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An international comparison of competitiveness in knowledge services☆

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ABSTRACT

Knowledge services is a field that is expected to greatly invigorate the national economy, as it is considered a new growth engine for a world economy that is facing growth without employment. This study aims to comparatively analyze the present state of the knowledge services industry in Korea, the United States, the United Kingdom and Japan, and based on the analysis, to derive implications for policy that will boost the knowledge services industry in Korea. The most recent Input-Output Tables published by each government are used as statistical data, and serve as the reference for the comparative analysis.

1. Introduction

Today, knowledge assets play an important role in enhancing competitiveness and achieving growth for companies all over the world. The Organization for Economic Cooperation and Development (OECD) has shown great interest in the knowledge-based economy since early on, and has discovered that the development gap between developed countries and developing countries can be attributed to Information and Communications Technology (ICT), R&D innovation which promotes ICT, and the presence or absence of a labor force that is skilled in working with ICT. The OECD has been taking the lead in sharing the development experiences and success stories of developed countries with developing countries. Companies in OECD countries have already invested as much in Knowledge-Based Capital (KBC) such as software, database, R&D, design, marketing, as in physical capital such as machinery, equipment, and buildings. In recent years, emerging developing countries, similarly to developed countries, are increasingly expanding their utilization of KBC (Martín-de Castro et al., 2013). For example, China is intensively investing in Intellectual Property (IP) and design sectors, and Thailand is also promoting IP capitalization projects (OECD, 2012). Knowledge assets have become an important barometer of competitiveness and growth for countries and companies alike (Conceição et al., 1998).

On the other hand, as Korea has until recently pursued manufacturing-based growth, its service industry has been given rather little weight compared to other OECD countries (OECD, 2009). In recent years, the potential growth rate in Korea has been falling due to a slump in investment and employment in the manufacturing sector. There has been rising interest in the role of knowledge service as a field that can provide a new engine for growth and job creation. Since the knowledge service industry leads to the creation of added value and a large number of jobs compared to the manufacturing industry, it is considered to be critical for the sustainable development of the Korean economy, which is going through a period of growth without new employment (Cooke and Leydesdorff, 2006). Against this backdrop, the Korean government, which recognizes the importance of the knowledge service industry, is striving to nurture and develop the knowledge service industry, but few analyses have been conducted on the current state of the industry, and sufficient policies have yet to be introduced.

This study aims to assess the competitiveness of the knowledge service industry in Korea through input-output analyses and comparative analyses on three countries - the United States (US), the United Kingdom (UK) and Japan, all of which are known to be advanced countries in the knowledge service industry sector - and to generate suggestions on policy for the purpose of sustainable growth in the knowledge service industry on this basis. The study did not use the endogenous models frequently used to analyze economic impact and attempted to more accurately estimate the economic impact of the knowledge service industry through exogenous models of the

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knowledge service industry subject to analyses. Exogenous models have the advantages of more accurately measuring the effects of output in specific sectors as well as the effects of the output on other industries instead of the total demand. In addition, previous studies on the economic impact of the knowledge service industry were mostly focused on analyses of the ripple effects on one country, but this study diagnoses the current state through an analytical comparison of the economic impact of the domestic knowledge service industry and the industrial structure in advanced countries, and suggests a direction for policy for the purpose of enhancing the competitiveness of the knowledge service industry in the future.

The study is organized as follows. Section 2 first identifies the concept of knowledge service and related previous studies and then reviews previous studies on input-output analysis, the methodology adopted by the study. Section 3 is focused on designating the scope of the knowledge service industry to be adopted by the study, and explaining the specific procedures for the application of the input-output analysis models. Section 4 deals with comparative analyses on production inducement coefficient, employment inducement coefficient and forward-backward linkage effects generated based on the application of models to the knowledge service industry by country, as mentioned in Section 3. In addition, comparative analyses are conducted on the importance of the knowledge service industry in the national economy from the perspectives of the input and output structure in each country and that of each sector constituting the knowledge service industry. Section 5 is the conclusion of the study, and it is focused on presenting policy suggestions for the purpose of achieving the sustainable growth of the knowledge service industry based on the results of the research conducted in each section.

2. Literature review

2.1. A study on knowledge service

The first conceptual research on knowledge service was conducted based on a research report titled *Knowledge-Intensive Business Services: their role as users, carriers and sources of innovation* (Miles et al., 1995), which was presented by the European Union (EU). In comparison with such major production factors in the existing industrial society as labor, capital and land, the concept of service aimed at improving productivity and increasing the added-value of product services in the existing industries was defined through the use of major production factors based on creativity-oriented knowledge, and it was named Knowledge-Intensive Business Services (KIBS). It is significant for being the first to designate knowledge-based service as something separate from general labor-intensive services such as cleaning services or information provision services such as real-estate brokerage. In an effort to apply a more clarified concept of KIBS to real industries, OECD (1998) defined R&D activities, input of ICT and highly skilled workers and high-utilization services as knowledge service and considered industries with a high portion of the service input as Knowledge-Based Industries (KBI).

In addition to a series of conceptual research, most research literature has focused on defining characteristics based on the concept of knowledge service and conducting empirical analyses on the role of knowledge service in the real industries. In an effort to define the role of KIBS as innovative agents in the real industries, Aslesen and Isaksen (2007) focused only on the region of Oslo in Norway for the purpose of empirical analyses. In addition to subdivision by region, the knowledge service industry was confined to the software industry and the organizational consultant sector, and analyses were conducted to identify if KIBS encouraged real innovation and growth, and the analyses identified its significance. The study is characterized by regional and industrial subdivision to conduct an empirical analysis on KIBS. Departing from KIBS, García-Quevedo et al. (2013) defined Knowledge Intensive Services (KIS) as knowledge-intensive business services, taking the meaning in a broader sense, and surveyed innovative firms in Valencia in Spain. Notably, this study found that R&D services play an important role in innovating companies. Similarly to the research conducted by Aslesen and Isaksen (2007), the survey was conducted in a specific area, but this study is differentiated as it was focused on examining companies regardless of whether or not they were in the knowledge service sector. Doloreux and Shearmur (2013) conducted a survey on 804 manufacturing establishments in Quebec in Canada, and analyzed the roles of KIBS in terms of innovative strategies. Through the analyses, it was found that the level of innovation in manufacturing companies was raised through interactions with KIBS. There are similarities to previous studies because the survey was conducted in a specific area, but it is differentiated because manufacturing firms were subdivided. Lee (2004) conducted research in order to analyze and understand the roles of KIS with regard to industrial innovation in Korea. Like the study conducted by Doloreux and Shearmur (2013), the level of contribution of KIS to manufacturing companies was analyzed, and the analyses indicated that KIS played an important role in innovating manufacturing businesses. However, it is difficult to expect that the research conducted by Lee (2004), who surveyed only the manufacturing companies, can define the roles of knowledge services in industrial innovation in Korea.

