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Korea-China Trade Route and Construction of Container Ports in Korea

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Abstract

After the adoption of open-door policy of Chinese government, Korea-China direct shipping routes started in 1989 and the bilateral shipping agreement between Korea and China was concluded in 1993, following the normaliztion of diplomatic ties in 1992. Korean ports such as Busan and Incheon have been affected widely by shipping activities in Korea-China trade. The present paper delves into the development of Korea-China shipping routes and its effects on construction of Korean ports. The paper collects the dataset of movement of shipping routes at each port mainly from the Ministry of Oceans and Fishery of Korea. Major findings are that the construction of two representative ports, Busan port and Incheon port, has been led by the growth of container movement of Korea/China shipping routes, and that movement in Chinese route in Busan port affects and stimulates the movements of US route and Japanese route. Nevertheless, major Korean container ports are facing new challenge of long-term recession in shipping market. Korean container ports necessiate a new growth engine of maritime sectors.

Keywords: Trade, Shipping, China, Container, Port, Construction
JEL classification: R48, R42, F14

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I. INTRODUCTION[1]

Nowadays, we observe a dynamic change in international transport and new trade routes among different continents and various nations. The One Belt One Road (OBOR) proposed by the Chinese government in 2013 is targeted at developing economic potentials by promoting flows of economic factors and resources (Cheng, 2016). Northern Ses Route (NSR), connecting Asia with Northern Europe through the Bering Strait and along the Russian Arctic coast, is another trial of a new trade route between Asia and Europe, which has attracted much attention on its commercialization and its effects on a new trade route between Asia and Northern Europe (Zhang et al.,, 2016 ; Zhao et al., 2016). Although these new trade routes assemble great interest from related nations and economic entities, their effects on existing transport infrastructures such as container ports and a hub port are discussed rarely. Port business as well as shipping business has been influenced by internal and external changes. Among those environmental changes, an introduction of a new trade partner and trade route brings sometimes shippers and shipping companies enourmous wealth, and restructs the existing routes and trade patterns.

The Korean economy shows higher dependency on foreign markets: 75.8% of GDP in 2014 (Korea International Trade Association (KITA), 2016). Korea moves about 99.6% of exports and imports through shipping (Ministry of Land, Transport and Maritime Affairs of Korea, 2009). In this context, shipping and port industries is a vital part of Korea. In the North-east Asia, Korean ports had been passive in attracting transshipment cargoes from neighbouring countries till the late 1980s. The Korean ports in the early 1990s experienced new environmental changes: sudden expansion of Korea/Japan shipping route and commencement of direct shipping route between Korea and China. While Korea/Japan shipping route was a traditional one in the aspect of trading partners, Korea/China route was a new

[1] Foot note

one for shipping companies which did not move directly containers from Korean ports to Chinese ports till the late 1980s.

The trade between Korea and China had commenced through indirect shipping route via Hong Kong since 1979 when Chinese government adopted reformation of economy and open-door policy. Although the two neghbouring countries are geographically close, the shipping trade volume was about 7 million tonnes in 1989, in contrast to 29 million tonnes of shipping trade between Korea and US in 1989 (KITA, 2016). After the direct shipping route between them started in 1989, the shipping trade volume soared to 13 million in 1990 and 29 million tonnes in 1991. Diplomatic ties between Korea and China were normailzed in 1992; both governments concluded the bilateral shipping agreement in 1993.

Busan port as well as Incheon port experienced incessant increasing volume of Korea/China routes: average annual increase rate of Korea/China routes at Busan from 1992 to 2011 records 19.8% in contrast to 7.2% of Korea/US routes and 11.8% of Korea/Japan routes. Therefore, it is important for policy makers, port operators, and port authorites, to assess effects of launch of new trade routes on port facility construction. An assessment of Korea/China route will give us essential implications for understanding interaction between trade routes and port business, and between different shipping networks.

The paper aims to examine the quantitive impact of trade amounts and trade volume in Korea/China route on expansion of facilities in Busan port. The paper also evaluates interaction between different shipping routes in a specific situation of continual increase of container volume.

Contribution to the literature has two sides. First, the present paper clarifies the interaction between trade, container throughput, and port construction in Korean container ports. The paper investigates the interaction through regression with panel datasets and time series data of Busan port and Incheon port. Second, the present paper divides trade routes into several main shipping routes and examines their effects on port development in accordance with growth of container volumes. By doing this, the paper tries to conclude a main propeller of continual growth in Korean container ports from the early 1990s to the early 2010s. Third, the present paper scrutinizes the strategy of Korean ports for attracting transshipment containers of foreign countries. A hub container port such as Busan port tends to be under pressure of competition due to volatile characteristics of transshipment cargoes and shipping companies. Furthermore, a long term recession in maritime industry requests Koreann container ports to redesign their strategies to grow sustainably.

