The Asian Journal of Shipping and Logistics ● Volume 30 Number 2 August 2014 pp. 155-173 ●

Changing Concentration Ratios and Geographical Patterns of Bulk Ports: The Case of the Korean West Coast

Taehwee LEE*· Gi-tae YEO** · Vinh V. THAI***

Contents

Abstract

Contrary to liner shipping, common shipping network patterns are difficult to organize in tramp shipping as origin and destination ports are irregular and they may change based on shippers' demands. Unlike liner shipping whereas the choice of ports is strongly related to their geographical locations among other factors and a topic of much research in the contemporary literature, the geographical issues related to bulk ports are an interesting yet currently under-researched topic. For this reason, this study aims to analyze the concentration ratios of bulk ports to reveal geographical patterns, using the case of bulk ports along the west coast of Korea including, Incheon Port (ICP), Pyeongtaek-Dangjin Port (PDP), and Gunsan Port (GSP). To examine and shed more light to the above mentioned research issue, this paper adopts a series of methods, such as Hirshmann-Herfindahl Index (HHI), Location Quotients (LQ), and Shift Effects (SE). Results from the HHI analysis, indicated that de-concentration has been gradually rising because of a considerable overlapping of ports' functions. Meanwhile, the LQs' confirmed this result. Finally, the SE' results effectively showed that a substantial shifting of cargo had occurred among the ports.

Key Words : Bulk Port, Port Concentration, Shifting of Cargo, Geographical Pattern of Port

* Ph.D Candidate, Incheon National University, Korea, Email : taehwee1031@incheon.ac.kr
**Professor, Incheon National University, Korea, Email : ktyeo@incheon.ac.kr (Corresponding Author)
***Assistant Professor, Nanyang Technological University, Singapore, Email : vvthai@ntu.edu.sg

I. Introduction

Containerization, the so-called transportation revolution, has created a huge impact upon maritime transportation.[1] Due to containerization, global trade is not only becoming more intensive and frequent, the world economy is also growing. Since the 1950s, when containerization first came into use, hub and spoke (H&S) network systems have increasingly been used to facilitate liner shipping networks. Thus, there have been many studies related to port research on strategic location evaluations because the ports with superior locations often have diverse shipping networks.[2] While containerization has been expanding gradually, this revolution has also generated a new development, supply chain integration in port, which highlights the importance of value-added services through the vertical integration of port logistics activities.[3] As a result of port competition, there has been transportation paradigm shifts leading to the concentration and de-concentration of ports, and thus transport geographers and port researchers had begun to focus on the geographical aspects of ports by radically examining port evolution stages and the interactions between ports and peripheral areas.[4] Severe port competition would gradually result in deconcentration as it is expected that there would be cargo shifting between competing ports. In other words, the level of cargo concentration in a port might be reduced if it is more competitive than other ports in a region.

Apart from studies examining the role of container ports in transportation patterns, the topic of bulk cargoes and bulk ports has never been in relation to transport geography in the contemporary literature. Bulk cargoes are commodities that are traded in large quantities, such as grain, iron ore, and coal.[5] The research issues related to bulk cargoes can be dealt with using an econometric approach. Oliveira and Cariou (2011), for instance, attempted to approach through data envelopment analysis (DEA) using iron ore and coal ports.[6] Besides, because freight rates change frequently, the forecasting of dry bulk freight rates has been

1) Levinson(2006); Notteboom and Rodrigue(2008)
2) Song and Yeo (2004); Lirn et al.(2004); Ugboma et al.(2006); Yuen et al.(2010)
3) Robinson(2002); Wang and Cullinane(2006); Song and Panayides(2008); Panayides and Song(2008); Tongzon et al.(2009)
4) Taaffe et al.(1963); Slack(1990); Barke(1986); Hayuth(1981); Le and Ieda(2010); Li et al.(2012)
5) Stopford(1997)
6) Oliveira and Cariou(2011)

attempted by several scholars using numerous methods. In particular, to forecast the dry bulk shipping index, many authors have adopted fuzzy methods,[7] or vector auto regression (VAR).[8] A variety of studies published in transport geography related journals focuses on both container port geographical systems and liner shipping networks. Most frequently analyzed, however, are port competition and co-operation[9], the concentration and de-concentration of ports[10], and liner shipping network analysis[11].

Yet bulk trade is non-liner shipping, and tramp shipping is difficult to configure with regard to the regularity of shipping network patterns as the origin and destination ports are irregular and change based on shippers' demands.

Geographical issues related to bulk ports are therefore interesting topic that remains under researched. This study thus raises the following research questions. How does the geographical pattern of bulk ports appear? How much do external changes influence bulk ports? And will port competition affect de-concentration significantly, as it does like container ports?