As mentioned above, existing studies related to knowledge services have mostly been focused on subdividing areas included in the knowledge service industry and examining particular regions. Although it is often stated that the knowledge service industry is playing an important role in innovating industries and that its importance in terms of economic development is continuously growing, there has been no study that aimed at macroscopically analyzing national economic status and the roles of the knowledge service industry, and suggesting quantitative results. In addition, previous studies have mostly adopted survey analysis as a method of research, and this is considered as an inappropriate methodology for dealing with national economic impact of the knowledge service industry, which is related to the purpose of the study. In most cases, survey analysis has limitations when it comes to figuring out or dealing with social context, and this is due to the fact that while a survey analysis enables us to understand and analyze fragmented informers' opinions or behavior based on questionnaires, it is not appropriate for asking complex and thoughtful questions or handling overall social opinions.

Only a few studies have been conducted on national comparative analyses on the knowledge service industry. Many studies have made suggestions for a national policy or R&D strategy based on comparative analyses among nations, but few analyses have been conducted on the knowledge service industry (Muller and Doloreux, 2009). As such, this study is differentiated from previous studies, as it selected the US and the UK as representative economic powerhouses centering on the knowledge service industry, and it also selected Japan, where the manufacturing industry serves as an industrial base, to vertically compare the knowledge service industries in the four countries of Korea, the US, the UK and Japan while examining the economic impact of the knowledge service industry. In addition, the study has significance in that quantitative information is acquired through the use of an economic approach known as input-output analysis, and that suggestions on policies can be made on the direction of enhancement and development of the knowledge service industry on this basis.

2.2. A study on input-output analysis

The study aims to analyze the knowledge service industries in Korea, the US, the UK and Japan through the use of input-output analysis, the quantitative analysis method most suitable to the purpose of the study. To quantify the economic impact of the knowledge service industry, it is necessary to be able to observe macroscopic correlations while microscopically understanding all economic sectors in addition to the knowledge service industry. At the same time, it is necessary to macroscopically observe correlations while figuring out all other economic

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sectors on a microscopic level. Input-output analysis is an analytical method that has the aim of quantifying industrial correlations based on production activities, and as it organically connects the entire national economy and each part thereof while including the industrial circulation of goods, it is useful for analyzing the economic structure in detail (Wu and Chen, 1990). In addition, as both macro and micro analyses can be conducted, it offers useful data on the establishment and prediction of economic plans and directions of industrial structure policy in addition to analyses on sectoral production, employment, forward-backward linkage effects according to changes in consumption, investment and export (Hailu and Veeman, 2000; Kwak et al., 2005; Suh and Kagawa, 2005; San Cristobal and Biezma, 2006; Hallegatte, 2008; Hauknes and Knell, 2009; Xing et al., 2011). Recently, a number of input-output analyses have been conducted on the energy and environmental sectors, in one country or in various countries (Lenzen et al., 2004; Wiedmann et al., 2007; Wiedmann, 2009; Druckman and Jackson, 2009; Wiedmann et al., 2010).

In terms of the Input-Output Table, which has become basic data for input-output analysis, input composition and output composition in each industry are created by matrix method. The vertical direction meaning input structure consists of production expenses spent on production activities carried out by each industry, and the horizontal direction meaning distribution structure indicates how much was used in the form of intermediate demand or final demand at the time of manufacturing certain products in each industrial sector. Intermediate demand and intermediate input indicating transactions on goods and services occurring in the industrial sectors are endogenous sectors, and the final demand and the value-added sector are exogenous sectors. That is, the endogenous sector refers to the part where value is manually determined within the models according to the value in the exogenous sector given outside models, and the exogenous sector refers to the part where the value is determined outside of the models, regardless of the endogenous sector.

The exogenous models adopted by the study pertain to a method of dealing with interest variables exogenously and determining the effects of the variables on the endogenous economy, and they have the advantages of clearly showing the effects of output in specific sectors on other industries instead of the total demand. There have been studies on exogenous models and their advantages (The Bank of Korea, 1987; Miller and Blair, 2009; Ritz and Spaulding, 1975), but few studies have been conducted to apply and analyze exogenous models and suggest results based on a real Input-Output Table. Most previous studies that aimed to conduct an input-output analysis dealt with interest variables endogenously and applied a method of identifying the effects of the variables on endogenous economic sectors. In this scenario, it is difficult to objectively evaluate the extent of the effects that the interest variable has on other economic sectors (Lenzen et al., 2004; Wiedmann et al., 2007; Wiedmann, 2009; Druckman and Jackson, 2009; Wiedmann et al., 2010). In other words, if the knowledge service industry is endogenously handled, it is impossible to accurately analyze the effects of an increase or decrease in output of the knowledge service industry on each industrial sector where the knowledge service industry serves as suppliers or clients. For this reason, the study adopts exogenous models for the knowledge service industry for the purpose of analyses so that the effects of the knowledge service industry on other economic sectors can be objectively understood, and it is considered meaningful to present analytical results through the application of exogenous models to the real industry.

3. Research methodology

3.1. Redefinition of the knowledge services industry

In this study, a knowledge-based service is defined as a higher value-added business among other services in which intangible capital containing knowledge is input as an intermediary good for the production activity to improve the productivity of existing industries. This definition is similar to the EU's definition of KIBS. However, it is different in that knowledge-intensive service is included in the scope of the knowledge service industry, although it is not business service.