The present paper is organized as follows, Section 2 reviews literature on interaction between trade and shipping networks. Section 3 describes data gathering, draws a figure of development trend of Korea/China shipping routes, and traces the facility construction at the two Korean ports: berth length, area of container yard, number of quay cranes and container handling capacity. Section 4 illustrates panel regression of trade volumes at shipping routes on port construction and main results. Section 5 discusses the main results of empirical models and implications. Section 6 includes the conclusion of the paper and policy implications.

II. LITERATURE REVIEW

Trade as one of the external variables in a port industry affects cargo throughput (Yap and Lam, 2013). Furthermore, introduction of a new trade routes changes widely maritime sectors by saving in fuel consumption and operating costs, and reducing pollutant emissions and transit times (Rahman et al., 2014). Changes of quality and frequency in shipping services are challenges for port industries. A trial of daily shipping service connecting continents by leading shipping companies such as Maersk Line will stimulate a structural change of shipping routes and their interaction in the North-East Asia (Lin and Tsai, 2014). Since incessant evolution and change in shipping will continue, a microscopic approach on effects of shipping route changes to port industries and to interaction between shipping routes will be a hint to draw a futuristic view of container ports, especially Korean ports which have been attracting transshipment containers mainly from China and Japan.

Recently, NSR has attracted much attention on its commercialization and its effects on global logistics chain (Zhang et al., 2016 ; Zhao et al., 2016). In addition One Belt One Road initiated by the Chinese government introducd new international intermodal corridors between Asia, Europe and Africa (Cheng, 2016 ; Huang, 2016).

When facing sudden increase of cargo thoughput, a port may experience severe congestion at water basin, moorage, berth, yard, warehouse and gate. The government or port authorities will decide the construction of port facilities with budget limitation. Nevertheless, since expansion of port facilities such as berth, container yard and quay cranes needs enormous investment, a port may face financial risks due to deficient influx of containers. Decision on construction of port facilities, however, contains various aims and targets of different players around a port. In some cases, annual growth rate of port throughputs may not affect the size of port facility construction but the timing of construction (Dekker et al., 2011). We can find also an approach of port construction from the view of competitions of inter-port, intermodality and inter route (Fan et al., 2012).

In the North-East Asia, Busan port started its career in the field of container transport in the early 1970s as a feeder port through being connected to hub ports, mainly via Kobe port, Japan. Growing to a hub port in the 1990s, Busan port has been linked with main hub ports in Asia and maintains stable relationship with them (Yap and Lam, 2006). However, the dominant ports in the region faced new challenge from newcomers since the late 1990s and experienced severe competition in catchment of transshipment containers of a neighbouring countries (Yap et al., 2006 ; Anderson et al., 2008). The dynamic growth and interrelationship of Chinese ports restructured shipping networks and hierarchical status of a container port in Asia (Notteboom, 2006 ; Chin, 2010). The analysis of effects by new trade agreement, and then introduction of a new trade route in a country on transport infrastructure has been rarely done, especially in Korea.

The exploration on effects of a new trade route will give us policy implications to solve challenges and problems in building and operating port facilities. Recent downfall of Korean shipping industry since 2012 puts new tasks to port industry: less frequent connection between hub and spoke shipping networks, diminution of transshipment containers of neighbouring countries, and growth of Chinese hub ports and their expansionary development.

III. DATA AND DESCRIPTION

1. Data Collection

The main data sources are the Ministry of Oceans and Fishery of Korea (www.spidc.go.kr) and the Korea International Trade Association (www.kita.net). The statistics of the Ministry are composed of container throughputs in ports in Korea; the statistics of the Association are based on cargo volume in customs clearance at each port. The Association provides the data on amounts and tonnage movements of trades between Korea and main trade partners such as US, Japan and China at each Korean port. While the data on container movements at a shipping route in Busan port can be gathered from 1990 to 2014, the data in Incheon port can be collected from 1995. Hence the panel data are composed of the statistics from 1995 to 2014. The time series data on container movements at a shipping route at Busan port from 1990 to 2014 are collected. We gather the data on facilities of container terminals from Busan Port Authority and Incheon Port Authority: number, outreach and tonnage capacity of quay cranes, length of berth, and area of container yard of container terminals.

