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A Comparative Study on Production Inducement Effects in Key Industries of Korea and the Netherlands

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ABSTRACT

Purpose: Although the growth of trade industry has been pushed mainly by intermediary trades due to Korea's geopolitical characteristics, intermediary trades fail to take the pivotal role in industrial growth because the environment could not support the industry on the national level. This study intends to help find new trade structures and directions to break the problem, by comparing Korea with the Netherlands, which has similar characteristics with Korea.

Design/methodology/approach: This study applied the competitive import model and used data from World Input-output Data(WIOD), and focused on Information and Communications Technologies(ICT) manufacturing and ICT service industries as the key industries in Korea, and chemical and medical industries as the key industries in the Netherlands.

Findings: The results indicated that Korea's ICT manufacturing and chemical industries have high backward linkage effect, while the Netherlands' ICT manufacturing, ICT service, and medical industries have high forward linkage effect.

Research limitations/implications: When comparing between industries, it is clearer to consider not only the effect of generating production but also the creation of value added and the creation of employment in order to directly compare differences. As a contribution, comparisons between countries with large-scale trade were found to require the use of competitive models over non-competitive ones.

Originality/value: This study showed that competitive analysis model should be used instead of non-competitive import model when Input-Output(IO) analysis is applied to countries with a high proportion of intermediary trade.

Keywords: IO analysis, ICT(Service and Manufacturing) industry, Chemical and Medical industry

1. Introduction

The global trade network continues to become more integrated and influential due to globalization. Strong industrial control, geographical characteristics,

society, and culture are the major factors that have strong impacts on trades. In this regard, Korea and the Netherlands have very suitable structures for continuous expansion and maintenance of trade volume. Among the various types of trades, intermediary trade refers to transactions among three countries, in which the intermediary country imports goods from one country for the purpose of exporting them to a third country without carrying the goods into its own country(Perry, 1990). Intermediary trades can

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be considered as reexports that involves shipping, storage, manufacture, and distribution (Ahn, 2010). That is to say, the intermediary country does not carry goods from the seller's country into its own country. Instead, it ships the goods directly to the buyer's country or creates added value through storage service, process, or distribution. Korea is strong in intermediary trade, which accounts for about 33% of the total export trade volume(\$573.7 billion) as of 2017("K-STAT", access on 2019). Intermediary trade in the Netherlands accounts for about 42% of its total export trade volume(\$652.5 billion) in 2017("K-STAT", access on 2019). Comparing the actual trade volume, the two countries have similar internal and external environments. The two countries have similar transit trade volumes and trade volumes, as well as similar geographical locations surrounded by the neighboring countries and harbor developments. Therefore, it is necessary to study these two countries.

Intermediary trade helps not only increase exports but also develop related service industries, leading to the convergence with other industries and expansion of influence (Suder et al., 2015). Production inducement effect represents the influence of such intermediary trades, and the extent of effect is measured by production inducement coefficients. Production inducement effect indicates the ratio of increase of production in other industries, derived from the increase of one unit of final demand product in a particular industry. IO Analysis is used most commonly for industrial analysis, and it can be classified into non-competitive model and competitive model. In the non-competitive model, domestic goods and imported goods are treated separately.

In contrast, in the competitive model, imported goods are treated the same as domestic goods, and are included in an industry's total output. Thus, it is hard to use a non-competitive model to analyze industries that must consider external environments instead of the domestic environment (Miller and Blair, 1985). Especially, since import coefficient of intermediary trade fluctuates along with the changes in both the domestic and international markets, the non-competitive model cannot be used for inter-country comparisons.

Instead, the competitive import model, which is stable for comprehensive economic predictions and plan establishments, should be used for the analysis. In other words, the competitive imported model is a research method that must be considered in case of high volume of intermediary trade.

According to the OECD (2017), Korea ranked fourth in the world and the Netherlands ranked 10th, indicating that Korea is larger than the Netherlands in terms of overall market size.

Korea is a country with advanced manufacturing and the Netherlands is a country with advanced service industries (Kim et al., 2017). Similarly, Korea has an excellent ICT manufacturing sector while the Netherlands has an excellent ICT service sector.

The Netherlands fosters new industries through R&D investments. Especially, the chemical and medical industries are invested and cultivated. The chemical industry accounts for about 18 percent of exports and 30 percent of R&D investment (Kotra, 2015). The medical industry has more than doubled in size in 2018 (KHDI, 2018). This research used the competitive model to compare the industrial production inducement effect between Korea and the Netherlands, in order to figure out the necessary capabilities for each country to stimulate the economy and create employment.

A. Research procedures

The procedure in this paper is shown in Figure 1. At the first stage of the research procedures, this study collected IO data for the period 2000~2014 from WIOD for analysis(Dietzenbacher et al., 2013). WIOD provides reliable data of 43 countries, and many studies related to or derived from brokerage trading have used data from WIOD (Wang et al., 2013, Costinot and Clare, 2014, Ottaviano et al., 2014). In particular, using 'Domestic' and 'Import' data for the two countries implies that the two countries that conduct intermediary trade can be analyzed. This study focused on ICT(Manufacturing and Service) industry, Korea's key industry, as well as chemical

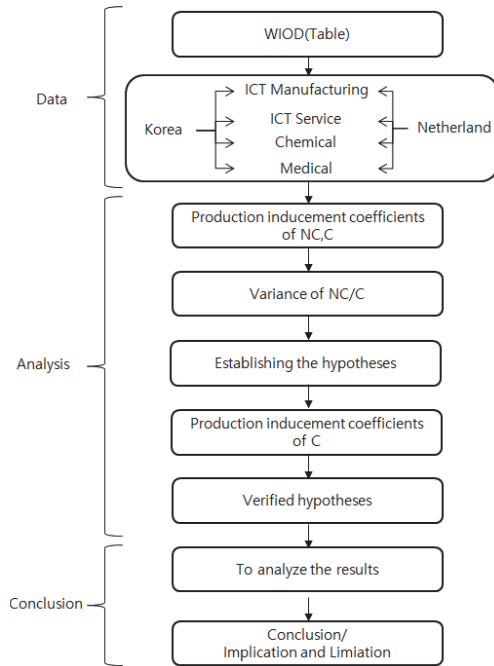


Figure 1. Analysis procedure

* NC(Non-competitive import model), C(Competitive import model)

and medical industries, the Netherlands' key industries, in order to conduct a comparative analysis between the two countries that are represented by intermediary trades.

The second stage is the analysis stage. A research comparison between the non-competitive and the competitive import models was conducted to determine exactly which analysis method should be applied to countries with active transit trade. The comparison shall be omitted as described in the methodology. The comparison confirmed the variance of coefficients of the non-competitive model and the competitive import model and this study established hypotheses based on these factors. After establishing the hypotheses on the differences in production inducement coefficients between the two countries, this study computed production inducement effects in the competitive import model. Hypotheses were verified by using the calculated coefficients.

The final stage is conclusion, in which this study used production inducement coefficients to analyze the results in the competitive model. Further, four

categories were analyzed for each industry, depending on the degree of the Backward Linkage effect and Forward Linkage effect. Implications and limitations are stated based on the analysis results.

II. Conceptual Backgrounds

A. Non-Competitive Import Model and Competitive Import Model of IO(Input-Output) Analysis

Isard(1951), Hollis and Watanabe (1958) and Hirschman(1958) suggested IO analysis. Leontief(1952, 1963, 1966), and Miller & Blair(2009) improved and applied it to various analysis depending on countries and regions. IO analysis can be classified into four different types (competitive analysis within a region, non-competitive analysis within a region, competitive analysis between regions, non-competitive analysis between regions) based on the targeted regions and the composition method of sectors. The non-competitive model was used in many existing studies until recently (Rohman, 2012).

Because intermediary trade accounts for high percentages of Gross Domestic Product(GDP) in both Korea and the Netherlands, using the competitive import model can explain industrial production inducement effects more effectively than using the non-competitive model(Stone, 1961). The non-competitive model reflects the consumption structure of imported goods to discriminate between domestic goods and imported goods, and it has been used in research on industries rather than research on added values. In contrast, the competitive import model does not discriminate between domestic goods and imported goods but express them in one data, and it is mainly used in research on added values.