For the purpose of a comparison by country based on input-output analysis, it is necessary to reclassify an Input-Output Table in each country. The study aims to newly establish a unified standard industrial classification system based on an Input-Output Table in Korea, the US, the UK and Japan. Table 1 indicates new industry classification based on the extraction of pertinent business types belonging to the knowledge service industry defined by the study in consideration of unified sub-classification (168 sectors), as indicated in an Input-Output Table compiled by the Bank of Korea in 2010. Through this process, industries in Korea are divided into 37 fields in total, and 10 of these fields, including “communication/broadcasting,” “finance/insurance,” “research and development,” “business/professional services,” “advertising,” “computer related services,” “educational services,” “social welfare services,” “medical/healthcare/sanitation services,” and “publishing/cultural/entertainment services” are classified as knowledge services industries. Here, business/professional services include legal & accounting services, market research & management consulting, and construction & engineering related services. According to the 28 by 28 Sector Tables used in the Input-Output Tables by the Bank of Korea, all businesses that belong to communication & broadcasting (No. 22), finance & insurance (No. 23), and education & healthcare (No. 26) as well as some businesses that belong to real estate & business services (No. 24) and social/other services (No. 27) are classified as knowledge services industries.

Each country has a different industrial classification system. However, Table 2 indicates the knowledge service industry classification in the US, the UK and Japan based on the Korean knowledge service industry classification as examined above. The 2010 Input-Output Table (65 classifications) is used for the US and the 2010 Input-Output Table (97 classifications) is used for the UK. The 2005 Input-Output Table (108 classifications) is used for Japan. In Japan's case, it may have been possible to extrapolate the 2005 Input-Output Table to become the 2010 Input-Output Table using an updated methodology (Bacharach, 1970; Stone, 1961). But due to the difficulties in obtaining data on gross output, intermediate demand, and intermediate input for the year 2010, the 2005 Input-Output Table is used in this study because it is the most recent Input-Output Table available.

In terms of an Input-Output Tables by country, empirical analysis data for input-output analysis are established through procedures for reclassification in the same manner as in Table 1 based on the unified knowledge service industry classification system in Table 2. Newly established data make it possible to conduct quantitative analyses on specific sectors belonging to both the knowledge service industry and the knowledge service industry, and to delve into comparative analysis with other industries such as agriculture, forestry, fishery, mining, manufacture and general service and the knowledge service industry. For vertical comparison in the knowledge service industry in each country, the study uses the reestablished Input-Output Tables in each country in order to acquire confidence in the horizontal comparison.

3.2. Analysis model

In this study, the economic impact of the knowledge services industry is compared and analyzed internationally using input-output analysis. The empirical analysis data used in the analysis are the 2010 Input-Output Tables from Korea, the US, and the UK and the 2005 Input-Output Table from Japan, which are the most recent data available at this point. There are various types of Input-Output Tables. However, the competitive import type of Input-Output Tables, which are readily available from all countries, were applied to the models. The

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Table 1
Spectrum and classification of knowledge services industry according to reclassified Input-Output Table.

Industrial classification in this study		Industrial classification in the Input-Output Table	
		Sections/divisions/groups	403 sectors
Agriculture/Mining	01 Agriculture/Forestry/Fishing	Section 1	001–029
	02 Mining/Quarrying	Section 2	030–044
Manufacturing	03 Food/Beverages	Section 3	045–084
	04 Textile/Leather products	Section 4	085–113
	05 Wood/Paper products	Section 5	114–128
	06 Printing/Reproduction	Section 6	129–130
	07 Other manufactured products	Section 16	288–297
	08 Petroleum/Coal products	Section 7	131–141
	09 Chemical products	Section 8	142–171
	10 Non-metallic minerals products	Section 9	172–187
	11 Basic metal products	Section 10	188–208
	12 Metal products	Section 11	209–219
	13 General machinery	Section 12	220–239
	14 Electronic/Electrical equipment	Section 13	240–267
	15 Precision instruments	Section 14	268–273
	16 Transportation equipment	Section 15	274–287
	17 Electricity/Gas/Water supply	Section 17	298–304
	18 Construction	Section 18	305–320
General services	19 Wholesale/Retail trade	Section 19	321–322
	20 Accommodation/Food service	Section 20	323–326
	21 Transportation/Warehousing	Section 21	327–340
	22 Real estate activities	Section 24-Division 65	354–356
	23 Other business services	Section 24-Division 68	368–371
	24 Public administration/Defense	Section 25	372–373
	25 Social organizations	Section 27-Division 76	393–394
	26 Other services	Section 27-Division 77	395–400
	27 Dummy sectors	Section 28	401–403
Knowledge services	28 Communication/Broadcasting	Section 22	341–347
	29 Finance/Insurance	Section 23	348–353
	30 Research and Development	Section 24-Division 66	357–360
	31 Business/Professional services	Section 24-Division 67-Group 150,152	361–362, 364–365
	32 Advertising	Section 24-Division 67-Group 151	363
	33 Computer related services	Section 24-Division 67-Group 153	366–367
	34 Educational services	Section 26-Division 70	374–376
	35 Social welfare services	Section 26-Division 72	380–381
	36 Medical/Healthcare/Sanitation services	Section 26-Division 71,73	377–379, 382–383
	37 Publishing/Cultural/Entertainment services	Section 27-Division 74,75	384–392

Source: The Bank of Korea (2012).

competitive import type table reflects a stable input structure. For this reason, it is useful in building long-term and comprehensive economic forecasts or economic plans. The strength of the non-competitive import type, however, lies in its usefulness with regard to the accurate assessment of the production inducement effect within the country. The economic impacts applied in this study include the effect on production and employment inducement and the forward-backward linkage effect. The following is a brief introduction to the techniques used to measure the various ratios applied in assessing these effects (Ghosh, 1958; Leontief, 1986; Miller and Blair, 2009; Richardson, 1985).

The industry of every country in this study is assumed to be composed of a total of 37 sectors. When the knowledge services industry is counted as the i-th industry, total supply or total input of i sector, X_i can be expressed as in Eq. (1). In Eq. (1), X_{ij} denotes the input of the knowledge services industry used in j sector; F_i the final demand in the knowledge services industry; and M_i the imports of the knowledge services industry.

$$\sum_{j=1}^{37} X_{ij} + F_i - M_i = X_i \tag{1}$$

If Eq. (1) is arranged using the input coefficient $a_{ij}\,(=X_{ij}/X_j)$, which is the input unit of good i required to produce one unit of good j, and evaluated for matrix X, then Eq. (2) is obtained. Here, A denotes the intermediate input coefficients matrix of the competitive import type; F, the final demand; and M, imports. The $(I-A)^{-1}$ matrix is referred to as the production inducement coefficient, which is used to obtain total output amount X that is directly and indirectly induced in each industry according to changes in F or M.