2. Trade between Korea and China

US and Japan are traditional trade partners for Korea. Nevertheless, Korea and China started to trade goods even in the late 1970 before the commencement of direct shipping route in 1989 (Kim, 2007). Trade amounts soared up from the late 1980s due to opening of direct shipping routes between Korean ports and Chinese ports. In 1988 Korea exported goods of 372 million US $ to China, about 0.6% of its total export and imported 1.4 billion US $ from China, about 2% of its total import. The two paries concluded diplomatic tie in 1992. Following the Korea Customs Office, trade amounts and cargo volume in tonnage between Korea and China increased from 31.5 billion US$ and 28.9 million ton in 1991 to 4.4 billion US$ and 69.9 million ton in 2001, to 220 billion US$ and 80.0 million ton in 2011, and to 225.4 billion US$ and 79.0 million ton in 2014 (Korea International Trade Association, 2016). Growth in trade between Korea and China shows recently stagnant step.

The trade commencement and expansion with China of Korea from the late 1980s affected shipping routes and port business in North-east Asia. Irregular shipping services for bulk cargoes started in the 1980s: liner shipping routes for containers and general cargoes in the late 1980s. Influx of differenct types of cargoes from China promoted construction of port facilities in Korea.

In addition, liner shipping routes between Korea and China has activated transshipment in shipping services in Busan port, leaping into a hub port in the 1990s. Therefore, the anaysis on Korea/China trade routes and its effects on port development in Korea may shed light on the futuristic shape of Korean ports in the 21st centutry.

3. Development of Korea/China Shipping Route

Direct liner shipping route between Korea and China started from 1989. SINOKOR-Jang Geum Shipping lines-, a joint venture by a Korean liner and a Chinese liner, deployed container vessels between Busan port and Shanghai port, Tianjin port, Qingdao port, and Dalian port, China. The size of container vessels was under 500 twenty-foot equivalant unit (TEU). Ro/Ro route was also introduced between Incheon port in Korea and Weihai port in China in 1990.

In the early 1990s Korea shipping companies established a few joint ventures of liners with Chinese shipping companies or Hong Kong's shipping companies as listed in Table 1: Weidong Ferry Co., Ltd built in 1990 and Coheung Shipping Co., Ltd built in 1991, Vigour Line and others (Kim, 1991; Park and Choi, 2013). During the early 1990s, the liner routes of container vessels were concentrated on Busan port in Korea but dispersed in Chinese ports; Ro/Ro routes mainly around Incheon port in Korea.

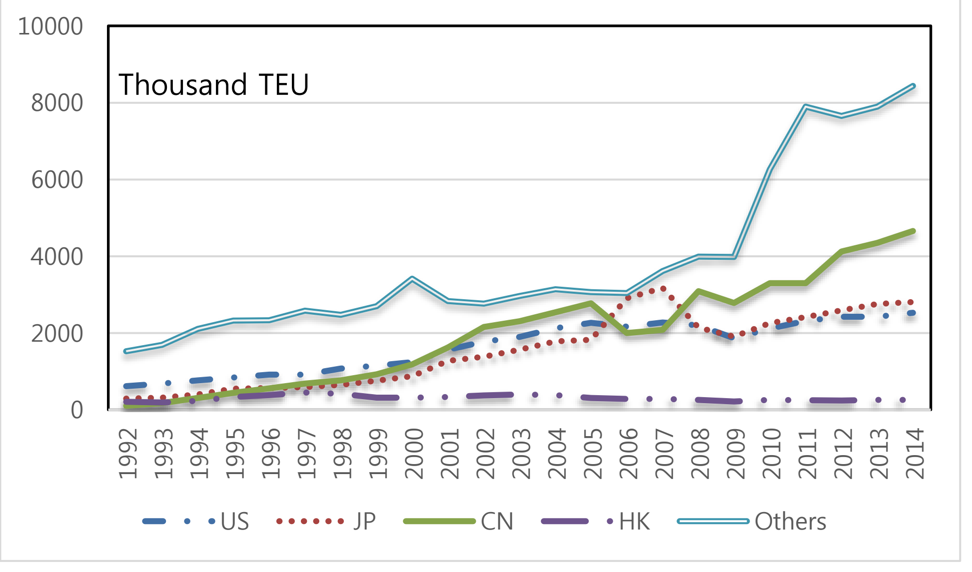
<Table 1> Joint Ventures of Korea and China in the early 1990s

Item/Company	SINOKOR	Weidong Ferry	Coheung Shipping
Head Office	Hong Kong	Weihai, China	Hong Kong
Vessels	Container vessels: 400TEU(1), 190TEU(1) 200TEU(1), 220TEU(1)	Ro/Ro	Container vessels: 103TEU(1), 127TEU(1) 277TEU(1)
Route	Busan/Shanghai	Incheon/Weihai	Busan/Shanghai

	Busan/Tianjin Busan/Qingdao Busan/Dalian	Incheon/ Qingdao	Busan/Tianjin Busan/Qingdao Busan/Dalian

Source: Kim(1991).