The two models have contrasting characteristics that the non-competitive model differentiates the productions of products, while the competitive import model does not. Thus, the non-competitive model cannot be used to study competition, whereas the

competitive import model is possible to use a single value to present competition. Thus, import coefficient in the non-competitive model is unstable due to the changeable input structures of domestic goods and imported goods. On the other hand, the competitive import model is stable to reflect input structure for long-term economic forecasting and plan establishment (Lau et al., 2010).

Based on WIOD's IO Table, time can be taken into account because the non-competitive model is actually used to examine a country's productivity competitiveness. However, the competitive import model cannot be used to do time-series analysis because it shows values that consist of the country's inventory, total domestic productions, and total imported products.

Production inducement coefficients in the competitive import IO table, which integrate domestic goods and imported goods, are different from the production inducement coefficients being derived from non-competitive IO table, which discriminates between domestic goods and imported goods. If the difference

between the two coefficients is large, the industry depends highly on imports because the size of difference depends on whether the imported intermediate goods are used or not. <Table 1> presents existing research on various industries that used IO Tables.

As shown in <Table 1>, the non-competitive model has been used far more than the competitive import model in previous research, because most existing studies focused on a single country or countries that are not intermediary trade oriented. However, the competitive model is more effective for IO analysis of countries that create considerably added values through intermediary trades, such as Korea and the Netherlands.

1. Core Industries of Korea and The Netherlands

i. ICT Manufacturing and ICT Service

Organization for Economic Cooperation and Development(OECD) defined that productions(products and services) in the ICT industry are those fulfill the function of information processing and communi-

Table 1. Studies that used IO Tables

Year	Source	Industry	Import assumption		Classification				
					Industry		MRIO(Regional)		
			NC	C	Single	Multi	SRIO	IRIO (Between)	IRIO (Within)
2016	Brizga et al.	Environmental	o		o				o
2014	Zhang and Anadon	Resource(water)	o		o				o
2013	Su and Ang	Environmental	o	o				o	
2013	Rohman	ICT	o		o				o
2011	Xing et al.	ICT Manufacturing and service	o			o	o		
2009	Peters et al.	Environmental	o		o				o
2009	Kim and Park	ICT	o		o		o		
2008	Liu et al.	Manufacturing			o				
2007	Lau et al.	-	o			o			o
2004	Lenzen et al.	Environmental	o		o		o		o
2004	Han et al.	Electric power	o			o			o
2004	Ozkan et al.	Agriculture	o		o				
1998	Lenzen	Environmental					o		
1994	Park	Manufacturing, Service	o			o			o
1955	Moses	Agriculture, Manufacturing, Service	o			o			o

* NC(Non-competitive), C(Competitive), SRIO(Single-regional IO), IRIO(Interregional IO or Intraregional IO, MRIO(Multi-regional IO)

cation by electronic means and transactions (2002). ICT industry of Korea is manufacturing-oriented. As of 2016, the Korean IT industry contributed 10.4% to GDP (contribution of IT industry to GDP), and the contribution is continuously increasing (IT Statistics of Korea). Korea has been experiencing high economic growth since the 1990s due to the development of communication devices and semi-conductors, and both industries have since become the country's key industries.

ICT is the core infrastructure in Korea and has high diffusion effect on other industries. On the other hand, ICT industry of the Netherlands is service-oriented, and the proportion of manufacturing is relatively low. Its contribution to real GDP was 2% in 2016, and it showed a more volatile trend than Korea according to data of the past ten years (CEIC (Euromoney institutional investor Company), 2016).

In the present, the ICT industry is developed due to investments on Big Data and Cloud Computing Solutions. Moreover, the ICT industry serves as a breakthrough in the economic crisis and may lead to national economic growth (Shin et al., 2012). <Table 2> presents previous studies that compared

the ICT industry between Korea/the Netherlands and other countries by using various methodologies.

In <Table 2>, Analysis of ICT industry used not only data published by WIOD, but also International Monetary Fund (IMF)'s trade data, OECD data, and data published by Korea Network Information Center (KRNIC) to compare ICT industry among Korea, Thailand, EU, USA, Canada, Australia, etc.

ii. Chemical Industry and Medical Industry

Chemical industry can be divided into multiple fields, including oil, textiles, plastics, products, and technology. Most sectors of the chemical industry of the Netherlands are developed through investments. The Netherlands promotes its industries through two types of infrastructures. One is to use the logistics infrastructure, which takes advantage of geographical benefits that the port of Rotterdam and the airport of Amsterdam are becoming the gateway to Europe because the transportation has been made since hundreds of years ago.

Thus, most trades between EU countries are intermediary trades, and the structures of both export and import are similar (CPB(Central Plan Bureau),

Table 2. Research on ICT Industry(Manufacturing and Service)

Year	Author	Methodology		Research	Results
		Data	Country		
2012	Mattes et al.	IMF's trade data and GDP from 1995 to 2007	To compare EU, the USA, Canada, Australia, Korea, and Japan	<ul style="list-style-type: none"> Measured ICT development index Calculated the infrastructure, degree of users, implementation cost of ICT in schools 	<ul style="list-style-type: none"> Discovered the relationship that if the influence of network and trade is higher to strengthen ICT trade, the development of ICT will increase
2011	Huang	Used data from 1999 to 2007	To compare between 107 countries (including Korea) on the three diffusion stage by clustering	<ul style="list-style-type: none"> Used Internet users and domestic productions as variables to investigate the changes in each country based on ICT diffusion stages 	<ul style="list-style-type: none"> In case of Europe that has a high economic development index, its stage of ICT development is not high in general
2004	Lee and Chan-Olmsted	Use data from OECD and KRNIC	Korea and the USA	<ul style="list-style-type: none"> Studied using policies, consumptions, technical supports, and related issues 	<ul style="list-style-type: none"> Presented the status of ICT in the USA
2003	Hempell	Used data from 1994 and 1999	Germany and the Netherlands	<ul style="list-style-type: none"> Compared innovation and achievements of ICT service 	<ul style="list-style-type: none"> Investment on ICT is an important factor, and it has a stronger direct positive influence on Germany than on the Netherlands

2017). Second, there are many global companies in the Netherlands. Because the economy is vitalized mainly by trades, in addition to entering and growing in other countries, the Netherlands was able to attract excellent local talents to integrate a variety of cultures and knowledge and become an economic power from various perspectives (Lim, 2014). Among the various industries, the bio-related chemical industry and medical industry are fostered as key industries in the Netherlands, and the global chemical market is expected to exceed \$2 trillion by 2025 (USDA (United States Department of Agriculture), 2008). The Netherlands takes the lead in both products and services of chemical industry, which continuously receives attention from all over the world since 19 out of the 25 top chemical companies in the world belong to the Netherlands. Major medical inventions are developed in medical industry, enabling medical industry to hold an excellent position in the field of healthcare.

Similar to the Netherlands, Korea is not promoting various chemical industries, but instead nurturing them intensively. Chemical industry of Korea has grown in size because of the oil-related economic sectors. Sales revenues of the petrochemical sector maintained at a certain level each year and contribute to the stable financial structure. The export volume ranks fourth in the world. In fact, Korea also fosters bio-related industries, which's market was represented by medicines, food, chemicals and energy, medical equipment, and service sectors, in order of market size in 2016. Most investments in this field are business investments rather than governmental investments, with amounts less than \$500 thousand. Instead of management-related research, most studies in this industry are experimental research on natural science and resources. Therefore, it will be meaningful to examine the economic inducement effect.

The medical industry is growing since the population ages and incomes increase. The medical industry includes medicine, medical devices, medical services, etc. Although expenditure on health care in a national economy is determined by various factors, such as health level, income level, medical resource level,

and health care system (Lee, 2016), it has been rising annually due to income growth. Medical industry of the Netherlands focuses on medical devices, which ranked third in both exports and imports in the global market (\$340.3 billion) as of 2014 and had an annual average annual growth rate of 10% (BMI, 2014).

On the other hand, medical industry of Korea remained a large scale for the long term, and Korea is currently making efforts to promote ICT and digital healthcare. Medical systems combined with smart devices are being implemented, and the medical service industry is being fostered (KHIDI (Korea health industry development institute), 2018).

Unlike ICT manufacturing and ICT service industries, lack of research focused on chemical and medical industries.