$$X = (I-A)^{-1}(F-M) \tag{2}$$

In this study, however, input-output analysis with an exogenous specification is performed to draw international comparisons and an analysis of the economic impact of the knowledge services industry. The exogenous specification model applied in this study is derived from a modification of Eq. (2). In Eq. (3), ΔX^e refers to the output variation of the industry sectors exclusive of the knowledge services industry, and represents the output increase of other sectors, which is affected by the output of the knowledge services industry. $(I-A^e)^{-1}$ represents the Leontief Inverse matrix, which is formulated by eliminating lines and columns of the knowledge services industry from the input coefficient matrix. A^e refers to the remaining column vector after eliminating elements of the knowledge services industry from the column vector of the knowledge services industry in the input coefficient matrix A, and ΔX refers to the output variation of the knowledge services industry.

$$\Delta X^e = \left(I-A^e\right)^{-1} A^e \Delta X \tag{3}$$

Employment inducement coefficient is applied based on the number of employees in order to analyze the employment inducement effects of the knowledge services industry. Eq. (4) shows the employment

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Table 2
Classifications in the Input-Output Tables of major foreign countries corresponding to Korea's knowledge services industry.

Korea classification 168	The US classification 65	The UK classification 97	Japan classification 108
Communication/Broadcasting (141–143)	512 Motion picture and sound recording industries 513 Broadcasting and telecommunications	59 Motion picture, video and TV programme production services, sound & music publishing 60 Programming and broadcasting services 61 Telecommunications services	086 Communication 087 Broadcasting
Finance/Insurance (144–146)	512CI Federal Reserve banks, credit intermediation, and related activities 523 Securities, commodity contracts, and investments 524 Insurance carriers and related activities 525 Funds, trusts, and other financial vehicles	64 Financial services, except insurance and pension funding 65.1–2&65.3 Insurance and reinsurance, except compulsory social securities & pension funding 66 Services auxiliary to financial services and insurance services	074 Finance and insurance
Research and Development (148–149)	5417 Scientific research and development services	72 Scientific research and development services	093 Research
Business/Professional services (150)	5411 Legal services 5412 Accounting, tax preparation, bookkeeping, and payroll services 5413 Architectural, engineering, and related services 5416 Management, scientific, and technical consulting services	69.1 Legal services 69.2 Accounting, bookkeeping and auditing services; tax consulting service 70 Services of head offices; management consulting services 71 Architectural and engineering services; technical testing and analysis services	101 Other business services
Advertising (151)	5418 Advertising and related services	73 Advertising and market research services	098 Advertising services
Computer related services (153)	5415 Computer systems design and related services	62 Computer programming, consultancy and related services	088 Information services 089 Internet based services
Educational services (156)	61 Educational services	85 Education services	092 Education
Medical/Healthcare/Sanitation services (157,159)	621 Ambulatory health care services	86 Human health services	094 Medical service and health 096 Nursing care
Social welfare services (158)	622HO Hospitals and nursing and residential care facilities 624 Social assistance	87 Residential care services 88 Social work services without accommodation	095 Social security
Publishing/Cultural/Entertainment services (160–162)	511 Publishing industries 711AS Performing arts, spectator sports, museums, and related activities 713 Amusements, gambling, and recreation industries	58 Publishing services 90 Creative, arts and entertainment services 91 Libraries, archives, museums and other cultural services 92 Gambling and betting services 93 Sports services and amusement and recreation services	090 Image information, character information production and distribution 102 Amusement and recreational services

Sources: Bureau of Economic Analysis (US) (2011); Office for National Statistics (UK) (2012); Statistical Bureau, Ministry of Internal Affairs and Communications (Japan) (2009).

inducement coefficient matrix that reflects the non-competitive production inducement coefficient.

$$\Delta L = \widehat{l^e}(I - A)^{-1} A^e \Delta X \tag{4}$$

Here, ΔL indicates Labor Inducement Personnel and $\widehat{l^e}$ indicates a diagonal matrix showing employment inducement coefficient, and these not only include the quantity of employment directly required to generate one unit of production in a certain industry, but also the employment indirectly needed in the process of production inducement. $\widehat{l^e}(I - A)^{-1}$ indicates the employment inducement coefficient.

The forward linkage effect and the backward linkage effect present the degree of interdependency among the different industries relative to the mean of all industries by employing the production inducement coefficients. The forward linkage effect indicates the sensitivity of dispersion and it is assessed through the response ratio. The response ratio of industry i, r_i, is defined by Eq. (5).

$$r_i = \frac{\sum_{j=1}^{37} b_{ij}}{\sum_{i=1}^{37}\sum_{j=1}^{37} b_{ij}/37} \tag{5}$$

The backward linkage effect is called the effect ratio, and indicates the power of dispersion. Here, b_{ij}, denotes the element in row i, column j of the Leontief Inverse matrix. The effect ratio of industry j, e_j, is calculated by dividing the sum of the columns of the production inducement coefficients by the mean of all industries, as shown in Eq. (6).

$$e_j = \frac{\sum_{i=1}^{37} b_{ij}}{\sum_{i=1}^{37}\sum_{j=1}^{37} b_{ij}/37} \tag{6}$$

4. Findings and analysis

4.1. Comparative analysis in terms of economic impact

The production inducement effect, employment inducement effects and the forward and backward linkage effects of each country, in Korea, the US, the UK and Japan, are calculated by applying the above models. The Japanese production inducement coefficient is the highest, followed in order by the UK, the US, and Korea (Fig. 1). Production inducement coefficient refers to the series of output increase effects on other industries generated by an increase in output by one unit of final demand in

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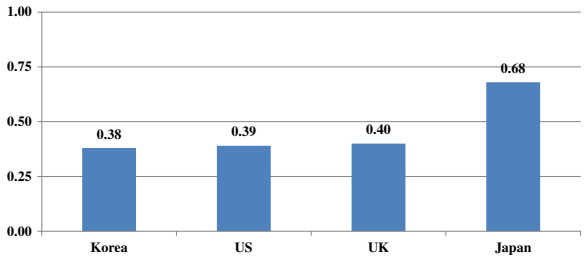

Fig. 1. Comparison of the production inducement coefficients of the knowledge services industry.

the knowledge service industry. In other words, when the knowledge service industry has a high production inducement coefficient it is interpreted as meaning that the knowledge service industry can induce production in other industrial sectors. Unlike the other three countries, the production inducement coefficient of Japan's knowledge services industry is very high. In reality, according to a study on the degree of contribution of the knowledge service industry to productive increase in other industries in Japan from 2000 to 2004, the degree of contribution of the knowledge service industry is 44%, which is higher than the 42.8% recorded in manufacturing business (OECD, 2006).