To fulfill the addressed research gap that currently exists and cope with the above questions, this paper attempts to analyze the geographical patterns of bulk ports and identify the concentration level using the case of Korean West Coast as the main example.

The remainder of this paper is organized as follows. Section II reviews the general features of bulk cargoes and bulk ports in the Korean West Coast then raises emerging issues related to bulk ports. Research methodologies and data analysis are briefly introduced in Section III, followed by the discussion of findings and policy suggestions in Section IV. Conclusions are then presented in Section V.

II. Overview of Bulk Ports

1. Characteristics of Bulk Cargoes

In this section, the features of bulk cargoes and bulk trade are reviewed. According to UNCTAD, most bulk cargoes are comprised of crude oil,

7) Bulut et al.(2012); Duru(2012); Duru(2010)
8) Ko(2013)
9) Song(2002)
10) Notteboom, 1997; Wang, 1998; Notteboom, 2010
11) Ducruet et al.(2010); Lam and Yap(2011); Laxe et al.(2012); Ducruet(2013)

iron ore, coal and so on. These cargoes require bulk handling for transport which, according to many transport economists, are those that have packaging that is too large to load on some specialized vessels. Stopford (1997)[12] also presented the characteristics of typical bulk cargo commodities dividing them into five groups. As indicated previously, there are specific handling and shipping requirements for each respective cargo type. In case of liquid bulk cargoes, which are mainly crude oil and certain chemical products, these are stored in tanks and transported by tanker vessels. The second type, homogeneous dry bulk cargoes are grouped in major bulks and minor bulks. This type of cargoes also requires special equipment for handling such as conveyers and grabs. Major dry bulk cargoes include such commodities as grain, iron ore, coal, and bauxite which are transported in big volume to take advantage of economies of scale. Meanwhile, minor bulk cargoes such as lumber, steel, fertilizers are transported in unit load and generally shipped in small quantities. The remaining types include wheeled cargo and refrigerated cargo, which are also transported in unit load. Despite the fact that bulk cargoes are divided into several commodity types, the common feature among them is that they require specialized vessels and unique methods of handling.

Most bulk cargoes show irregular trade pattern in the market.[13] This is because of the nature of the goods being shipped for instance, if grain cargoes present seasonal trade patterns that depend on the yearly harvest, matching the demand is more difficult and bulk trade patterns are more irregular. Also, the origin and destination ports of bulk cargoes are often more changeable than those of container ports for the same reason.

2. Overview of Bulk Ports in the Korean West Coast

In the 1960s, the Korean government strategically developed several ports in various regions. These ports were divided into two categories: international trading ports and coastal ports. In Korea, there are now 29 international trading ports and 26 coastal ports. International trading ports are situated in three regions: the western coast, southern coast, and eastern coast as summarized in Table 1.

12) Stopford(1997)
13) Scarsi(2007)

<Table 1> International trading ports in Korea

Region	Ports
Western coast (9)	Gyeongin, Incheon, Pyengtaek-Dangjin, Daesan, Tae-an, Boryeong, Janghang, Gunsan, Mokpo
Southern coast (13)	Wando, Yeosu, Gwangyang, Jeju, Seoguipo, Samchenpo, Tongyoung, Gohyun, Okpo, Jangweungpo, Masan, Jinhae, Busan
Eastern coast (7)	Ulsan, Pohang, Samcheock, Donghae, Mukho, Okgae, Sokcho

It is well known that Busan port is one of the busiest container ports both in South Korea and in all of Northeast Asia. However, many bulk ports are now also growing in size, including Incheon Port (ICP), Pyeongtaek-Dangjin Port (PDP), and Gunsan Port (GSP).

In western coastal area, the ICP plays a pivotal role, simulating Korean industrialization and functioning as the gateway of the Korean metropolitan region, Seoul handling imported bulk cargoes like steel, hardwood, grain, and iron ore. The ICP was artificially created with a lock gate because of the changing tide.

Within 200km of the ICP, the PDP was developed in 2000 to cater to the Chungcheong province hinterland, while the GSP caters to the Jeonbuk province.

According to Fung (2011), if the hinterlands of two ports overlap, there could be competition between the two.[14] Table 2 shows the tonnage handled by respective ports and their annual growth rates. In 2008, all ports in this table experienced limited growth or slippage when compared with the previous year as a result of the global financial crisis. Since 2009, all these ports have rebounded with regard to their throughput with the exception of ICP, and this could reveal the shifting of cargoes between ports due to the competition amongst them.