<Figure 1> Container movements of main shipping routes in Busan port



Source: Ministry of Oceans and Fishery of Korea.

The Korean government and the Chinese government at the bilateral shipping agreement in 1993 regulated that the container shipping market between them was a free market and the same number of ships of both parties was deployed in Korea/China routes (Baik and Park, 2002). Korea and China tried to keep equivalent market power of both by inputting same number of ships by each party. From the mid of 1990s, calling ports of container vessels were included other Korean and Chinese container ports while number of shipping companies were increasing: both Korean ports such as Gwangyang, Masan and Ulsan and Chinese ports, Ningbo, Nanjing, Fuzhou, and Xiamen and other ports (Korea Maritime Institute, 2001). Furthermore, the opening of direct routes between Incheon port and Chinese ports by container vessels was not permitted till 2002 and remains still in entry barrier of participation agreement by the incumbent at Incheon port.

Container movement of Busan/Chinese ports has been recorded upswing since 1992: from 106 thousand TEU in 1992 sharing about 3.8 % of total container throughput of Busan port to 1.6 million TEU, sharing 21.2% in 2001, to 3.3 million TEU sharing 20.3% in 2011, and to 4.6 million TEU sharing 24.9% in 2014 as described in Figure 1. Incheon port also experinced continual increase of container movement due to the expansion of Incheon/Chinese Ro/Ro (rolling on rolling off) shipping routes. However, while container routes by container vessels at other Korean ports except Incheon and Pyungtaek could be opened relatively easily, the commencement of container routes at the two ports was strictly restricted in order to protect Ro/Ro shipping companies at the ports. Liner shipping routes at Incheon port to Chinese ports by container vessels were freed in 2002 on the condition that existing shipping companies in Korea/China routes agree that (Yoo, 2010). Nevertheless, container movement of Chinese routes at Inchen port has transported mainly by Ro/Ro ships and has risen continually from 47 thousand TEU in 1995 to 177 thousand TEU in 2001 and 1.2 million TEU in 2011, 1.4 million TEU in 2014.

4. Construction of Port Facilities in Korean Ports

Construction of port facilities in Busan was done mainly in the mid of 1990s and the late 2000s. Number of quay cranes at Busan port rose from nine in 1991 to 40 in 2001, to 86 in 2011, and to 104 in 2014 as listed in Table 2: 62 super panamax cranes in a mechanical capacity of 45 vans/hour, 52 post-panamax cranes in capacity of 40 vans/hour, and 10 panamax in capacity of 25 vans/hour and other quay cranes in capacity of 22 vans/hour in 2014. However at Incheon port, the number of quay cranes rose slightly in the 1990s but surged in the 2000s: five post-panamax cranes, and 14 panamax and other quay cranes in 2011 and also in 2014.

<Table 2> Number of Quay Cranes at Busan port and Incheon port

Crane/ Year	1991		2001		2011		2014	
	Bs	Inc	Bs	Inc	Bs	Inc	Bs	Inc
Super panamax	0	0	0	0	44	0	62	0
Post-panamax	3	0	31	0	32	5	52	5
Panamax and others	6	5	9	8	10	14	10	14