In <Table 3>, the analysis of ICT industry used not only data published by the Bank of Korea, but also China's statistical yearbook to compare Chemical or Medical industry between Korea and China.

III. Research Methodology and Interpretation

A. Research Methodology

The global trade network continues to become more integrated and influential due to globalization. Major factors that have strong

In the second stage of the analysis, as stated in the research procedure, the method used to calculate the existing production inducement coefficients was conducted through various methods to ensure that they were suitable for the study. The Competitive Income Model (C) can express competition between domestic and imported products at a single value. In contrast, the non-competitive revenue model (NC) is represented by two data (Domestic and Import) and can be distinguished from the production of products, but cannot compete with each other. The obvious difference between the two models is the structure of the separation between domestic demand

Table 3. Research on Chemical Industry and Medical Industry

Year	Author	Methodology		Research	Results
		Data	Country		
2011	Xu et al.	<ul style="list-style-type: none"> China's statistical yearbook and Input-Output table Use 1987, 1992, 1997, 2002, 2007 	China	<ul style="list-style-type: none"> China's petroleum industry (including chemical industry) are analyzed in this study by using the Input-Output approach 	<ul style="list-style-type: none"> In the case of the Chemical Industry part, the effect was higher when combined with other parts than the effect alone.
2010	Jung et al.	<ul style="list-style-type: none"> Used the IO Tables from the Bank of Korea From 1985 to 2007 	Korea	<ul style="list-style-type: none"> Analyzed the trends of employment structure Inducement effect of medical and measure equipment industry 	<ul style="list-style-type: none"> Medical and measure equipment industry has higher final demand than other industries
2009	Seo	<ul style="list-style-type: none"> Used the IO Tables from the Bank of Korea From 2003 to do the measurements 	Korea (including medicines, medical and measurement equipment, medical services, etc.)	<ul style="list-style-type: none"> Computed added-value, employment inducement coefficient, forward and backward linkage coefficients of healthcare industry 	<ul style="list-style-type: none"> Suggested effective policies to domestic healthcare and medical industries
2005	Lee	<ul style="list-style-type: none"> Used the IO Tables from the Bank of Korea From 2000 to do the measurements 	Korea	<ul style="list-style-type: none"> The production inducement effect on medical service industry 	<ul style="list-style-type: none"> Although medical industry and medical service industry are highly related, services are not mutually close

Table 4. Production inducement coefficients formula

Non-competitive / Competitive import model	
Backward	Forward
$BL_{ij} = \frac{\frac{1}{n} \sum_i B_{ij}}{\frac{1}{n^2} \sum_{ij} B_{ij}}$	$FL_i = \frac{\frac{1}{n} \sum_j B_{ij}}{\frac{1}{n^2} \sum_{ij} B_{ij}}$

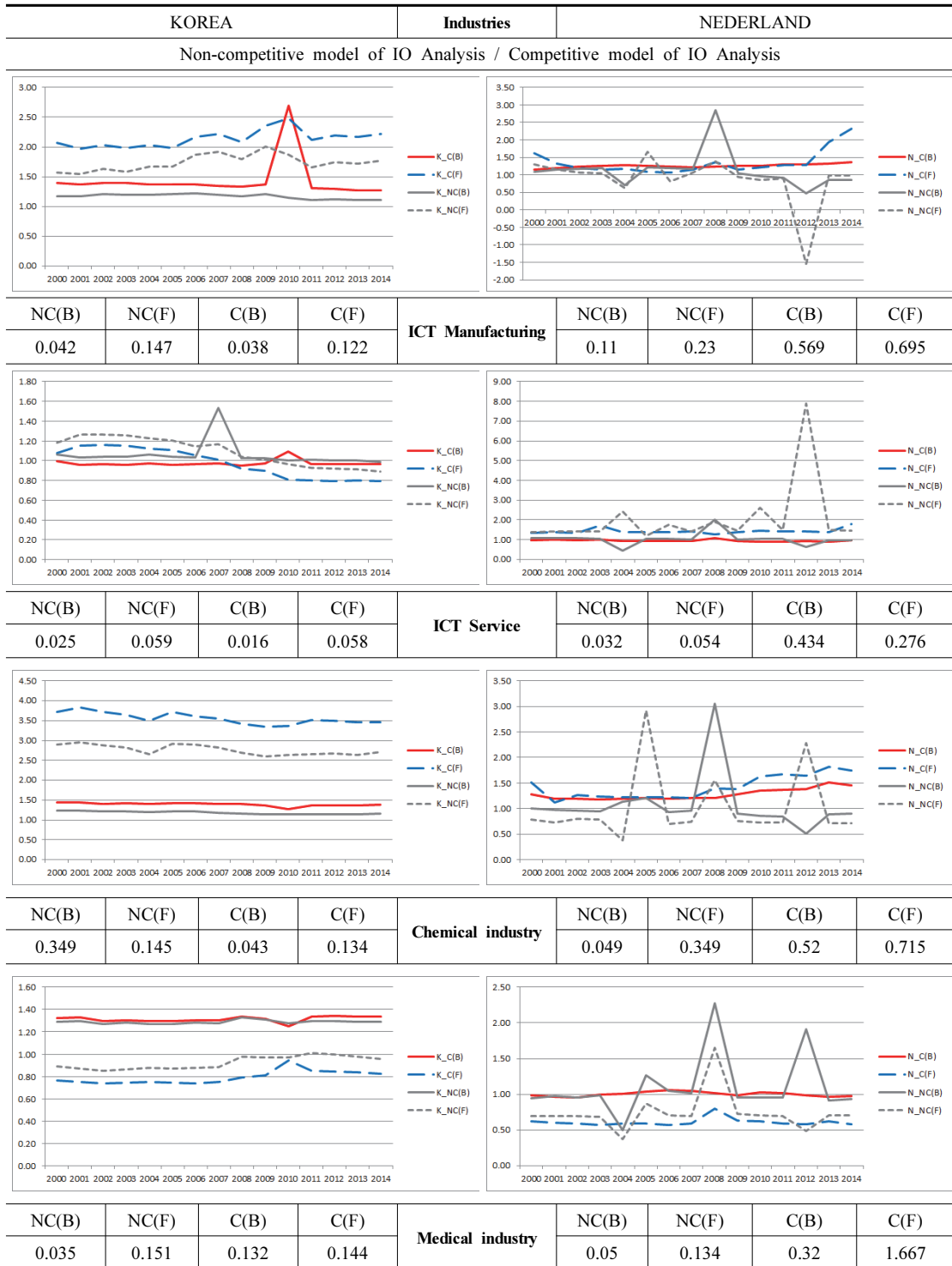
* $\sum_i B_{ij}$ is the sum of the column elements of the Leontief inverse matrix.
 ** $\sum_j B_{ij}$ is the sum of the row elements of the Leontief inverse matrix.

and income, which also affects the analysis results. This study identified which method is better to explain this situation to confirm the production inducement coefficients, in order to understand the two countries that create strong influences and important added values through re-exporting.

Data of Korea's and the Netherlands' ICT manufacturing, service industry, chemical industry, and medical industry is extracted from WIOD and listed in order from 2010 to 2014 for easy calculation. This is called the Matrix. Production inducement coefficients are computed by the formula $X=(1-A)^{-1}d$ (X is the vector of production, in which A refers to

IO Matrix and d refers to the vector of demand). This matrix is called Leontief Inverse Matrix. <Table 4> is Leontief's Formula, in which row means output and column means input, and row (i) and column (j) of the matrix are composed of codes constituting the industry.

In the examination of variance between the two conflicting models, this study also showed that variances between the non-competitive model and the competitive-model are significant. <Figure 2> illustrates that the range of production inducement coefficients of the Netherlands is very volatility in the non-competitive model. By excluding the industry



* Standard deviation

** K: Korea / N: Netherland, NC: Non-Cometitive model / C: Competitive model, B:Backward effect / F: Forward effect

Figure 2. Comparison of Industry Inducement Effect between competitive model and non-competitive model

and analyzing the variance of the rest of industries, the results showed that domestic industrial production inducement coefficients of the Netherlands greatly fluctuate, and thus statistically significant results can hardly be obtained. Since the value of intermediate input is almost the same as a tax, the value appears to be a negative number and the final output appear to be 0 (Liu et al., 2008). In addition, the non-competitive import model is unstable due to previous inventories and external environment of the countries. Also, a country where intermediary trade dominates has to consider for exact relation of IO analysis method.