<Table 2> Cargo throughput of respective ports and their annual growth

Unit: Tons

Year	ICP	PDP	GSP
2005	34,331,578	17,058,644	7,343,513
2006	39,710,669 (15.67%)	15,630,590 (-8.37%)	7,797,858 (0.15%)
2007	44,534,059 (12.15%)	17,963,834 (14.93%)	7,809,858 (-3.81%)
2008	47,816,608 (7.37%)	17,583,282 (-2.12%)	7,512,090 (-2.67%)
2009	40,014,339 (-16.32%)	18,548,966 (5.49%)	7,311,440 (19.43%)

14) Fung(2001)

2010	44,758,092 (11.86%)	32,035,073 (72.71%)	8,731,986 (2.40%)
2011	40,279,790 (-10.01%)	42,320,784 (32.11%)	8,941,692 (3.61%)

Source: Incheon Port Authority (IPA)

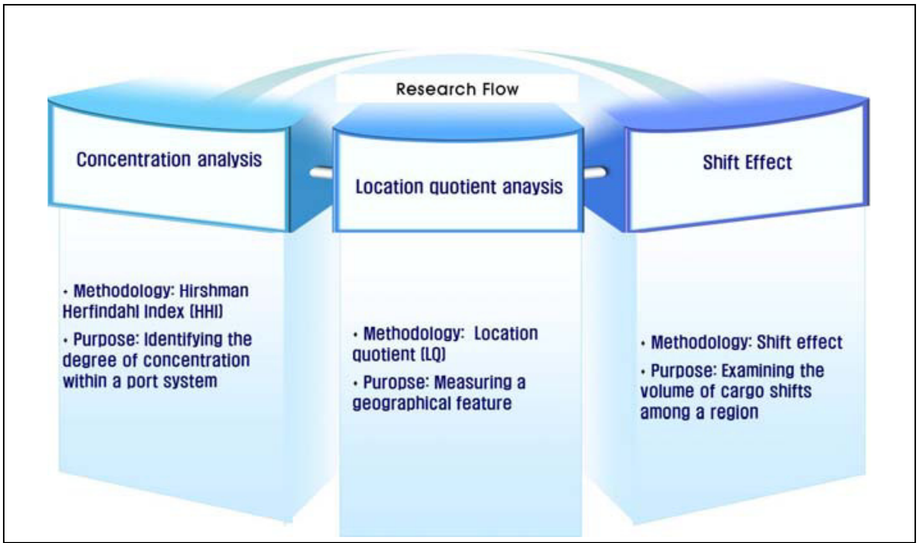
Note: The numbers in parentheses are the annual growth rates

III. Data and Analysis

The data used for analysis was taken from the Incheon Port Authority (IPA). The IPA had collected cargo' throughput data through customs' declarations. The collected data apply only to bulk cargoes including grain, cement, sand, iron ore, fertilizer, hardwood, scrap iron, steel, and vehicles, and do not include containers. These bulk cargoes handled by the ICP had decreased between 2005 and 2011. Meanwhile, the amount of these bulk cargoes handled by the PDP and GSP has increased since 2005; it can therefore be assumed that these cargoes have shifted from the ICP to the PDP and GSP.

To shed more light to the above observation and address the previously mentioned research questions, we adopted the multi-staged research methodology as illustrated in Figure 1.

<Figure 1> Flow of empirical analysis



1. Concentration Analysis

To investigate the concentration of the selected three bulk ports in this research, this paper first adopts the Hirshmann Herfindahl Index (HHI). The HHI offers a good tool for identifying the degree of concentration within a port system.[15] This index is represented by D_j in the following expression:

$$D_j = \frac{\sum_{i=1}^{n} Cargo_{ij}^2}{(\sum_{i=1}^{n} Cargo_{ij})^2} \text{ and } \frac{1}{n} < D_j < 1$$

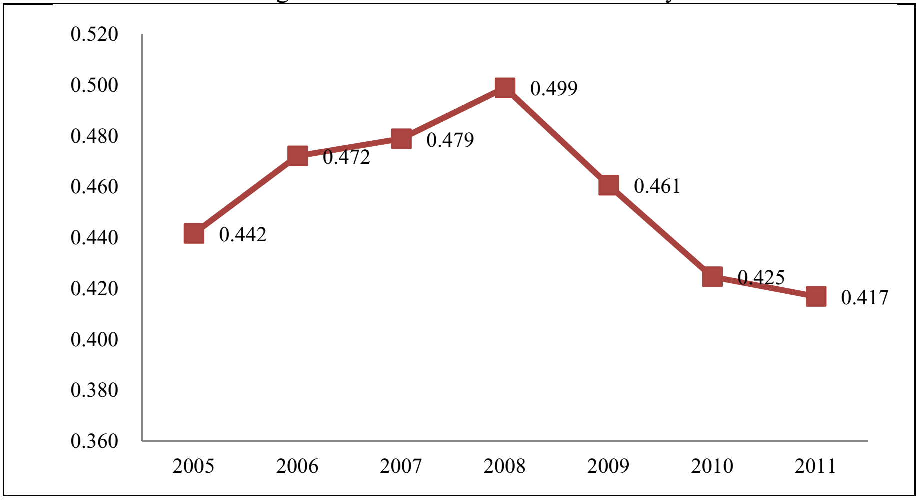
where D_j is the concentration index for the port system (or port range) j, Cargo volume_{ij} is the cargo traffic, expressed in tons, for port *i* of the port system (port range) *j* and n is the number of ports in the port system (port range) *j*. If the total traffic structure is completely dominated by one specific port, the index would attain the maximum value of 1 (full concentration). If, on the other hand, the traffic structure within the port system is equally divided among all ports and no port dominance exists, the index would have its minimum value of 1/n.

