0.1 | 0.4 | 0.2 | 0.3 |
| shipping agent fee | 3.5 | 3.5 | 24.8 | 1.8 | 1.8 | 1.9 |
| vessel quarantine charge | − | − | 0.4 | − | − | − |
| customs house charge | − | − | − | − | 0.0 | − |
| Watchman charge | − | − | − | − | 0.1 | − |
| Maritime Welfare fee | − | − | − | 0.1 | − | − |
| container tax | 42.1 | − | − | − | − | − |
| garbage disposa | l0.1 | 0.1 | 0.2 | 0.6 | − | 0.0 |
| total? | 177.7 | 93.2 | 194.4 | 257.3 | 439.2 | 190.7 |

Prerequisite : 1) 5,300 TEU container vessel(66,654GT, 24,405NT, 67,115DWT)
2) container movement : 2,000TEU(inbound : 300TEU, 350FEU outbound : 300TEU, 350FEU)

Source : KMI, A Study on the Reform of Korean Port Tariff, 2004