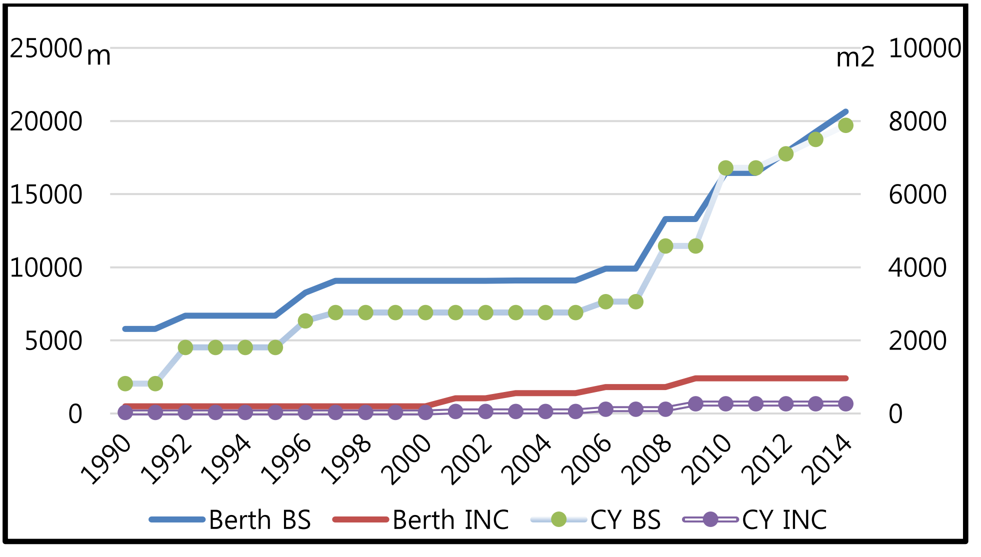
Total	9	5	40	8	86	19	104	19

Source: Ministry of Oceans and Fishery of Korea.

Note: Bs means Busan port; Inc means Incheon port.

The berth length of container terminals in Busan port rose from 5.8 km in 1991 to 9.1 km in 2001, to 16.4 km in 2011, and to 20.6 km in 2014 as shown in Figure 2; area of container yard expanded from 817 thousand m^2 to 2.7 million m^2, to 6.7 million m^2, and to 7.9 million m^2 during the same period. Incheon port shows later construction of port facilities since 2000. The berth length and area of container yard of container terminals in Incheon port increases from 1.0 km and 56 thousand m^2 in 2001, to 2.4 km and 272 thousand m^2 in 2011as shown in Figure 2.

<Figure 2> Berth lenth and area of container yard of Busan port and Incheon port



Source: Ministry of Oceans and Fishery of Korea, at each year.

5. Calculation of Container Handling Capacity

Since container ports play a role of junction in international intermodal transport, the capacity of container ports is related with depth of berth, length of quay, number and mechanical capacity of quay cranes, area of yard, and even number of gates. Considering available dataset of worldwide level such as Containerisation International (Informa UK, 2011) and Ports and Terminals Guide (IHS Global Ltd, 2010), the present paper considers mainly the handling capacity of containers at each port and counts number of quay cranes and their capacities when measuring handling capacity of container ports. Following the calculation method of UNCTAD(1985), we can develop the method of handling capacity of a container port per day as shown in Equation 1. UNCTAD assumes that the ratio of operation time of cranes to the berthing time of ships is 0.8.

$$\begin{aligned} \mathrm{PC} &= 0.781 \times 18\ \mathrm{hour} \times (\text{Average movement per crane}) \times (\text{Number of cranes}) \\ &\quad \times (\text{Operation time of cranes}/\text{Berthing time of ships}) \\ &= 0.781 \times 18\ \mathrm{hour} \times (\text{Average movement per crane}) \times (\text{Number of cranes}) \\ &\quad \times 0.8 \end{aligned} \tag{1}$$

If we consider that working days are 330 (Chang et al., 2012) and the mechanical capacity of each type of cranes are different as in Table 3, we get the annual capacity of each type of crane (Korea Maritime Institute, 1988; Rankine, 2003). Furthermore, the capacity of Ro/Ro terminal and multi-purpose terminal can simply be calculated to be the same level of ship's gear (Korea Maritime Institute, 2000a and 2000b; Rankine, 2003).

IV. Methodology and Panel Regression

1. Methodology

The handling capacity of a port works as a constraint for international cargo flows (Fan et al., 2012). In short run, quay cranes and their mechanical capacity in view of productivity measurements of container ports are inputs of ports : container thorughput is considered as ouput (Wilmsmeier et al., 2013). However, in long-term, a container port and its facilities such as quay cranes are designed to handle forecasted containers at each shipping route which shows its peculiarities in ship size and average container movement (Lin et al., 2014).

Total revenue of a container port can be calculated as in the Equation 2.

$$TR_x = a_1 V_1 + \cdots\cdots\cdots + a_r V_r \tag{2}$$

TR: total revenue
a_r : average terminal tariff at route R
V_r : container movement at route R

Nevertheless, when investing port facilities, container terminal anticipates the present value of total revenues from o year to t year as shown in Equation 3.

$$PV_{\mathrm{p}} = TR_{\mathrm{p0}} + \frac{TR_{p1}}{(1+r)} + \cdots\cdots + \frac{TR_{pt}}{(1+r)^t} \tag{3}$$

p: container port p
PV_{p} : present value of flows of total revenues at container port p
TR_{pt} : total revenue at t year at container port p

If we assume that average tariff per a container is decided by competition between container ports and the container movement in future is largely varied by present movement, we can rewrite Equation 3 as in the following Equation 4,

$$PV_{\mathrm{p}} = f(V_1 \cdots\cdots\cdots, V_r) \tag{4}$$

Equation 4 implies that present value of total revenue at container port depends on container movement at each shipping route.