Thus, based on prior research and results, competitive import model should be used because it takes imports into account.

B. Research Interpretation

In the context of production inducement effect, backward linkage effect can be used to measure the index of the power of disperation, while forward linkage effect can be used to estimate the index of the sensitivity of disperation. Therefore, industries can be classified into four different types based on their coefficients of backward and forward linkage effects.

<Figure 3> illustrates the classification made by Bank of Korea in 2009. First, if an industry has high backward linkage effect but low forward linkage effect, the economic inducement effect of the industry

will be increased by investment expenditure. That is, it relates to the growth of other industries. Second, an industry that has both high backward and forward linkage effects is dependent on both the supply- and the demand-side. Third, if an industry has low backward linkage effect but high forward linkage effect, the industry is highly dependent on the supply-side. Finally, industry is independent and has relatively fewer connections with other industries in case both backward and forward linkage effects are low.

Therefore, the coefficient of production inducement effect is presented by a power of disperation in the entire economy(Schultz, 2007). If the power of disperation is higher, industry has a stronger influence on other industries and is more influential among countries.

In other words, if the production inducement coefficient is high, the industry's connectivity with other industries is high and the scale is large. On the contrary, when the production inducement coefficient is low, the industry can be independent and small in scale.

IV. Hypothesis

This study uses the competitive import model to compare the production inducement effects in ICT Manufacturing industry, ICT Service industry, chemical

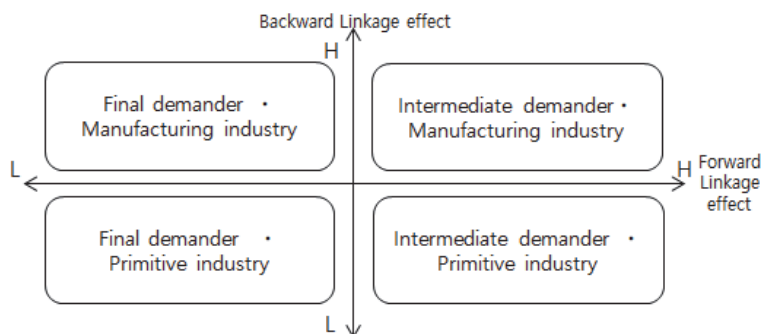


Figure 3. Classification Based on Industrial Linkage Coefficient

industry, and medical industry between Korea and the Netherlands.

According to the literature reviews, since the proportions of imports and intermediary trades are high in Korea, Korea needs to compare with other trading countries in order to boost its trades. Thus, this study proposed hypotheses about the key industries (ICT manufacturing, ICT service, chemical, and medical industries) of Korea and the Netherlands, in order to compare between the two countries using the competitive import model. A total of eight hypotheses were made in this study. The four main hypotheses are established on the production inducement coefficients(backward and forward linkage effects) of each of the four industries, and each main hypothesis contains two sub-hypotheses. <Figure 4> shows the hypotheses of this study.

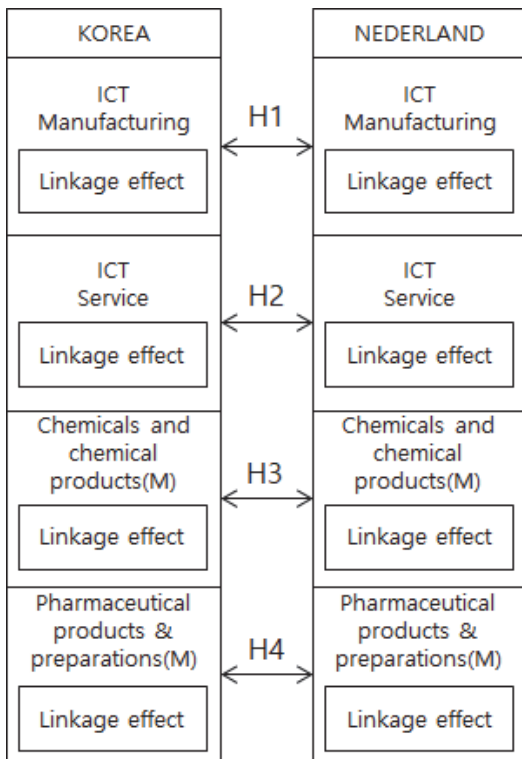


Figure 4. Research model

* (M): Manufacturing, (Linkage effect): Backward and Forward

A. Industrial Linkage Effects in ICT Manufacturing Industry between the Two Countries

Manufacturing industries are technology-based and require high initial costs to provide final goods. Although manufacturing industries are decreasing globally, the percentage of manufacturing industries in Korea is increasing continuously. Moreover, Korea's ICT industry is strong, and its synergy effect with manufacturing industries does not only lead to an expansion of the industries, but also have various types of influences on development to keep creating added values. Korea's manufacturing industry has continued increasing over the past decade, and it accounted for 37.6% of WTO Government Procurement Agreements (GPA) in 2016. The percentage was much higher than the global average of manufacturing industries (World Bank, 2014). Manufacturing industry consists of the automobile, electrical and electronic equipment, chemical, steel, food, and other manufacturing sectors, and electrical and electric equipment sectors account for more than 50%.

On the other hand, the Netherlands's manufacturing industry accounted for 17.8% of GPA in 2016 (CIA(The world factbook), 2016). Along with the growth of a variety of industries, such as the energy industry, paper industry, food and beverage industry, and the medical industry, the proportion of manufacturing industry is gradually decreasing. According to the comparison in CIA (2013), Korea is about 1.65 times higher than the Netherlands in the ICT manufacturing industry. Based on World Bank (2016) data, exports were 22.27% in Korea and 11.34% in the Netherlands. The imports were about 15.69% in Korea and 13.68% in the Netherlands. Therefore, this study hypothesized that forward and backward linkage effects in ICT manufacturing industry between Korea and the Netherlands are different.

H1. Production inducement coefficients of ICT manufacturing industry(C26, C27 WIOD standard) between Korea and the Netherlands are different.

H1-1. Backward linkage effect in the ICT manu-

facturing industry of Korea is higher than that of the Netherlands.

- H1-2.** Forward linkage effect in the ICT manufacturing industry of Korea is higher than that of the Netherlands.

B. Industrial Linkage Effects in ICT Service Industry between the Two Countries

Korea's service industry accounted for 60%(as of 2016) of GDP, which ranked 27th in the world, but it was still lower than service industries of developed countries that contributed 70% to GDP. The industrial foundation of service is weak because it can hardly be specialized and it focuses on the internal activities of manufacturing companies. The Netherlands's service industry accounted for 70.4%(as of 2016) of GDP, which ranked 7th in the world (CIA(The world factbook), 2016).

Besides, service-related employment accounts for 81.6%. Roxburgh et al., (2012) suggested that the service industry can be classified into capital-intensive, knowledge-based, and labor-intensive based on its industrial forms. Both Korea and the Netherlands are doing knowledge-based ICT-related trades. In comparison with OECD countries, the Netherlands is a major exporter of computers and information services, and the share of its exports is increasing and specialized in various fields. Since the infrastructure that serves as the foundation of the service industry is strong, it is more easily to increase trades and expand with other industries (Garcia-Milà et al., 1996). The CIA (2013) table shows that the size of ICT service industry is 1.3 times higher in the Netherlands than in Korea. In addition, ICT service exports in the World Bank (2015) were about twice higher in the Netherlands (9.77) than Korea (4.91). Therefore, this study hypothesized that forward and backward linkage effects in the ICT service industry between Korea and the Netherlands are different.

- H2.** Production inducement coefficients of ICT service industry(J61, J62, J63 WIOD standard) between Korea and the Netherlands are different.

- H2-1.** Backward linkage effect in the ICT service industry of the Netherlands is higher than that of Korea.

- H2-2.** Forward linkage effect in the ICT service industry of the Netherlands is higher than that of Korea.