Figure 3 shows the concentration analysis result of the total sum of commodities in the studied ports. In the year 2005, the HHI shows a value of 0.442, which gradually increase until the year 2008.

After this year, as can be seen from Figure 2, a significant de-concentration occurs until 2011. While in the first period before 2008, the HHI increases by 12.9%, it decreases by -19.7% after this period. It can therefore be assumed that a fierce port competition has occurred among the studied ports during the period from 2008 to 2011.

15) Notteboom(1997)

<Figure 2> Result of concentration analysis



We next applied HHI analysis to various respective types of cargo among the ports. As can be seen from this further analysis, a severe drop in grain is evidenced, and a slight de-concentration in cement, fertilizer, hardwood, and scrap iron can also be seen as reflected in the HHI results in Table 3. In particular, grain cargo showed a de-concentration rate of -26.5%, while cement, fertilizer, hardwood, and scrap iron experienced de-concentration rates of -12.9%, -10.8%, -10.3%, and -16.8% respectively.

<Table 3> Concentration trend for respective types of cargo

Year	Grain	Cement	Sand	Iron ore	Fertilizer	Hardwood	Scrap iron	Steel	Vehicle
2005	0.890	0.667	0.501	0.504	0.632	0.630	0.469	0.504	0.388
2006	0.836	0.670	0.691	0.503	0.561	0.612	0.441	0.503	0.387
2007	0.857	0.654	0.792	0.482	0.650	0.582	0.534	0.482	0.360
2008	0.872	0.644	0.779	0.469	0.591	0.600	0.382	0.469	0.362
2009	0.898	0.613	0.742	0.461	0.564	0.576	0.411	0.461	0.385
2010	0.808	0.645	0.735	0.474	0.639	0.585	0.508	0.474	0.415
2011	0.654	0.581	0.741	0.535	0.564	0.565	0.390	0.535	0.435

As can be seen from Table 3, it is possible that some ports acquired the share of cargo throughput, such as sand, iron ore, steel, and vehicle, from others. The Location Quotient (LQ) computation shall therefore be carried out to show this proposition.

2. Location Quotient Analysis

LQ is the land use variable. The following definition, proposed by Miller and Blair (2009)[16)], shows how the LQ is calculated:

$$LQ_i^e = \frac{E_i^e/E_i}{E^e/E}$$

where E_i^e is the volume (in tons) of cargo e in port i, E_i is the total volumes of all cargo types in port i, E^e is the total volume of cargo *e* in all ports, and *E* is the total volume of all cargo types in all ports. If the LQ value increases to above 1, indicates the concentration of cargo *e* in port *i*.[17)] Table 4 presents the LQ values of all cargo types in the studied ports in 2011. For the complete LQ analysis of all analyzed periods, please see the Appendix (Table 6).

<Table 4> LQ analysis results of the studied ports (2011)

2011	Grain	Cement	Sand	Iron ore	Fertilizer	Hardwood	Scrap iron	Steel	Vehicle
ICP	**1.81**	**1.61**	**1.93**	0.00	**1.57**	**1.60**	0.63	0.65	0.45
PDP	0.20	0.02	0.29	**2.15**	0.03	0.08	**1.13**	**1.46**	**1.28**
GSP	**1.17**	**2.90**	0.16	0.07	**3.00**	**2.66**	**2.05**	0.44	**2.10**

Note: Values highlighted in bold indicate the degree of concentration of respective cargoes.

As can be seen from Table 4, in year 2011, the ICP and GSP experienced an identical concentration with regards to grain, cement, fertilizer, and hardwood. The same pattern was observed in terms of scrap iron and vehicles in the PDP and GSP. Given the above findings, it is evident that most concentration occurs in the main types of cargo that a port handles. Next, a shift effect (SE) analysis will be conducted to examine the shifting of handled cargoes among the studied ports.