Despite having world-class manufacturing competitiveness in the 1990s, Japan identified the insufficient development of its knowledge service sector as one of main causes of a long-term recession in the Japanese economy. The Ministry of Economy, Trade and Industry (METI) in Japan announced its goal of concentrated development of the knowledge service sector through *Service Forum Report* in 2003 (PACST, 2007). In 2004, Japan selected seven strategic industries for concentrated development through its *2005 Creative Strategy for New Industry*, and of these, four industries were designated as service sectors, and the facilitation of future-oriented investment was induced (METI, 2005; PACST, 2007). As it was recognized that facilitating the service industry is the best way to increase industrial productivity in Japan, support was provided to develop the service industry in consideration of the changes in consumption structure caused by the aging of society and the overseas transfer of manufacturing businesses. The production inducement coefficient in the knowledge service industry was much higher in Japan than in other countries, from which it can be interpreted that the series of policies pursued to facilitate the knowledge service industry have paid off.

The production inducement coefficient of the knowledge services industry in the US was expected to be high, since its service industry has reached maturity. Yet the actual production inducement coefficient of the US falls short of expectations. For the past 40 years, the contribution of the service industry including the knowledge service industry to overall Gross Domestic Product (GDP) in the US has been gradually increased, thanks to the promotion of an industrial policy centering on service business since the 1980s (Duesterberg and Preeg, 2003). However, with the financial crises caused by the subprime mortgage collapse in 2007, the US government began to depart from a service industry-centered policy based on the judgment that excessive growth in the financial sector and weakened competitiveness in the manufacturing sector endanger the economic system. In 2009, the Obama administration introduced a policy to enhance competitiveness in the manufacturing sector through providing intensified support to the advanced manufacturing sector in a way that would improve actual profits in comparison with the past. In reality, the results of this policy appear to have had an effect on the knowledge service industry (EOP, 2009).

It is encouraging to find that the production inducement coefficient of Korea's knowledge services industry is only slightly lower than that of the US. However, when compared with Japan, which has an economic structure that is relatively similar to Korea's, and like Korea has achieved economic growth based on its manufacturing industry, the production inducement coefficient of Korea's knowledge services industry is substantially lower. This seems to reflect the fact that while Korea has promoted related policies to achieve the growth of both manufacturing and the service industry, these have not produced any tangible results.

Table 3
International comparison of employment inducement coefficients by industry.

	Knowledge services	Agriculture/Mining	Manufacturing	General services
Korea	13.92	7.89	7.53	13.13
US	9.81	4.90	6.68	5.30
UK	20.59	10.32	15.13	21.52
Japan	11.59	8.92	10.09	10.72

As seen in Table 3, the knowledge services industry shows high employment inducement effects compared to the agriculture/mining, manufacturing and general services industry. Employment inducement coefficient means the quantity of increase in employees in all industrial sectors directly or indirectly induced to generate one unit of final demand in the specific industrial sector. Korea, the US and Japan post a high employment inducement coefficient in the knowledge services industry compared to other industries, and the UK records a comparatively lower coefficient in the knowledge services industry than in other general services industries, which indicates that there is a high employment inducement coefficient in the knowledge service industry compared to other industries. This suggests that the knowledge services industry accounts for a much greater share of employment than other industries, as its role and importance are increased in the socioeconomic structure where knowledge has become a basis.

Gradual growth in the knowledge services industry is expected to slowly reduce the importance of simple laborers, while advancing a manpower structure in which the importance of knowledge workers is increased. As the knowledge services industry is not only highly capable of creating jobs but also offers jobs that require expertise and technology, it can produce quality jobs for highly educated people. Accordingly, the knowledge services industry is expected to contribute to advancing the quality of jobs in all industries.

The UK records an employment inducement coefficient of 20.59, which is the highest value, and this is followed by Korea, Japan and the US. The UK posts a much higher employment inducement coefficient than the other countries, and this is remarkable given the relatively lower production inducement effects in the UK. As the employment inducement coefficient is the value calculated by multiplying the production inducement coefficient by the employment coefficient, the employment coefficient in the knowledge services industry in the UK is expected to be much higher than in other countries. According to an estimation of the employment coefficient in 10 types of business constituting the knowledge services industry by country, the employment coefficient is similarly high in all sectors in the UK (Table 4). In particular, the employment coefficient is higher than 20 in the educational services and social welfare services sectors, and it is estimated to be

Table 4
International comparison of employment coefficients in the knowledge services industry.

	Korea	US	UK	Japan
Communication/Broadcasting	2.61	2.14	4.41	3.12
Finance/Insurance	5.07	2.45	4.69	4.03
Research and Development	9.82	4.58[a]	13.85	5.34
Business/Professional services	8.63		11.38	16.24
Advertising	3.38		8.17	2.45
Computer related services	7.14		9.87	5.77
Educational services	14.92	14.05	22.47	9.60
Medical/Healthcare/Sanitation services	8.61	8.64	14.31	10.65
Social welfare services	34.46	18.28	24.86	15.93
Publishing/Cultural/Entertainment services	6.35	5.13	12.21	6.18

[a] This value includes research and development, business/professional services, advertising and computer related services.

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higher than 10 in the medical/healthcare/sanitation services, research and development, publishing/cultural/entertainment services, and business/professional services sectors. It is also relatively high compared to other countries in terms of broadcasting/communication, finance/insurance, where relatively lower employment coefficients are registered in the knowledge services industry in the UK. This indicates that a relatively larger population is engaged in the knowledge services industry in the UK compared to in other countries. In reality, the UK has considered the knowledge service industry including education and medicine to be a new-growth engine since 2000, and unlike other industries that are showing negative growth in employment, it has consistently increased employment, to make a great contribution to enhancing the economic situation in the UK (Moneytoday, 2013).