C. Industrial Linkage Effects in Chemical Industry between the Two Countries

Korea's chemical industry ranked fifth in the world with an annual average growth of 8% over the past 10 years (As of 2015). Since the figure is mostly made up of petrochemistry industry, the rate of returns yields greatly along with oil price. The recent drop in oil price gave a blow to the industry, causing a drop in the industry's profit margin. The government implemented an upbringing policy to promote functionally(Posco, 2015). The Netherlands's chemical industry contributed 3% to GDP in 2010, which stood out in the situation that environmental problems were emerging all over the world.

Over a long period, the Netherlands has been investing in research and development of chemical industry, one of the most interested industries in the world. The chemical industry is developed mainly based on the infrastructure of storage facilities and relay facilities. According to World Bank (2014) data, the value generated by the chemical industry is about 1.5 times higher in the Netherlands (15.85) than in Korea (10.86). Therefore, this study hypothesized that forward and backward linkage effects in the chemical industry between Korea and the Netherlands are different.

- H3.** Production inducement coefficients of chemical industry(C20 WIOD standard) between Korea and the Netherlands are different.

- H3-1.** Backward linkage effect in the chemical industry of the Netherlands is higher than that of Korea.

- H3-2.** Forward linkage effect in the chemical industry of the Netherlands is higher than that of Korea.

D. Industrial Linkage Effects in Medical Industry between the Two Countries

The medical market is one of the fields that receive the most attention in the world. Research and investment in the medical industry are increasing in every country with an annual growth rate of 5.1% (as of 2017), for the purpose of creating a disease-free aging society. The medical industry consists of medical service, medicine, medical equipment, and medical supply sectors. Since medical service can be considered as a public good for nationals, it is limited in growth and spread by medicines and medical devices. Expenditure on medical cares is commonly used to evaluate the medical industry. The medical industry of the Netherlands contributed 8.9% and that of Korea contributed 6.9% to GDP. The comparison between the two countries showed that although consumer's expenditure in the Netherlands was high, the expenditure has been decreasing significantly over the long term. On the other hand, Korea's medical industry is mainly driven by revenue from medical devices. The share of healthcare-related added value is large in the medical industry of the Netherlands. The medical industry of the Netherlands is promoted through connections with healthcare services that are provided to the market and the medical-related insurance market. According to the Korea Health Industry Development Institute (KHDI), the export volume of the Netherlands is 6.4 times larger than that of Korea in 2018. Therefore, this study hypothesized that forward and backward linkage effects that the Netherlands is higher than Korea in the medical industry.

- H4.** Production inducement coefficients of the medical industry(C21 WIOD standard) between Korea and the Netherlands are different.
- H4-1.** Backward linkage effect in the medical industry of the Netherlands is higher than that of Korea.
- H4-2.** Forward linkage effect in the medical industry of the Netherlands is higher than that of Korea.

V. Results

This study adjusted the 56 industries classified by WIOD to a total of 54 industries and used the data to derive production inducement coefficients. As presented in <Table 5>, C26 and C27 were combined to ICT manufacturing industry while J61, J62, and J63 were combined to ICT service industry(Min, 2018, Lee et al., 2019). C20 refers to the bio-related chemical industry(Gorgoni et al., 2018), and C21 is defined as a medical industry that manufactures medicines and medical supplies(Feracutte et al., 2017).

This study used the adjusted data to verify the hypotheses on ICT manufacturing, ICT service, chemical, and medical industries of the Netherlands and Korea in the competitive import model. This study intended to investigate production inducement coefficients(backward and forward linkage effects) and added values. Backward linkage effect means the industrial influence on other industries of an industry through demands of raw materials from other

Table 5. Industry Classification by WIOD

ICT-M	C26	Manufacture of computer, electronic and optical products
	C27	Manufacture of electrical equipment
ICT-S	J61	Telecommunications
	J62_J63	Computer programming, consultancy and related activities; information service activities
Chemical industry	C20	Manufacture of chemicals and chemical products (chemical products and manufacturing of chemicals)
Medical industry	C21	Manufacture of basic pharmaceutical products and pharmaceutical reparations (Basic Mediucal Supplies and Manufacturing of Medical Supplies)

industries. The coefficient represents the influence as a demander (Gracia-Muniz and Vicente, 2014). That is to say, the higher an industry's backward linkage effect is, the industry requires more productions from other industries as an intermediate input.

Forward linkage effect means an industry's influence on other industries by inputting its products into productions of goods in other industries. The coefficient refers to the influence as a supplier (Gracia-Muniz and Vicente, 2014). In other words, the higher an industry's forward linkage effect is the industry inputs more goods to other industries as intermediate inputs during their production processes.

A. Production Inducement Effects in ICT Manufacturing Industry of The Netherlands and Korea

H1 proposed that production inducement effect in ICT manufacturing industry of Korea and that of the Netherlands are different. <Figure 5> presents the values of production inducement coefficients (backward and forward linkage effects) of Korea and the Netherlands between 2000 and 2014 in the competitive import model. <Figure 5> shows the results of the yearly comparison that backward linkage effect in the ICT manufacturing industry of Korea

was higher 13 out of the 15 years, while forward linkage effect was higher 11 out of the 15 years. Backward and forward linkage effects of the Netherlands were at a similar level. On the other hand, the backward linkage effect of Korea dropped sharply after reaching a peak in 2010, due to the base effect of the 2008 global financial crisis. Backward linkage effects of Korea by every 5 years were 1.40(2000)→1.37(2005)→2.69(2010)→1.27(2014), while forward linkage effects were 2.07(2000)→1.98(2005)→2.48(2010)→2.22(2014). In the early period, the backward linkage effect of Korea was low and forward linkage effect was high, meaning that it was independent on the demand-side, but it improved gradually and production was increased. On the other hand, backward linkage effects of the Netherlands were 1.16(2000)→1.25(2005)→1.26(2010)→1.36(2014), while forward linkage effects were 1.62(2000)→1.09(2005)→1.22(2010)→2.32(2014).

Similar to Korea, the Netherlands had a demand-conscious structure with low backward linkage effect but high forward linkage effect in the early years, but the situation improved gradually. Therefore, the results of H1(H1-1, H1-2) suggested that production inducement effects(backward and forward linkage effects) in the ICT manufacturing industry of Korea were higher than that of the Netherlands. High production inducement coefficients indicate high

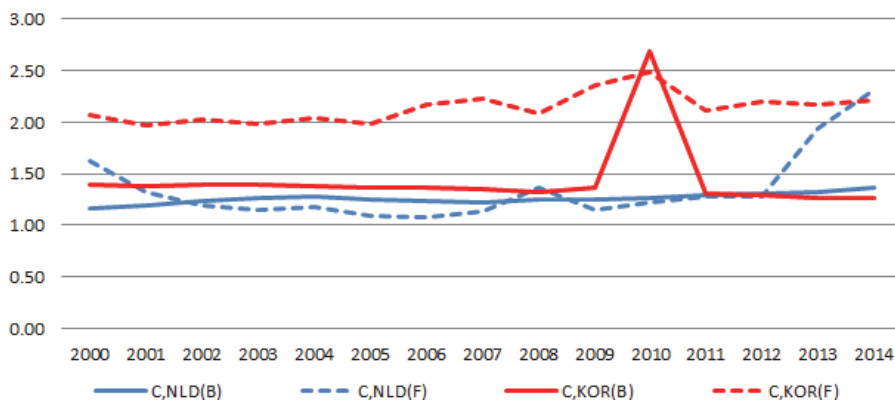


Figure 5. Comparison of Production Inducement Effects in ICT Manufacturing Industry Using Competitive import model

* C: Competitive import model, B: Backward, F: Forward

power of disperation (Schultz, 2007), and thus the power of disperation in the ICT manufacturing industry of Korea was higher.

B. Production Inducement Effects in ICT Service Industry of The Netherlands and Korea

H2 proposed that production inducement effect in the ICT service industry of Korea and that of the Netherlands are different. <Figure 6> presents the values of production inducement coefficients (backward and forward linkage effects) of Korea and the Netherlands between 2000 and 2014 in competitive import model. <Figure 6> shows the results of the yearly comparison that forward linkage effect in the ICT service industry of Korea was higher nine out of the 15 years, whereas backward linkage in the ICT service industry of the Netherlands was higher during the entire study period.