16) Miller and Balir(2009)
17) Maoh and Tang(2012); Graaff et al.(2012); Papatheodorou and Arvanitis(2009)

3. Shift Effect Analysis

SE is useful for examining the volume of cargo shifts among ports, port ranges, and port categories as it provides a better assessment of a port's competitive position by eliminating the growth of the overall sector. Let SHIFT_i be the total shift of port *i* for the period $t_0 - t_1$, shift effect is then formulated as follows.[16)]

$$Shift_1 = Cargo_{i1} - \frac{\sum_{i=1}^{n} Cargo_{it1}}{\sum_{i=1}^{n} Cargo_{it0}} \times Cargo_{it0}$$

Table 5 presents the findings of the SE analysis. It can be seen from Table 5 that all types of cargo show significant shifting over the examined periods. Regarding grain cargo, specifically, the ICP is shown to have lost 944,297 tons, whereas the PDP acquired 581,849 tons and GSP acquired 362,449 tons. For cement, the ICP lost 340,583 tons, while the PDP gained 39,133 tons and the GSP gained 301,450 tons. The results in Table 5 indicated that there was a significant shifting of cargo traffics between the listed ports because of their competition.

<Table 5> Shift effect in the studied ports from 2005 to 2011

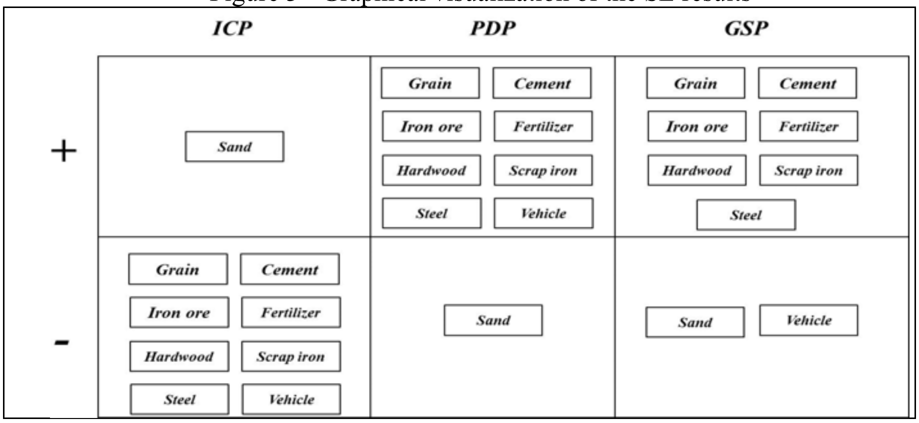
2005-2011	Incheon	Pyeongtaek-Dangjin	Gunsan
Grain	-944,297	581,849	362,449
Cement	-340,583	39,133	301,450
Sand	4,288,803	-3,062,810	-1,225,993
Iron ore	-8,348,147	8,337,545	10,603
Fertilizer	-32,155	7,484	24,671
Hardwood	-170,928	71,165	99,763
Scrap iron	-894,506	589,682	304,824
Steel	-7,962,612	7,432,096	530,515
Vehicle	-1,206,954	1,430,352	-223,399

Figure 3 visually demonstrate the results of the SE analysis, separating gains and losses between the studied ports on the vertical axis. It can be seen that the ICP gained in terms of sand cargo while grain, cement, iron

16) Notteboom(1997)

ore, fertilizer, hardwood, scrap iron, steel, and vehicle shipments were all shifted to other ports. Considering the economic role of the ICP in the regional economy, this indicated significant economic loss. For the PDP, the results show outstanding gains in terms of acquiring bulk cargo shipments such as grain, cement, iron ore, etc., followed by the GSP, which also acquired seven types of bulk cargoes: sand, cement, iron ore, fertilizer, hardwood, scrap iron, and steel.

<Figure 3> Graphical visualization of the SE results



Note: The + symbol indicates the acquiring of cargo, and – symbol indicates the loss of cargo.

IV. Findings and Policy Suggestions

Having analyzed using series of methods, it is imperative to recall the remained research questions.

1. *How does the geographical pattern of bulk port appear?*
2. *How much do external changes influence bulk port?*
3. *Will port competition affect deconcentration significantly like container port does?*

This section discusses the implications of findings in this research and presents suggestions for policy makers. Essentially, the density of ports in a region leads to inevitable competition. The extent of this can be determined by examining the possible overlapping roles of ports which are geographically located too closely with each other. As evidenced by the HHI analysis, this study found that bulk port competition could lead to de-concentration patterns, as is the case with container port.[17)] At the same time, the geographical pattern of ports showed shift phenomenon which is in line with the SE analysis results in this research.

A port that is in close proximity to a city is exposed to concerns such as traffic congestion, air and noise pollution. As Incheon is the biggest city in the Korean western coastal region, it is possible that these are becoming a significant obstacle for its development. Taking into account the inevitable conflict between port and city functions, ICP production facilities have been restricted from expanding. This is mainly because of high rental costs in the hinterland caused by the higher land values in the city region. This could contribute to the finding of cargo shifting from the ICP to the PDP or GSP.