2. Correlation Analysis

The main facilities of container ports include quay cranes, berth and container yard. When adopting indicators of these facilities: handling capacity of quay cranes, length of berth, and area of container yard, we found that the container movement in Korea/China route (KOR/CN) with handling capacity and with area of container yard show higher correlation than those of Korea/USroute (KOR/US), Korea/Japan route (KOR/JP) and Korea/other countries' routes (KOR/OTH) routes as listed in Table 3.

<Table 3> Correlation analysis

	conth	KOR/US	KOR/JP	KOR/CN	KOR/OTH
capa	0.93	0.82	0.85	0.92	0.78
length	0.95	0.74	0.96	0.94	0.75
cy	0.86	0.71	0.78	0.85	0.81

Note: capa means handling capacity ; length, length of berths ; and cy, area of container yards

3. Panel Unit Root Test and Suitability Test of Panel Models

First we test the stationarity of data on handling capacity (capa) of a container port and container movements in KOR/US, KOR/JP, and KOR/CN routes. In the panel unit root test of Levin-Lin-Chu illustrated in Table 4, level variables of capacity and movement at KOR/JP show stationarity of data. Logarithm variables of capacity, container thorughput, and movement in KOR/US route are generally better in stationarity than level variables.

In panel regression, we test suitability of fixed effects model. The error term in the fixed effects model does not show the particularity of each panel as shown in Table 5. When comparing the efficiency of two models: fixed effects model and random effects model, we find that random effects model is more efficient than fixed effects model. Therefore, we choose random effects model and generalized least squares (GLS) model in panel regression, and use time series regression at each port.

<Table 4> Panel unit root test

		Period : 1995-2014				
		Capa	comth	KOR/US	KOR/JP	KOR/CN
Including time trend	Level variables	-0.73 (0.23)	-1.31* (0.09)	-0.72 (0.23)	-1.86** (0.03)	-1.08 (0.14)
	Logarithm formation	-1.98** (0.02)	-2.29*** (0.01)	-3.15*** (0.00)	-0.72 (0.24)	-0.28 (0.39)

Note: * significant at 10 percent level; ** significant at 5 percent level; *** significant at 1 percent level. The figures are adjusted t value and the figures in parenthesis are p-value.

<Table 5> Summary of suitability tests for models

Test	*Result*
Characteristics of error term in fixed effects model	F(1, 36)=2.13; Prob. > F = 0.153
Hausman Test	$\chi^2(5)$= 2.13; Prob.>χ^2: 0.831

Note: Prob. means probability.

Source: Authors' elaboration.

4. Regression and Results

A port handles vessels and containers. Construction scale of a container port grows in proportion to number of vessels and containers in order to keep optimal service ratio (UNCTAD, 1987; Ng and Wong, 2006; Ottjes et al., 2006). Number of calling vessels varies with volume of containers. In addition, we can suppose that the size of vessel at each shipping route adapts to the characteristics of the route. Hence, we can premise that the scale of port construction and frequency of construction depend on cargo movement at each shipping route.

Accepting this assumption and using basic panel regression equation (Maddala, 2001), we can build the following panel regression equation in logarithm formation which relates the indicators of port construction such as handling capacity, berth length and area of container yard, with container movement at each shipping route.

$$I_{pt}=\alpha_p+\beta_1V_{1pt}+\beta_2V_{2pt}+\beta_3V_{3pt}+....+V_{rpt}+u_{pt} \quad (2)$$

where,

I_{pt}: indicator of handling capacity or facilities in port *p* in year *t*

V_{rpt}: container movement at *r* shipping route in port *p* in year *t*

u_{pt}: error term

<Table 6> Regression results of movements of shipping routes on handling capacity of a container port