By comparing between backward and forward linkage effects, this study found that backward and forward linkage effects of Korea were similar, while forward linkage effect of the Netherlands was higher. In regard of the two countries' production inducement coefficients, backward and forward linkage effects of Korea were similar, while forward linkage effect of The Netherlands was relatively higher than the

backward linkage effect of the Netherlands. Backward linkage effects of Korea by every 5 years were 1.00(2000)→0.96(2005)→1.09(2010)→0.96(2014), while forward linkage effects were 1.08(2000)→1.10(2005)→0.81(2010)→0.79(2014). On the other hand, backward linkage effects of the Netherlands were 0.98(2000)→0.94(2005)→0.81(2010)→0.79(2014), while forward linkage effects were 1.34(2000)→1.39(2005)→1.44(2010)→1.78(2014). Most service-related industries recorded low production inducement coefficients(backward and forward linkage effects), indicating that they are labor- and knowledge-inventive industries that depend on high-quality labor sources.

To conclude, the results of H2(H2-1, H2-2) showed that production inducement effects(backward and forward linkage effects) in the ICT service industry of Korea and that of the Netherlands are different. While the backward linkage effect of Korea has higher coefficients, forward linkage effect of the Netherlands has higher coefficients.

C. Production Inducement Effects in chemical Industry of The Netherlands and Korea

H3 proposed that production inducement effect in chemical industry of Korea and that of the Netherlands

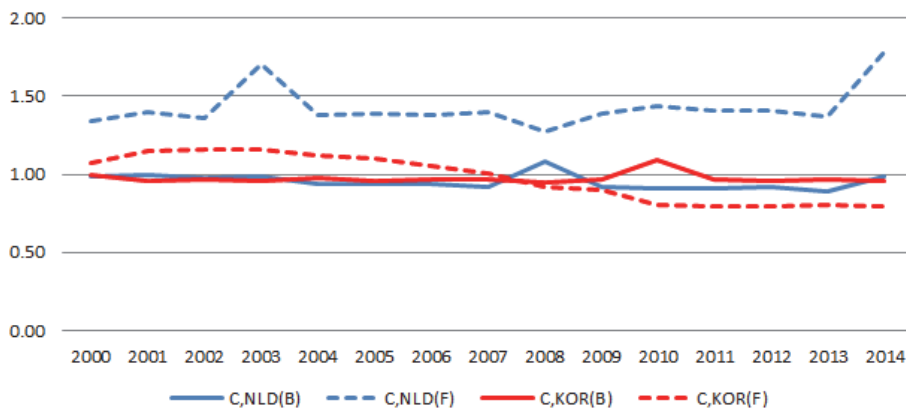


Figure 6. Comparison of Production Inducement Effects in ICT Service Industry Using Competitive import model

* C: Competitive import model, B: Backward, F: Forward

are different. <Figure 7> presents the values of production inducement coefficients(backward and forward linkage effects) of Korea and the Netherlands between 2000 and 2014 in competitive import model. <Figure 7> shows the results of the yearly comparison that backward linkage effect in chemical industry of Korea was higher nine out of the 15 years, while forward linkage in chemical industry of Korea was higher during the entire study period.

By comparing between backward and forward linkage effects within each of the two countries, this study found that backward and forward linkage effects of the Netherlands were similar, while forward linkage effect was higher than backward linkage effect in Korea. Backward linkage effects of Korea by every 5 years were 1.44(2000)→1.42(2005)→1.28(2010)→1.38(2014), while forward linkage effects were 3.73(2000)→3.73(2005)→3.3.6(2010)→3.45(2014). On the other hand, backward linkage effects of the Netherlands were 1.28(2000)→1.21(2005)→1.36(2010)→1.46(2014), while forward linkage effects were 1.51(2000)→1.22(2005)→1.63(2010)→1.74(2014). Although chemical industry in both of the two countries have high interdependence with other industries, the difference between forward and backward linkage effects in the Netherlands was much smaller.

In summary, results of H3(H3-1, H3-2) showed that production inducement effect(backward and

forward linkage effects) in chemical industry of Korea and that of the Netherlands were statistically different, and Korea's power of disperation was higher.

D. Production Inducement Effects in Medical Industry of The Netherlands and Korea

H4 hypothesized that production inducement effects in medical industries between Korea and the Netherlands are different. <Figure 8> shows the results of comparison on production inducement coefficients(backward and forward linkage effects) between Korea and the Netherlands from 2000 to 2014 in the competitive import model. According to the results of the yearly comparion presented in <Figure 8>, both backward and forward linkage effects in the medical industry in Korea were higher during the entire study period. That is, production inducement coefficients of Korea are higher than that of the Netherlands. Production inducement coefficients showed that the backward linkage effects of both countries were high. Backward linkage effects of Korea by every 5 years were 1.32(2000)→1.30(2005)→1.25(2010)→1.34(2014), while forward linkage effects were 0.77(2000)→0.75(2005)→0.94(2010)→0.83(2014). On the other hand, backward linkage effects of the Netherlands were 0.98(2000)→

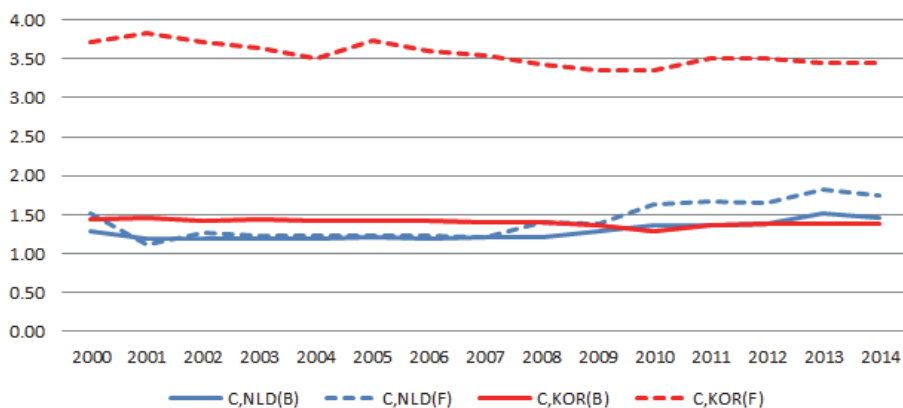


Figure 7. Comparison of Production Inducement Effects in Chemical Industry Using Competitive import model

* C: Competitive import model, B: Backward, F: Forward

1.04(2005)→1.03(2010)→0.97(2014), while forward linkage effects were 0.62(2000)→0.59(2005)→0.62(2010)→0.58(2014). Backward linkage effects of both countries were higher than forward linkage effects, implying that both countries have high dependence. Besides, the value of IO coefficients of both Korea and the Netherlands remained at a similar level.

Results of H4(H4-1, H4-2) revealed that production inducement effect(backward and forward linkage effects) in medical industry of Korea is significantly higher than that of the Netherlands, indicating that Korea has higher industry power of disperation.

VI. Conclusions

<Table 6> presents the differences in each industry between the two countries. Based on the results of the statistical test, five out of the eight hypotheses were accepted. The statistical test and literature reviews showed different results in forward linkage effect in ICT Manufacturing industry, as well as backward and forward linkage effects in the chemical industry. This study discusses those differences and the four industries that were examined.