These circumstances therefore prompt the following recommendations. Prior to developing a new port in a region, the government should first consider whether its roles and hinterland will be overlapping with those of existing ports in the same region. This is because overlapping roles and contested hinterland between ports can give rise to unnecessary competition that then generates social cost. This cost can be seen in the SE analysis results, as they effectively show extensive cargo shifting that results in money wasted on inland trucking and idle port facilities, contributing to inefficient port investment.

Additionally, as a port expands in size, adjacent cities can be exposed to many negative effects such as air and noise pollution, and traffic congestion. Port and city planning should therefore be reciprocally organized. A port that mainly handles environmentally unfriendly cargoes such as hardwood and scrap iron should ideally be isolated from cities. For example, in the case of Incheon International Airport (ICN), the government reclaimed land from the sea then built the ICN on a new reclaimed island to allow it to operate freely without worrying about disturbing city inhabitance with air and noise pollution. Gimpo International Airport (GMP), on the other hand, has incurred complaint from many residents because of the significant noise pollution it creates. Ports should therefore take the example of the ICN, and to accomplish this, the present study suggests a joint task force of city and port planning, especially in Incheon.

---

17) Li et al.(2012); Notteboom(1997); Wang and Ng(2011)

V. Conclusions

The issue of port geography has thus far been given extensive attention by scholars[18]. In terms of bulk port, however, this issue is still under researched within the discipline. To fill this research gap and answer the posed research questions, this study attempted to analyze the concentration of cargoes entering bulk ports and the shifting of bulk shipments in the ICP, PDP, and GSP, Korean west coast bulk ports.

This paper provides insightful results by adopting a variety of methodologies including HHI, LQ, and SE analyses. According to the HHI results, it was found that the concentration of bulk cargoes had been gradually decreasing as a result of intense competition between the studied ports. In particular, grains, cement, fertilizer, hardwood, and scrap iron were found in the de-concentration pattern.

In terms of the LQ results, the ICP and GSP showed considerable concentration in terms of grain, cement, fertilizer, and hardwood shipments. In addition, the PDP and GSP were found to overlap in the main types of cargo they handle, both handling a lot of scrap iron and vehicle shipments. Finally, the SE analysis results show that a shifting of cargoes was occurring among the ports. To explain and remedy this, the present study has provided suggestions to port and city planners, and relevant stakeholders, with particular regard to Incheon city. Notably, the city and port planning should be conducted harmoniously between these two stakeholders. To further validate the findings in this paper, it is recommended that future research should attempt to expand the time horizon from which data are collected for the relevant analyses.*

Acknowledgment

This work was supported by the Incheon National University (International Cooperative) Research Grant in 2014

18) Taaffe et al. (1963); Slack (1990); Barke (1986); Hayuth (1981); Le and Ieda (2010); Li et al. (2012); Notteboom (1997); Notteboom (2010); Wang and Ng (2011)

* Date of Contribution ; May 12, 2014
Date of Acceptance ; August 1, 2014

References

BARKE, M. (1986), *Transport and Trade*, Oliver & Boyd, Edinburgh.

BULUT, E., OKAN, D. and SHIGERU, Y. (2012), “A fuzzy integrated logical forecasting (FILF) model of time charter rates in dry bulk shipping: A vector autoregressive design of fuzzy time series with fuzzy c-means clustering”, *Maritime Economics & Logistics*, Vol.14, No.3, pp.300-318.

DUCRUET, C. (2013), “Network diversity and maritime flows”, *Journal of Transport Geography*, Vol.30, pp.77-88.

DUCRUET, C., ROZENBALT, C. and ZAIDI, F. (2010), “Ports in multi-level maritime networks: evidence from the Atlantic (1996-2006)”, *Journal of Transport Geography*, Vol.18, No.4, pp.508-518.

DURU, O. (2010), “A fuzzy integrated logical forecasting model for dry bulk shipping index forecasting: An improved fuzzy time series approach”, *Expert Systems with Applications*, Vol.37, No.7, pp.5372-5380.

DURU, O. (2012), “A multivariate model of fuzzy integrated logical forecasting method (M-FILF) and multiplicative time series clustering: A model of time-varying volatility for dry cargo freight market”, *Expert Systems with Applications*, Vol.39, No.4, pp.4135-4142.

FUNG, K.F. (2001), “Competition between the ports of Hong Kong and Singapore: a structural vector error correction model to forecast the demand for container handling services”, *Maritime Policy & Management*, Vol.28, No.1, pp.3-22.

GRAAFF, T.D., OORT, F.G., and FLORAX, R.J.G.M. (2012), “Sectoral heterogeneity accessibility and population-employment dynamics in Dutch cities”, *Transport Geography*, Vol.25, pp.115-127.