But in contrast to its relatively lower production inducement effects, Korea also posts a higher employment inducement coefficient. As Korea is experiencing development without employment, growth in the knowledge services industry is expected to make a positive contribution to creating jobs in the future. In particular, the social welfare services sector posts an employment coefficient of 34.46 while generating the highest employment inducement effects in the knowledge services industry, and this is the highest level among comparative countries. The increased demand for workers in the social welfare sector under Moo-hyun Roh's administration since February 2003 has been cited as a reason for this (Kang, 2010). Korea became an aging society, which is a society in which the population aged 65 or older accounts for 7% to 14% of the entire population, in 2000, when the percentage of the population aged 65 or older reached 7.2%. Since then, the population aged 65 or older has been consistently growing (Statistical Research Institute, 2008, 2012). Various social phenomena, including a reduced birthrate in line with the aging population, have led to an increase in demand for social welfare services. Since the inauguration of President Moo-hyun Roh in 2003, high employment inducement coefficient has been recorded to meet such demand through institutionalization and quantitative expansion in the social service sector.

Japan registers a very low employment inducement coefficient, despite posting a high production inducement coefficient. In particular, it registers much lower employment coefficients than other countries in terms of educational services and social welfare services, where relatively high value is posted in the knowledge services industry. In addition, it is estimated that low employment inducement effects are generated throughout the knowledge services industry. These phenomena indicate that the abovementioned knowledge service development policy, which was pursued in Japan since 2003, did not have any effects on employment. In the early 2000s, Japan put an emphasis on productivity improvement in the knowledge service industry, and since 2010, it has added a new policy objective of raising added value. As the Japanese policy on the knowledge service industry enters an active stage that goes beyond simple enhancement of competitiveness, and is expanded into business foundation and job creation, the importance of employment in the knowledge service industry is gradually increase.

The US records an employment inducement coefficient of 9.81, which is the lowest value, and the knowledge services industry in the US is considered to be going through stagnation in consideration of the previously estimated production inducement coefficients. The service industry in the US began to create new jobs in the late 1970s, and its share of the employment market gradually increased until 2007 (OECD, 2008). However, given the data generated in 2010, the employment inducement coefficient is lower than in comparative countries, and the rate of employment has been dramatically reduced in the knowledge services industry after 2007.

Japan's response ratio, which indicates the forward linkage effect of the knowledge services industry, is 1.16, and the response ratio of the US is 1.09, so both are larger than one. The response ratios of the UK and Korea are 0.95, and 0.90 respectively, both smaller than one. The response ratio indicates the relative effects of a specific industry whenever one additional unit of final demand for products is generated compared to the industrial average. Given that the response ratio is larger than 1, the industrial average, in Japan and the US, the knowledge service industry in Japan and the US is relatively more strongly influenced by economic fluctuations, but the knowledge service industry in the UK and Korea, whose response ratio is smaller than 1, is relatively less influenced by economic fluctuations.

Reviewing the results of the backward linkage effect of the knowledge services industry in the four countries, the US is highest at 1.12, followed in order by the UK, Korea, and Japan. Effect ratio indicating backward linkage effects refers to the relative effect on all industrial sectors whenever one additional unit of final demand for products in a specific industrial sector is generated. The effect ratio of the three countries other than the US was assumed to be smaller than 1, the industrial average. This indicates that the economic impact of investment expenditure on the knowledge services industry influences other industries relatively less compared to the average industry. Unlike other countries, the US recorded a response ratio and effect ratio that was larger than 1. In consideration of production inducement coefficient and employment inducement coefficient, the knowledge service industry in the US appears to have great effects on the US economy (Table 5).

4.2. Comparative analysis in terms of input and output

4.2.1. Comparison in terms of input

Table 6 presents information on knowledge services industry's intermediate input as a percentage of overall industry's intermediate input using each country's Input-Output Table. In the UK, the knowledge services industry's intermediate input is 27.7% of overall industry's intermediate input, a higher percentage than the other countries studied. For the US, Japan, and Korea, it is 25.8%, 17.2%, and 11.2%, respectively.

The fact that this percentage is higher in the UK than in the other three countries is evidence that the UK has striven to maintain its engine of growth by investing heavily and from an early stage in service industries that creates high added value and employment, particularly in the knowledge services industry, rather than in the manufacturing industry, which has lost its competitiveness. On the contrary, Korea's low percentage of intermediate input at 11.2% reflects the state of the current Korean economy, which has considerably less competitiveness in the knowledge services industry compared to other major developed countries. Even compared to Japan, which achieved economic growth that was focused on manufacturing businesses, there are great differences. Compared to other advanced countries such as the US and the UK, Japan records a relatively high rate of manufacturing businesses. As for the rate of manufacturing business in GDP, the US and the UK recorded 11.9% and 10.7%, respectively, in 2009, while Japan continued to maintain high rates (17.8% in 2009 and 18.1% in 2012). Although Japan has maintained an economic structure that is focused on the manufacturing business, it appears to be pushing for high added value in the manufacturing sector through intermediate input into the knowledge service industry. As of 2012, the manufacturing sector accounted for 28% of GDP, which is the highest rate among comparative countries. As the amount of intermediate input into the knowledge service industry is very small, efforts need to be made to achieve shared growth along with the manufacturing industry through the development of the knowledge service industry (United Nations Statistical Division, 2012).

Table 7 presents information on the ratio of value added to the total input of the knowledge services industry, which is estimated using the Input-Output Tables of Korea, the US, the UK, and Japan. In Japan, the

Table 5
International comparison of the response ratio and the effect ratio of the knowledge services industry.

	Korea	US	UK	Japan
Response ratio	0.90	1.09	0.95	1.16
Effect ratio	0.86	1.12	0.91	0.78

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Table 6
Knowledge services industry's intermediate input as a percentage of total intermediate input.

	Knowledge services industry's intermediate input (A)	Total intermediate input (B)	Percentage (%, A/B)
Korea (trillion won)	195	1742	11.17
US (billion dollars)	2914	11,285	25.82
UK (billion pounds)	377	1360	27.72
Japan (trillion yen)	80	466	17.23

ratio of value added to the total input of the knowledge services industry is highest, at approximately 64%, followed by the US, Korea, and the UK at 59.8%, 58.7%, and 56.6%, respectively.

The result shows that among the four countries the knowledge services industry's input as a percentage of total industry's intermediate input is highest in the UK, yet the ratio of value added to the knowledge services industry's total input is the lowest in the UK. This means that while the knowledge services industry in the UK is highly active, it hasn't led to the creation of much added value. This suggests a direction for improving the policy related to the knowledge service industry in the US in the future. For the knowledge service industry to continue playing a pivotal role as a key driver of economic growth, it is necessary to reduce the input into relatively low value-added sectors and concentrate on high value-added sectors through effective restructuring. It is necessary to conduct analyses in order to see if appropriate strategic selections were made and specialized policy support was provided in the promising knowledge service sectors, from the perspective of the effective use of resources.