Variable/Port	Busan and Incheon, 1992-2014			Busan, 1992-2014		Incheon, 1995-2014	
	M 1: R.E.	M 2: GLS	M 3: F.E.	M 4	M 5	M 6	M 7
Constant	2.71	2.71	4.43	5.42	9.22	5.04	6.69
KOR/US	-0.01	-0.01	-0.32	-0.68	-1.63**	-0.64	-0.32
	(-0.42)	(-0.45)	(-1.04)	(0.93)	(-2.47)	(-1.46)	(-0.86)
KOR/JP	0.19***	0.19***	0.1	0.30	0.76**	0.07	0.14
	(2.69)	(2.90)	(1.08)	(0.93)	(2.64)	(0.47)	(1.28)
KOR/CN	0.20***	0.20***	0.34	0.34	0.46**	0.50**	0.47***
	(3.48)	(3.75)	(3.00)	(1.44)	(2.17)	(2.84)	(3.33)
KOR/HK	-0.08	-0.76	-0.25	-0.82	-0.01	-0.48	-0.51
	(-0.54)	(-0.59)	(-1.38)	(-0.34)	(-0.45)	(-1.37)	(-1.75)
KOR/OTH	0.54***	0.55***	0.38**	0.59***	0.48*	0.22	-0.24
	(5.26)	(5.67)	(2.45)	(3.05)	(2.62)	(0.76)	(-0.09)
Sample Size	43	43	43	23	22	20	19
R^2(Overall)	0.97	-	0.90	0.92	0.93	0.89	0.93
F	χ^2: 1169 Prob.>F =0.00	χ^2: 1358 Prob.>F =0.00	F:55 Prob.> F =0.00	F:39 Prob.> F=0.00	F:43 Prob.> F=0.00	F:23 Prob.> F=0.00	F:36 Prob.> F=0.00

Note: * significant at 10 percent level; ** significant at 5 percent level; *** significant at 1 percent level.

The figures in parenthesis mean t value or z value. Prob. means probability.

F.E.: Fixed Effects Model; R.E.; Random Effects Model; GLS; Generalized Least Squares

Source: Author's elaboration.

Table 6 illustrates sevel regression models and main results: three panel models for Busan port and Incheon port, two models of time series for Busan port, and two models of time series for Incheon port. The three panel models are composed of Model 1 of random effects model (RE), Model 2 of generalized least squares model (GLS), and Model 3 of fixed effects model (FE). The two models for Busan port include Model 4 and Model 5 with time lags of independent variables; so do the two models of Model 6 and Model 7 for Incheon port.

The results of panel regression demonatrates the main sources of growth in container throughputs in Korean ports as shown in Model l and 2 in Table 6: KOR/JP and KOR/CN routes. Individually, Busan port shows characteristics of a hub port: the regression with time series data in Model 5 illustrates a strict correlation between handling capacity and container movements in KOR/JP, KOR/CN, and KOR/OTH routes. This phonomenon coincides with the fact that Busan port handles the transshipment containers mainly for Japanese ports and Chinese ports, which are related with container ports in other continents.

Model 6 and 7 clarify the effects of container movements of KOR/CN route on port expansion of Incheon port. Although other shipping routes could not show clear effect on port expansion, KOR/CN routes show positive coefficient on port expansion. Contrarily to Busan port, Incheon port demonstrates the growth source of cargo throughputs, mainly from Chinese route.

In the next step, an analysis of Granger causality between container throughputs and handling capacity, and between container movements in major shipping, will give us an information on interaction between main factors around Busan port and Incheon port.

5. Granger Causality

Granger causality in Table 8 says the interaction between handling capacity (capa) and container throughput (conth) in Busan port. Incheon port does not show any Granger causality between handling capacity and container throughput. When specifying the Granger causality between handling capacity and container movement of Chinese route, Busan port show the causality from handling capacity to container throughput; Incheon port having the causality from container throughput to handling capacity.

<Table 8> Granger causality Wald tests

Statistics		Capacity and container throughput		Capacity and China route	
		Conth→ Capa	Capa → Conth	China route → Capa	Capa → China route
BS	χ^2	8.76	7.42	1.35	7.78
	Prob. > χ^2	0.03	0.06	0.72	0.05
INC	χ^2	5.59	1.24	30.3	3.64
	Prob. > χ^2	0.13	0.74	0.00	0.30

Note: Prob. means probability; BS, Busan port; and INC, Incheon port.

<Table 9> Granger causality Wald tests between container movements in Busan port

Statistics		KOR/CH and KOR/US		KOR/CH and KOR/JP		KOR/CH and KOR/OTH	
		KOR/CH → KOR/US	KOR/US → KOR/CH	KOR/CH → KOR/JP	KOR/JP → KOR/CH	KOR/CH → KOR/OTH	KOR/OTH → KOR/ CH
Lag (1/3)	χ^2	14.0	0.7	8.5	2.1	4.0	2.9
	Prob. > χ^2	0.00	0.87	0.04	0.54	0.26	0.39
	AIC	-2.98		-1.46		-1.41	
Lag (1/2)	χ^2	9.5	0.7	9.3	3.3	2.8	3.3
	Prob. > χ^2	0.01	0.69	0.01	0.19	0.25	0.20
	AIC	-3.29		-1.68		-1.66	

Note: Prob. means probability.