HAYUTH, Y. (1981), “Containerisation and the load centre concept”, *Economic Geography*, Vol.57, No.2, pp.160-176.

KO, B.W. (2010), “A Mixed-Regime Model for Dry Bulk Freight Market”, *The Asian Journal of Shipping and Logistics*, Vol.26, No.2, pp.185-204.

KO. B.W. (2013), “Analysis of Term Structure in Dry Bulk Freight Market”, *The Asian Journal of Shipping and Logistics*, Vol.29, No.1, pp.1-22.

LAM, J.S.L. and YAP, W.Y. (2011), "Dynamic of liner shipping network and port connectivity in supply chain systems: Analysis of East Asia", *Journal of Transport Geography*, Vol.19, No.6, pp.1272-1281.

LAZE, F.G.L., SEOANE, M.J.F. and MONTES, C.P. (2012), "Maritime degree, centrality and vulnerability: Port hierarchies and emerging areas in containerized transport (2008-2010)", *Journal of Transport Geography*, Vol.24, pp.33-44.

LE. Y. and IDEA, H. (2010), "Evolution dynamics of container port systems with a geo-economic concentration index: A comparison of Japan, China and Korea", *Asian Transport Studies*, Vol.1, No.1, pp.46-61.

LEVINSON, M. (2006), *The box: How the shipping container made the world smaller and the world economy bigger*, Princeton University Press, Princeton.

LI, J.B., and OH, Y.S. (2010), "A research on competition and cooperation between Shanghai Port and Ningbo-Zhoushan Port", *Asian Journal of Shipping and Logistics*, Vol.25, No.1, pp.57-92.

LI, K., LUO, M. and YANG, J. (2012), "Container port systems in China and the USA: A comparative study, *Maritime Policy & Management*, Vol.39, No.5, pp.461-478.

LIRN, T., THANOPOULOU, H., BEYNOM, M. and BERESFORD, A. (2004), "An application of AHP on transhipment port selection: A global perspective", *Maritime Economics & Logistics*, Vol.6, No.1, pp.70-91.

MAOH, H. and TANG, Z. (2012), "Determinants of normal and extreme commute distance in a sprawled midsize Canadian city: Evidence from Windsor, Canada", *Journal of Transport Geography*, Vol.25, pp.50-57.

MILLER, R. and BLAIR, P. (2009), *Input-Output Analysis: Foundations and Extensions*. Cambridge University Press, Cambridge.

NOTTEBOOM, T. (2010), "Concentration and the formatting of multi-port gateway regions in the European container port system: An update, *Journal of Transport Geography*, Vol.18, No.4, pp.567-583.

NOTTEBOOM, T. (1997), "Concentration and load centre development in the European container port systems, *Journal of Transport Geography*, Vol.5, No.2, pp.99-115.

NOTTEBOOM, T. and RODRIGUE, J. P. (2008), "Containerisation, box logistics and global supply chains: The integrated of ports and liner shipping networks", *Maritime Economics & Logistics*, Vol.10, No.1-2, pp.152-174.

OLIVEIRA, G. and CRIOU, P. (2011), "A DEA study of the efficiency of 122 iron ore and coal ports and of 15/17 countries in 2005", *Maritime Policy & Management*, Vol.38, No.7, pp.727-743.

PANAYIDES, P. M. and SONG, D. W. (2008), "Evaluating the integration of seaport container terminals in supply chains", *International Journal of Physical Distribution & Logistics*, Vol.38, No.7, pp.562-584.

PAPATHEODOROU, A. and ARVANITIS, P. (2009), "Spatial evolution of airport traffic and air transport liberalization: The case of Greece", *Transport Geography*, Vol.17, No.5, pp.402-412.

ROBINSON, R. (2002), "Ports as elements in value-driven chain systems: The new paradigm", *Maritime Policy & Management*, Vol.29, No.3, pp.241-255.

SCARSI, R. (2007), "The bulk shipping business: market cycles and shipowners' biases", *Maritime Policy & Management*, Vol.34, No.6, pp.577-590.

SLACK, B. (1990), "Intermodal Transportation in North America and the development of inland centres", *Professional Geographers*, Vol.42, No.1, pp.72-83.

SONG, D.W. and PANAYIDES, P.M. (2008), "Global supply chain and port/terminal: Integration and competiveness", *Maritime Policy & Management*, Vol.35, No.1, pp.73-87.

SONG, D.W. and YEO, K.T. (2004), "A Comparative analysis of Chinese container ports using the analytical hierarchy process", *Maritime Economics & Logistics*, Vol.6, No.1, pp.34-52.

STOPFORD, M. (1997), *Maritime Economics*, Routledge.