On the contrary, while the percentage of the Korean knowledge services industry's intermediate input is relatively lower, its creation of added value compared to its input is relatively higher than that of the UK. This highlights the need for a policy that aims to develop the knowledge service industry in Korea, and suggests the necessity of a proactive support policy. In consideration of Korea's economic structure, in which growth potential and profitability in the manufacturing sector are decreased and dependence on export in the manufacturing sector is increased, strategic investment in research and development in the high value-added knowledge service industry will lead to a balanced growth structure (The Bank of Korea, 2012, 2013).

The ratio of added value to the knowledge services industry's total input is higher in Japan and the US than in Korea and the UK. This provides evidence that Japan and the US have established the stable creation of value added in the knowledge services industry compared to Korea and the UK.

4.2.2. Comparison in terms of output

Table 8 is calculated based upon each country's Input-Output Table, and presents the weight of the knowledge services industry given in each country in terms of total output. The UK's knowledge services industry has the highest percentage of total output at 32.6%, followed in order by the US at 28.1%, Japan at 23.0%, and Korea at 17.0%. With the exception of Korea, the countries studied anticipated the importance of service in the economy early on, and made efforts at the national level to foster their service industries, particularly the knowledge services industry. Korea realized the importance of the service industry rather late compared to the other three countries, and has attempted to comprehensively promote the knowledge services industry. But Korea's knowledge services industry has not yet matured, and is still developing slowly. As a result, the Korean knowledge services industry's output as a percentage of total output is about half that of the UK.

Table 8
Knowledge services industry's output as a percentage of total output.

	Knowledge services industry's output (A)	Total output (B)	Percentage (%, A/B)
Korea (trillion won)	530	3124	16.97
US (billion dollars)	7249	25,811	28.09
UK (billion pounds)	869	2669	32.55
Japan (trillion yen)	223	972	22.95

Table 9 shows the knowledge services industry's value added as a percentage of the country's total value added. The knowledge services industry's percentage of value added is the highest in the UK, where it is calculated to represent 37.6% of total value added. In the US, Japan, and Korea the shares are 29.8%, 28.2% and 26.9% respectively. While the UK's knowledge services industry has the highest percentage of total value added among the four countries, its creation of value added in the knowledge services industry compared to its total output has not reached a satisfactory level. The significance of this is clearly shown when it is compared to Korea. The Korean knowledge services industry's input over total output, as a percentage, is approximately 52% that of the UK, yet in terms of Korea's value added it is 71% that of the UK. From this, it can be interpreted that Korea's potential in developing its knowledge services industry is quite substantial considering the fact that the most fundamental reason for fostering the knowledge services industry is to create higher value added. According to the results of an analysis conducted based on an Input-Output Tables in the US in 2002, that the weight of the US knowledge services industry's output and value added is higher than in any other country (Heo and Yoo, 2009). Compared to the 2010 results, the percentage of the knowledge services industry's output and added value in the US is lower than before. The financial crisis that began in the late 2000s is a major factor contributing to this (Grigor'ev and Salikhov, 2009). From the actual comparative analysis of the previously classified 10 sectors of the knowledge services industry using the 2002 and 2010 Input-Output Tables of the US, the value added ratio of the finance/insurance sector, which is the key industries in the US, is shown to be substantially lower than before. The value added ratio of the publishing/cultural/entertainment services sector also becomes significantly lower in 2010. In a 2004 report titled *Innovate America*, the US concluded that to reach a higher level of economic growth, innovation had to be achieved in the service industry, which had been at a standstill (Council on Competitiveness, 2005).

Judging from the results of this study, the result of innovation in the US services industry, which was to be accomplished by promoting the knowledge services industry, remains insignificant despite these efforts. Given the abovementioned policy, which has been pursued by the Obama administration since 2009 to promote the manufacturing sector in the US, it is necessary to push for policy that can achieve the balanced development of manufacturing businesses and service businesses rather than being preoccupied with existing service businesses, and it is

Table 7
Percentage of value added of the knowledge services industry.

	Value added of the knowledge services industry (A)	Total input of the knowledge services industry (B)	Value added percent (%, A/B)
Korea (trillion won)	277	472	58.73
US (billion dollars)	4335	7249	59.80
UK (billion pounds)	492	869	56.60
Japan (trillion yen)	143	223	63.99

Table 9
Knowledge services industry's value added as a percentage of total value added.

	Knowledge services industry's value added (A)	Total value added (B)	Percentage (%, A/B)
Korea (million won)	277	1029	26.91
US (million dollars)	4335	14,527	29.84
UK (million pounds)	492	1309	37.57
Japan (million yen)	143	506	28.21

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considered to be critical to lead shared economic growth based on the manufacturing sector and the service sector in terms of mutual demand base. Accordingly, the knowledge service industry needs to intensively pursue R&D for the development of knowledge service that can support a flexible value chain in the manufacturing business, with the aim of converging with the manufacturing business on the strength of service functions in the manufacturing business (EOP, 2009).

5. Conclusions and implications

The goal of this study was to analyze the input-output structure and economic impact of the knowledge service industry in four countries – Korea, the US, the UK and Japan – through an input-output analysis, and horizontally compare the result while determining the competitiveness of the knowledge service industry in Korea and generating policy suggestions on that basis. The strategic implications that can be drawn from the findings of the international comparison analysis of the competitiveness of the knowledge services industry are as follows.

First, the weight of the knowledge services industry in the US economy is less than that in British economy considering all aspects of input and output other than the value added ratio. This finding runs counter to the results of analyses conducted based on the Input-Output Tables in the US in 2002, and means that the knowledge service industry in the US is at a standstill as of 2010 (Heo and Yoo, 2009). However, compared to Japan, the knowledge services industry of the US is superior in every respect, except for the value added ratio index. Compared to Korea, it is superior in every respect. This indirectly suggests that Korea and Japan still maintain a manufacturing-oriented economic structure. While the knowledge services industry in the US has a small impact on production inducement and employment inducement effects, both the effect ratio and the response ratio, which indicate the forward and backward linkage effects, are bigger than one. This shows that the knowledge services industry still has a big impact on the US economy. The US established a service-base economic structure centering on service-centered policy that embraces the knowledge service industry. In the meantime, the financial sector achieved rapid growth. However, since 2008, it has been recognized that there are limitations in the ability to realize stable growth based on the service industry (including financial businesses) alone (EOP, 2009, 2012).