In Busan port, we observe in Table 9 that container movement in Chinese route to movement in US route and to movement in Japanese route has Granger causality. This Granger causality implies that Busan port could attract mainly transshipment containers from Chinese regional ports for US ports and secondly, from Japanese regional ports. The Granger causality from Chinese route to Japanese route seems to be caused by the linkage of hub and spoke around Busan port, which interlinks Chinese regional ports and Japanese regional ports.

Ⅴ. Discussion

We find Granger causality in both direction between handling capacity of containers and container throughputs in Busan port. Nevertheless, Incheon port does not show Granger causality in both direction between handling capacity of containers and container throughputs. If we narrow the range of shipping route to Chinese routes, Busan port shows only the Granger causality from handling capacity to container throughputs but Incheon port illustrates only the Granger causality from container throughputs to handling capacity of containers.

From these main results of Granger causality test, on the one hand, port expansion in Busan port led the growth of container throughputs. On the other hand, container movements at Chinese shipping routes led the construction of port facilities in Incheon port.

Busan port has grown from a regional feeder port till the late 1990s to a hub port in North-east Asia since the 1990s. It handles traded cargoes of Korea and transshipment containers of Japan and China. From the regression results in Table 6, we found that port expansion and growth of container movements have affected each other. Nevertheless, continual recession in shipping market since 2008 and financial crisis of Korean major shipping companies cause a dull growth in container movements at Korea/Japan and Korea/China routes in the 2010s. In addition, external changes in international intermodal transport such as OBOR and NSR will bring new challenges to Korea maritime industries. Therefore, Korean major ports are facing the possibility of excess capacity in their facilities. Since Busan port presents Granger causality and container throughput, it is imperative for Busan port to design a new strategy which promotes its growth in container volume and profits. Incheon port also meets a new challenge due to stagnant trade record between Korea and China. Since it has handled mainly the cargoes of china, recession of Chinese economy will bring excess capacity of port facilities. Furthermore, Incheon port has restriction in attracting transshipment containers.

VI. CONCLUSIONS

Port, an intermediate node between shipping and inland transport, faces continual environmental changes from international trade shipping and other logistic activities. The present paper explores the response of port business by exemplifying port construction at Busan port and Incheon port when handling continually increasing volume of a new route, Korea/China. At the initial years of starting Korea/China feeder routes, the opening of liner routes was restricted to the main Korean ports, Busan port, Incheon port, and Pyungtaeg port. The shipping market in Korea/China routes has been become gradually a free market but some limitations such as agreement of newcomer's participation by the incumbent shipping companies at Incheon port existment. Continer production of trade between Korea and China and

The paper finds first that container movement of Korea/China shipping route has been a strong stimulus to construction of container terminal in Korea after the 1990s. The movement accelerated the increase of number and productivity improvement of quay cranes, the development of berth, and other port facilities such as container yards in both Busan port and Incheon port. Second, however, from the view of an individual port, on the one hand, Busan port has caught transshipment containers from neighbouring countries such as China and Japan and grown as a hub port. On the other hand, Incheon port could expand its facilities due to the continual increase in trade volume of Chinese shipping route.

The results of the present paper resent a few policy implications. First, since a dull growth of container throughputs in Korea/Chinatrack will continue, new strategies not focusing an attractiving transshipment containers of neighbouting countries are necessary. Busan port enjoyed fruits of continual increase of container movement in Korea/China routes in the 1990s and Incheon port could share partially the fruits after the early 2000s when both governments freed Korea/China routes at Incheon port to a certain extent. Although Busan port has succeeded to grow through building hub and spoke network in North-east Asia, the port is facing a long term maritime recession. Second, policy makers could find a core growth engine in maritime sectors by diversifying contents of services and enhancing activities of value added. Third, a new maritime strategy suitable with OBOR and NSR should be designed and assessed. Fourth, shipping routes around Busan port have been connected at each other. By initaillizing Korea/China direct shipping routes in 1989, Korean ports could attract the movement and vessels of other shipping routes. The container movements of Korea/China shipping routes have affected both main shipping routes such as Korea/US and Korea/Japan and other minor routes. Hence, the collapse of shipping routes to Chinese regional ports and Japanese regional ports due to financial crisis of Korean liners such as Hanjin Shipping may cause a shrinkage of holistic shipping network and, in result, higher logistics costs of Korean trade.

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