TAAFFE, E.J., MORRILL, R.L. and GOULD, P.R. (1963), "Transport expansion in underdeveloped countries: A comparative analysis", *Geographical Review*, Vol.53, No.4, pp.503-529.

TONGZON, J.S., CHANG, Y.T. and LEE, S.Y. (2009), "How supply chain oriented is the port sector?", *International Journal of Production Economics*, Vol.22, No.1, pp.21-34.

UGBOMA, C., UGBOMA, O. and OGWUDE, I. (2006), “An analytical hierarchy process (ahp) approach to port selection decisions – empirical evidence from Nigerian Ports”, *Maritime Economics & Logistics*, Vol.8, No.3, pp.251-266.

WANG, J.J. (1998), “A container load center with a developing hinterland: A case study of Hong Kong”, *Journal of Transport Geography*, Vol.6, No.3, pp.187-201.

WANG, T.F. and CULLINANE, K. (2006), “The efficiency of European container terminals and implications for supply chain management”, *Maritime Economics & Logistics*, Vol.8, No.1, pp.82-99.

WANG, J.J. and NG, A.K.Y. (2011), “The geographical connectedness of Chinese seaports with foreland markets: a new trend?”, *Tijdschrift voor Enonomishe en Sociale Geografie*, Vol.102, No.2, pp.188-204.

YEO, H.J. (2013), “Geography of mergers and acquisitions in the container shipping industry”, *The Asian Journal of Shipping and Logistics*, Vol.29, No.3, pp.291-314.

YUEN, C., ZHANG, A. and CHEUNG, W. (2010), “Port competitiveness from the users’ perspective: An analysis of major container ports in China and its neighboring countries”, *Research in Transportation Economics*, Vol.35, No.1, pp.34-40.

Appendix

<Table 6> LQ analysis results of the ports (2005-2010)

Year	Cargo	ICP	PDP	GSP
2005	Grain	1.61	0.00	0.47
	Cement	**1.35**	0.00	**1.68**
	Sand	1.10	0.97	0.59
	Iron ore	1.63	0.13	0.05
	Fertilizer	**1.29**	0.00	**1.95**
	Hardwood	**1.30**	0.04	**1.82**
	Scrap iron	**1.04**	**1.05**	0.71
	Steel	**1.03**	**1.30**	**0.17**
	Vehicle	0.45	**1.80**	**1.73**
2006	Grain	1.45	0.00	0.73
	Cement	**1.26**	0.00	**1.69**
	Sand	1.30	0.55	0.37
	Iron ore	1.50	0.17	0.14
	Fertilizer	**1.11**	0.13	**2.20**
	Hardwood	**1.17**	0.00	**2.13**
	Scrap iron	0.65	2.09	0.59
	Steel	0.98	1.43	0.26
	Vehicle	0.39	**2.11**	**1.86**
2007	Grain	1.46	0.00	0.69
	Cement	**1.23**	0.00	**2.25**
	Sand	1.40	0.29	0.26
	Iron ore	**1.27**	0.45	**1.68**
	Fertilizer	**1.23**	0.03	**2.78**
	Hardwood	**1.13**	0.08	**2.23**
	Scrap iron	0.28	**2.73**	**1.15**
	Steel	0.83	1.77	0.19
	Vehicle	0.51	**1.77**	**2.02**
2008	Grain	1.42	0.00	0.66
	Cement	**1.17**	0.00	**2.25**
	Sand	1.34	0.40	0.26
	Iron ore	0.73	**3.27**	**1.68**

	Fertilizer	**1.09**	0.14	**2.78**
	Hardwood	**1.13**	0.12	**2.23**
	Scrap iron	0.37	**1.97**	**2.35**
	Steel	0.80	1.82	0.36
	Vehicle	0.49	**1.84**	**2.12**
2009	Grain	1.56	0.00	0.48
	Cement	**1.22**	0.00	**2.36**
	Sand	1.40	0.34	0.32
	Iron ore	0.05	2.64	0.44
	Fertilizer	**1.16**	0.11	**2.29**
	Hardwood	**1.18**	0.12	**2.25**
	Scrap iron	0.44	**1.80**	**1.60**
	Steel	0.73	1.50	0.40
	Vehicle	0.42	**1.51**	**2.02**
2010	Grain	**1.81**	0.20	**1.17**
	Cement	**1.61**	0.02	**2.90**
	Sand	1.93	0.29	0.16
	Iron ore	0.00	2.15	0.07
	Fertilizer	**1.57**	0.03	**3.00**
	Hardwood	**1.60**	0.08	**2.66**
	Scrap iron	0.63	**1.13**	**2.05**
	Steel	0.65	1.46	0.44
	Vehicle	0.46	**1.28**	**2.10**

Note: The italic means the degree of being overlapped for respective cargoes.