First, in comparison with the Netherlands, ICT Manufacturing industry in Korea has higher backward linkage effect than forward linkage effect, meaning

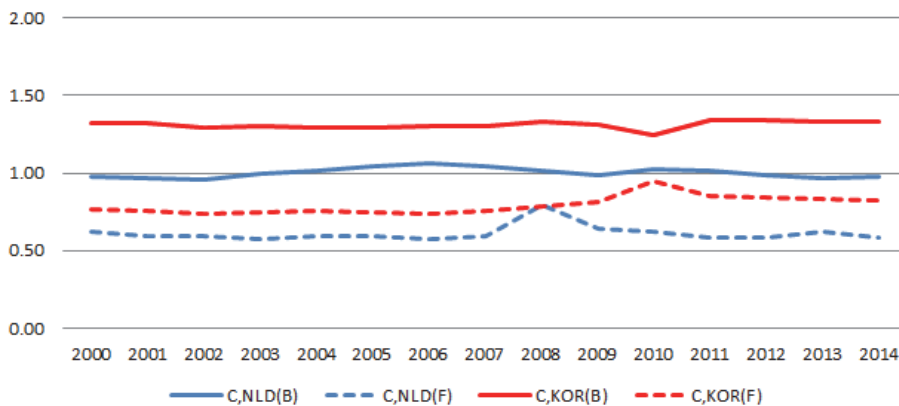


Figure 8. Comparison of Production Inducement Effects in Medical Industry Using Competitive import model

* C: Competitive import model, B: Backward, F: Forward

Table 6. Hypothesis Tests

	Homoscedasticity (levene)		P value(statistical significance_one-way)	Acceptance
H1-1 (ICT M)	.135	X	0.026	Accepted
H1-2 (ICT M)	.019	O	0.096	Rejected
H2-1 (ICT S)	.000	O	0.000	Accepted
H2-2 (ICT S)	.345	X	0.000	Accepted
H3-1 (Chemical)	.003	O	0.076	Rejected
H3-2 (Chemical)	.055	X	0.058	Rejected
H4-1 (Medical)	.002	O	0.000	Accepted
H4-2 (Medical)	.240	X	0.000	Accepted

* Test statistic in independent sample T-TEST

that the manufacturing industry is a final demander. However, the Netherlands's ratio in the global manufacturing market is gradually declining, while Korea is gradually increasing. Although some people may state that such a situation is hard to be developed, it can lead to a good direction if the process and system of manufacturing industry are well constructed and developed.

Second, regarding the size of the ICT service industry of The Netherlands, the results well accord with the hypothesis.

Numerically, the Netherlands had both higher backward and forward linkage effects than Korea. However, since the difference is not statistically significant, the Netherlands can be classified as an intermediate demander. The reason Korea failed to create production inducement effect in ICT service industry is due to the expansion imports. No matter to what extent import and export are expanded, the expansion is meaningless if it does not induce national economic expansion.

ICT manufacturing and ICT service industries have a highly interactive connection. Thus, it is necessary to identify the barriers and characteristics of the ICT market entry (Yang et al., 2013). Manufacturing industry creates added values through service industry (Saara, 2005) because a country can use the developed ICT manufacturing industry to develop ICT service industry more easily. The Netherlands focuses on fostering service and related industries by actively utilizing R&D, which has shown visible growth and development. Therefore, there will be a positive influence if Korea fosters its service industry by analyzing the service industry of the Netherlands.

Third, both H3-1 and H3-2 were rejected because that both backward and forward linkage effects in the chemical industry of the Netherlands are statistically slightly higher than that of Korea. However, the differences in coefficients between the two countries are not large. In the setting of the hypothesis, the analysis of industrial aspects was calculated by considering the relative size of the country and global figures, but the actual scale of petrochemicals in Korea was found to be relatively large and the national

policy for fostering them was very high. OECD(2016) supported this point by reporting that the Netherlands was ranked in the order of manufacture, medicine, chemicals, food processing, and agricultural products. Korea came in the order of automobiles, steel, petrochemicals, shipbuilding, and semiconductors (Korea Institute of Industrial Economics and Trade, 2017). Since chemical industries in both countries are dependent on demands, both countries need continuous investments and research on chemical industry to increase its economic power of disperation. However, there is a disparity in the environment between the two countries, because a lot of major companies related to chemical industries are located in the Netherlands, bringing it stronger economic power. Therefore, Korea should focus on fostering its chemical industry by benchmarking major companies in countries that are currently at the forefront of the market, such as the USA, Germany, Denmark, France, and Belgium.

Finally, production inducement effect in medical industry of Korea was far higher. Medical industry has several characteristics. Basically, the development of chemical industry requires expertise, and the construction of human resources and facilities in chemical industry requires a lot of time and capital investments. In addition, chemical industry is a labor-intensive industry that has high economic power of disperation. Therefore, continuous investments on it can contribute to value-creation and lead to the continuous growth of the industry.

In regard to the four major industries, Korea only conducted industrial developments on a single dimension. In other words, although the technological power and influence of ICT industry are strong, it failed to connect with other industries, such as service industries, causing the failure of industrial expansions. In Korea, trade has played an important role since the past, but such unconnected investments and developments will end in one-dimensional level.

On the other hand, although the Netherlands is not experiencing drastic developments in the entire industries, it actively increases the economic power of disperation of its industries through governmental

investments and research. Furthermore, Korea currently has limitations on creating added values through intermediary trades or processing trades due to a variety of diplomatic issues. However, if Korea can well develop and differentiate core factors, it will be able to achieve good results through synergies between industries.

VII. Contribution

It may be inappropriate to apply the commonly used non-competitive model for an IO Analysis of Korean industries. In case the research intends to study a country with huge trade volume or to compare between countries, it will be more appropriate to use the competitive model instead of the non-competitive model. Therefore, this study is meaningful and has significant contributions to the research field that focuses on countries that have huge trade sizes.

The Netherlands studies promising industries on a national level. Each time it becomes the initial entrant of the industry and fosters it based on R&D. Such a foundation forms a structure that enables the continuous exploitation of new markets and greatly contributes to the development of new industries. According to the Embassy of Korea in the Netherlands, the Netherlands focuses on industries that are more likely to enter the overseas market. The market consists of SMEs which are very solid and highly competitiveness. In other words, the Dutch development process for single or multi industries is precise, flexible to internal and external changes, and very progressive in the future innovation industry. According to the World Economic Forum's Global Competitiveness Report, the Netherlands is ranked at 4th, significantly higher than South Korea's rank of 26. If Korea adopts the strong national support structure of the Netherlands, it will be able to not only foster new industries but also create employment. Therefore, this study is meaningful and contributive in the field of research on countries with large trade scale.

VIII. Limitations

Based on literature reviews, production inducement effects in ICT manufacturing and ICT service industries in Korea were high, while production inducement effects of chemical medical industries in the Netherlands were high. Based on the analysis using the objective index production inducement coefficients(backward and forward linkage effect), the results showed that ICT manufacturing and chemical industries of Korea had high production inducement effects, whereas ICT service and medical industries of the Netherlands had high production inducement effects. The differences between the findings indicate that it was difficult to specifically and objectively compute each industry's proportion from the trade aspect, and there were limitations in simply deriving direct differences in sizes between different countries from literature reviews.

In order to calculate production inducement effect more effectively, studies should use the input factors in the IO tables to compute the production inducement coefficients (backward and forward linkages), and then use the coefficients to estimate added values, imports, employment inducements coefficients(The Bank of Korea, 2014). In other words, it will be more clear to not only examine backward and forward linkage effects in the context of production inducement effect, but also examine the creation of added value and employment, etc.