As seen in the analytical results of the study, the employment inducement effects of the knowledge service industry turned out to be very low, which led to the pursuit of new economic growth engines that can create new jobs and a concentration on manufacturing business. Unlike Japan and Korea, which made efforts to achieve economic growth by developing the knowledge service industry in a manufacture-centered economic structure, the US needs to pursue comprehensive and systematic strategies in terms of selection of advanced manufacturing technology, investment in R&D, tax benefits and manpower training with the aim of converging with the existing service industry, beginning with a policy to manufacturing businesses in the US. Furthermore, it is deemed necessary to recognize that the knowledge service industry is at a standstill, and conduct research to determine how to innovate the knowledge service industry along with policy focused on developing the manufacturing sector.

Second, the weight of the knowledge services industry in the British economy is substantially higher than those of the other three countries from all aspects of input and output other than the value added ratio. The British economy experienced an economic recession as a residual effect of the bubble economy in the early 1990s. However, the British economy recovered from it shortly thereafter and has been experiencing a long economic boom after overcoming its financial crisis in 2007 (Cooper, 2009). One of the most important factors considered to have a favorable impact on this is the increase in the knowledge services industry that creates higher value added (OECD, 2005). The UK government established a policy framework in order to nurture the knowledge service industry at an earlier stage and appeared to focus on advancing service businesses, particularly the high value-added service industry, at a more rapid speed than other advanced countries. As a result of implementing consistent policy with the aim of increasing the economic growth rate, creating jobs, achieving regional development and protecting IP rights on the strength of the knowledge service industry, the knowledge service industry was able to grow at a rapid speed, which led to job creation, and the employment inducement coefficient in the UK was much higher than in comparative countries in 2010. However, both the response ratio and the effect ratio of the knowledge services industry are smaller than one, indicating that the knowledge services industry does not have significant forward and backward linkage effects on the British economy. In addition, the added value, compared to total input in the UK's knowledge services industry, represented as a percentage, is the lowest among the four countries. It is predicted that there will not be stable growth in the knowledge services industry until this improves. It is time to seek a way of improving R&D in the knowledge service industry in the UK. In terms of the implementation of policy on the knowledge service industry, the UK needs to identify areas in which there is lower value added compared to input, and endeavor to provide systematic R&D support based on strategic priorities.

Third, Japan's knowledge services industry has the highest production inducement coefficients and value added ratio, the percentage of value added over total input, among the four countries. The knowledge services industry in Japan is superior to that of Korea from every aspect of input and output except for these values, yet is inferior to those in the US and the UK. At an earlier stage of development of the knowledge service industry, an emphasis was put on enhancing competitiveness based on improved productivity, but it is currently more active and diversified in terms of contents of policy. In particular, Japan has been endeavoring to secure competitiveness by breaking away from growth strategies focused on the manufacturing industry and preparing for differentiated goods by fusing products and services using knowledge as an intermediate input. If Japan achieves positive results in a series of efforts to realize high added value in the knowledge service industry in the future, it can be expected to achieve stabilized growth in terms of input and output. However, it needs to be taken into account that Japan has a lower employment inducement coefficient than Korea. The singularity of the knowledge services industry in Japan lies in the fact that the medical and health care service sectors were given more weight in the knowledge services industry than the finance and insurance sectors, which sets it apart from other countries. Efforts need to be made to see if the increased demand for new services caused by the changing social structure in the region – i.e., the low birth rates and the aging society – is being met in an appropriate way. It is considered to be helpful to develop R&D programs so that new business models can be created in the knowledge service industry with regard to areas with a lot of changes (Hayes, 2011). The introduction of new business models is expected to naturally lead to job creation.

Lastly, the percentage of total input and output of the knowledge services industry in Korea is substantially lower than in the US, the UK, and Japan. The economic impact of the knowledge services industry, shown by the effect on production inducement and the forward-backward linkage effect, is also estimated to be small compared to that of the other three countries. This implies that Korea's knowledge services industry has less weight in the whole economy than the knowledge services industries of other major developed economies, and its competitiveness is weaker. This seems to be the inevitable result of Korea's late start, as it only began to realize the importance of the knowledge services industry in the mid 2000′s.

Korea has been promoting the development of its knowledge services industry since 2007 through *Development Strategies for the Knowledge Services Industry* announced by the Ministry of Knowledge Economy. Korea, which like Japan started its development with a strong manufacturing industry, aims to promote a virtuous cycle enabling mutual growth by fusing manufacturing and services, and create higher

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value added businesses throughout all of industry. Japan gained an advantage in competition through *Service Science* (Mizuno, 2005), while Korea should be able to enhance its global competitiveness through the best ICT infrastructure in the world. To accomplish this, it is necessary for Korea to develop its own models for successful conversion into a knowledge-based economy and conduct related research as soon as possible. The integration of ICT with the transition of existing manufacturing business into "smart" businesses, the advancement of the knowledge service industry and the creation of new knowledge service businesses through industrial convergence is expected to increase competitiveness. It is considered that this will be realized through enhanced support for existing R&D programs for the purpose of innovating both the weak knowledge service industry and the manufacturing industry and through the establishment of a national infrastructure, which can be facilitated by carrying forward comprehensive strategies to promote the industry as well as legislating on the regulation of national policies and support plans (Welfe, 2008). These positive results of relatively higher rates of value added over total input and employment inducement coefficients that are much higher than other industries in Korea justify the development of the knowledge services industry. With Korea's potential, the aggressive promotion of the knowledge services industry will likely contribute to the creation of national wealth.

This study conducts a comparative analysis on international competitiveness in the knowledge services industry based on the Input-Output Tables of each country. But several problems are detected in the process of acquiring the Input-Output Tables of the four countries subject to comparison. First of all, to enable an accurate international comparison, it is necessary to use the latest Input-Output Table for each country over the same period. While it is possible to acquire the 2010 Input-Output Tables for Korea, the US and the UK, the most recent Input-Output Table available from Japan was made in 2005, so there are time differences from other countries in terms of international comparison. As for the analysis of the economic impact, it is impossible to acquire the current non-competitive import Input-Output Table for any country other than Korea, so our input-output analysis is conducted by using the current competitive import Input-Output Table for each country. As a result, the study fails to estimate value added inducement effects for each country. In this regard, further studies need to be conducted to overcome these limitations.

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