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References

- Costinot, A., & Rodríguez-Clare, A. (2014). Trade Theory with Numbers: Quantifying the Consequences of Globalization. *Handbook of International Economics*, 4, 197-261.
- Ahn, J., Khandelwal, A. K., & Wei, S. J. (2011). The role of intermediaries in facilitating trade. *Journal of International Economics*, 84(1), 73-85.
- BMI. (2014). Worldwide Medical Market Forecasts to 2019, BMI.
- Brax, S. (2005). A manufacturer becoming service provider—challenges and a paradox. *Managing Service Quality: An International Journal*, 15(2), 142-155.
- Brizga, J., Feng, K., & Hubacek, K. (2013). Drivers of CO2 emissions in the former Soviet Union: A country level IPAT analysis from 1990 to 2010. *Energy*, 59, 743-753.
- Chenery, H. B., & Watanabe, T. (1958). International comparisons of the structure of production. *Econometrica: Journal of the Econometric Society*, 487-521.
- Dietzenbacher, E., Los, B., Stehrer, R., Timmer, M., & De Vries, G. (2013). The construction of world input-output tables in the WIOD project. *Economic Systems Research*, 25(1), 71-98.
- Ferracuti, N., Soggi, C., & Spigarelli, F. (2017). The Healthcare Industry in the Chinese Economy: Insights from Input-Output Analysis. *Healthcare Policies And Systems In Europe And China: Comparisons And Synergies*, 79.
- García-Mila, T., McGuire, T. J., & Porter, R. H. (1996). The effect of public capital in state-level production functions reconsidered. *The review of economics and statistics*, 177-180.
- García-Muñiz, A. S., & Vicente, M. R. (2014). ICT technologies in Europe: A study of technological diffusion and economic growth under network theory. *Telecommunications Policy*, 38(4), 360-370.
- Gorgoni, S., Amighini, A., & Smith, M. (2018). *Networks of International Trade and Investment: Understanding*. Vernon Press.
- Han, S. Y., Yoo, S. H., & Kwak, S. J. (2004). The role of the four electric power sectors in the Korean national economy: an input-output analysis. *Energy policy*, 32(13), 1531-1543.
- Hempell, T. (2003). Do computers call for training? Firm-level evidence on complementarities between ICT and human capital investments.
- Hirschman, A. O. (1958). *The strategy of economic development*. Yale University Press.
- Huang, K. H. (2011). A comparative study to classify ICT developments by economies. *Journal of Business Research*, 64(11), 1174-1177.
- Isard, W. (1951). Interregional and regional input-output analysis: a model of a space-economy. *The review of Economics and Statistics*, 318-328.
- Lee, J. H. (2005). World medical industry change and progress, KIET(Korea Institute for Industrial Economics & Trade).
- Jung, D. Y., Jang, J. Y., & Park, J. U. (2010). A Study on the Structural Change of Employment and Labor-induced Effects of the Korean agri-fishery Industry by the Input-Output Analysis. *Korean Journal of Agricultural Management and Policy*.
- KHIDI(Korea health industry development institute). (2018). *Smart Health Care Medical Devices Technology and Standards Strategy Report*, Korea health industry development institute.
- Kim, M. S., & Park, Y. (2009). The changing pattern of industrial technology linkage structure of Korea: Did the ICT industry play a role in the 1980s and 1990s?. *Technological forecasting and social change*, 76(5), 688-699.
- Kim, S. W., Kim B. W., & Park, J. E. (2017). Analysis and Significance of OECD Digital Economic Outlook, *Korea information Society Development institute*, 29(19), 1-48.
- KOTRA(Korea Trade-Investment Promotion Agency). (2015). *Netherlands*. Amsterdam Trade Center, May.
- Lau, L. J. (2010). Input-occupancy-output models of the non-competitive type and their application—an examination of the China-US trade surplus. *Social Sciences in China*, 31(1), 35-54.
- Lau, L. J., Chen, X., Cheng, L. K., Fung, K. C., Sung, Y., Yang, C., ... Tang, Z. (2007). Non-Competitive Input-Output Model and Its Application: An Examination of the China-US Trade Surplus. *Social Sciences in China*, 5, 91-103.
- Lee, C., & Chan-Olmsted, S. M. (2004). Competitive advantage of broadband Internet: a comparative study between South Korea and the United States. *Telecommunications Policy*, 28(9-10), 649-677.
- Lee, D. H. (2016). Comparison of efficiency of healthcare systems of countries with global competitiveness using data envelopment analysis. *Global Business and Finance Review*, 21, 46-55.
- Lee, D. H., Hong, G. Y., & Lee, S. G. (2019). The relationship among competitive advantage, catch-up, and linkage effects: a comparative study on ICT industry between South Korea and India. *Service Business*, 13(3), 603-624.
- Lenzen, M. (1998). Primary energy and greenhouse gases embodied in Australian final consumption: an input-output analysis. *Energy policy*, 26(6), 495-506.
- Lenzen, M., Pade, L. L., & Munksgaard, J. (2004). CO2 multipliers in multi-region input-output models. *Economic Systems Research*, 16(4), 391-412.
- Leontief, W. W. (1952). Input-Output Economic. *Operational Research Quarterly*, 3(2), 30-31.
- Leontief, W. W. (1966). *Input-output analysis*. Oxford University Press.
- Leontief, W., & Strout, A. (1963). Multiregional input-output analysis. In *Structural interdependence and economic*

- development (pp. 119-150). Palgrave Macmillan, London.
- Lim, S. A. (2014). Starter of Bio chemical industry, December.
- Liu, X., Wang, C., & Wei, Y. (2009). Do local manufacturing firms benefit from transactional linkages with multinational enterprises in China?. *Journal of International Business Studies*, 40(7), 1113-1130.
- Mattes, A., Meinen, P., & Pavel, F. (2012). Goods Follow Bytes: The Impact of ICT on EU Trade. *DIW Discussion Papers*, 1-25.
- Miller, R. E., & Blair, P. D. (2009). *Input-output analysis: foundations and extensions*. Cambridge university press.
- Min, Y. K., Lee, S. G., & Aoshima, Y. (2019). A comparative study on industrial spillover effects among Korea, China, the USA, Germany and Japan. *Industrial Management & Data Systems*, 119(3), 454-472.
- Moses, L. N. (1955). The stability of interregional trading patterns and input-output analysis. *The American Economic Review*, 45(5), 803-826.
- Ottaviano, G. I., Pessoa, J. P., Sampson, T., & Van Reenen, J. (2014). The costs and benefits of leaving the EU.
- Ozkan, B., Akcaoz, H., & Fert, C. (2004). Energy input-output analysis in Turkish agriculture. *Renewable energy*, 29(1), 39-51.
- Park, S. H. (1994). Intersectional Relationship between Manufacturing and Service: New Evidence from selected Pacific Basin Countries. *ASEAN Economic Bulletin*, 10(3), 245-263.
- Perry, A. C. (1990). The evolution of the US international trade intermediary in the 1980s: a dynamic model. *Journal of International Business Studies*, 21(1), 133-153.
- Posco. (2015). Korea chemical industry in commodity trap, POSCO.
- Rohman, I. K. (2013). The globalization and stagnation of the ICT sectors in European countries: An input-output analysis. *Telecommunications Policy*, 37(4-5), 387-399.
- Roxburgh, C., Manyika, J., Dobbs, R., & Mischke, J. (2012). *Trading myths: Addressing misconceptions about trade, jobs, and competitiveness*. McKinsey Global Institute.
- Schultz, S. (1977). Approaches to identifying key sectors empirically by means of input-output analysis. *The Journal of development studies*, 14(1), 77-96.
- Seo, J. K. (2009). Analyses on the Economic Effects of Investment in Health Industry and Korean Medicine. *Review of business & economics*, 22(5), 2457-2475.
- Shin, T. Y., Hong, S. J., Kang, J. Y., Hong, H., Park, M. S., & Song, S. S. (2012). *Dynamic analysis and development strategy of innovation system in Korea*, Seoul: STEPI.
- Stone, R. (1961). Input-output and national accounts. Organisation for European Economic Co-operation.
- Su, B., & Ang, B. W. (2013). Input-output analysis of CO2 emissions embodied in trade: competitive versus non-competitive imports. *Energy Policy*, 56, 83-87.
- Suder, G., Liesch, P. W., Inomata, S., Mihailova, I., & Meng, B. (2015). The evolving geography of production hubs and regional value chains across East Asia: Trade in value-added. *Journal of World Business*, 50(3), 404-416.
- The Bank of Korea. (2014). Korea economic structure for 2012 industry linkage table, Bank of Korea.
- Wang, Z., Wei, S. J., & Zhu, K. (2013). *Quantifying international production sharing at the bilateral and sector levels* (No. w19677). National Bureau of Economic Research.
- Xing, W., Ye, X., & Kui, L. (2011). Measuring convergence of China's ICT industry: An input-output analysis. *Telecommunications Policy*, 35(4), 301-313.
- Xu, T., Baosheng, Z., Lianyong, F., Masri, M., & Honarvar, A. (2011). Economic impacts and challenges of China's petroleum industry: an input-output analysis. *Energy*, 36(5), 2905-2911.
- Yang, C., Lee, S. G., & Lee, J. (2013). Entry barrier's difference between ICT and non-ICT industries. *Industrial Management & Data Systems*, 113(3), 461-480.
- Zhang, C., & Anadon, L. D. (2014). A multi-regional input-output analysis of domestic virtual water trade and provincial water footprint in China. *Ecological Economics*, 100, 159-172.
- <http://stat.kita.net/stat/world/trade/CtrImpExpList.screen>
- <https://www.ceicdata.com/ko/indicator/the+Netherlands/real-gdp-growth>
- <https://www.cia.gov>
- <https://www.csb.gov/kw>
- <https://www.usda.gov>
- <https://www.worldbank.org>