An analysis of monetary production and CO_2 emission in tourism industries in Japan and Korea using input output model

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ABSTRACT

The objective of this study is to compare monetary consumption and CO_2 emission from tourism industries of multi-country regions using input output model framework supported by input output table, data on tourism consumption and GHG emission factor database provided in research publications and official national statistics. Japan and Korea are selected as an example in the study.

Firstly, Japanese national I-O table and Korean national I-O table are converted into those with common 25 industries. Secondly, tourism industry is newly set in both tables using tourism consumption databases. Japanese tourism industry is divided into two parts, production by all travelers excluding Korean and that by Korean travelers. Similarly, Korean tourism industry is divided in into production by all travelers excluding Japanese and that by Japanese travelers. In consequence, I-O tables with 27 industries are produced. Thirdly, monetary production-based I-O tables are converted into CO_2 emission-based I-O tables using official CO_2 inventory databases.

Major results of the study are, 1) both Japanese and Korean tourism industry are the large CO_2 producer, and 2) the promotion of Japanese tourism industry may contribute to increase CO_2 emission not only through its own production activity but also through production activities of other industries.

Key words: CO_2 emission, Input output table, tourism industry, consumption survey, emission factor

1. INTRODUCTION

Tourism industry is now regarded as one of the emerging industries in the twenty first century all over the world. The UNWTO has focused in their “Tourism 2020 Vision” that number of international

tourist arrivals will be 1.6 billion in 2020, around 1.5 times of that in 2013. Especially, radical growth of the number will be expected in Asia and Africa regions thanks owing to their successive economic growth. Like European countries, number of cross border tourists within either of these regions is expected to increase radically for the next decade owing to the economic integration among adjacent countries. These kinds of growth conduce the increase of production in tourism industry, as well, the increase of CO_2 emission in the industry.

It has been widely recognized that increase of CO_2 emission is one of the reasons of global warming. The UNWTO has published the technical report of problem on climate change and tourism in 2008. In the report, they have estimated that the total CO_2 emission volume from tourism industry in 2005 covers 4.9% of the total emission volume which is considered to be large enough. Therefore, significant efforts for reducing CO_2 emission from tourism industry is inevitable by all stakeholders in the industry.

There are certain amount of researches on greenhouse gas including CO_2 from tourism industry all over the world. For example, The Travel Foundation (2007) provided the detailed information of carbon footprint at tourism destinations in energy consumption base. Sustainable Tourism Cooperative Research Centre (2008) estimated Australian tourism carbon footprint also in energy consumption base. Sustainable Tourism Cooperative Research Centre (2010) also estimated tourism carbon footprint in Queensland, Australia in the same manner. Rendeiro *et al* (2010) analyzed ecological footprint of tourism activities on road network in Lanzarote Island using the ecological footprint indicator.

On the other hand, Munday *et al* (2013) accounted for the tourism carbon footprint in Wales, UK using input output model framework. Sun (2014) accounted for the tourism carbon footprint in Taiwan using the same framework as Munday *et al*. However, few researches have dealt carbon footprint analysis in multi-countries context.

The objective of this study is to compare monetary consumption and CO_2 emission from tourism industries of multi-country regions using input output model framework, supported by input output table, data on tourism consumption and GHG emission factor database provided in research publications and official national statistics. Two countries, Japan and Korea, are selected in this study. Chapter 2 describes the methodology of this study. Chapter 3 describes the analytical results. Chapter 4 is the conclusions.

2. METHODOLOGY

2.1 Analytical Framework

Japanese national I-O table with 53 industries in 2010[*1] and Korean national I-O table with 28 industries in 2010[*2] are used as the base tables. Tourism industry in these original I-O tables is not regarded as an individual industry. Firstly, these tables are converted into those with common 25

industries. Secondly, tourism industry is newly set in both tables using tourism consumption databases obtained in Japan[*3] and Korea[*4]. Japanese tourism industry is divided into two parts, production by all travelers excluding Korean and that by Korean travelers. Similarly, Korean tourism industry is divided in into production by all travelers excluding Japanese and that by Japanese travelers. In consequence, I-O tables with 27 industries are produced. Thirdly, production-based I-O tables are converted into CO_2 emission-based I-O tables using official CO_2 inventory databases provided in Japan[*5] and Korea[*6].

2.2 Making of Tourism Industry in I-O table

Consumption Trend Survey reports product-based monetary travel consumption by Japanese tourists annually. In the survey report, product-based consumption status in domestic overnight travel, domestic day return travel and overseas travel can be referred. The consumption status includes average monetary consumption by a tourism product, ratio of consumption in the product in a travel, and total number of tourists in three travel categories. Total annual monetary consumption of tourism product *p* by Japanese tourists, C_p^{JJ} is calculated by the following equation,

$$C_p^{JJ} = \sum_{c=1}^{3} N^{Jc} B_p^{Jc} M_p^{Jc} \tag{1}$$

where, N^{Jc} is the total number of Japanese tourists in travel category *c*, B_p^{Jc} is the percentage of tourists who consume *p* in *c*, and M_p^{Jc} is the average monetary consumption per consumption of *p* in *c*. Consumption Trend Survey for Foreigners Visiting Japan also reports product-based monetary consumption by inbound tourists. The consumption status by Korean tourists can also be understood in the survey. The total monetary consumption of product *p* in Japan by inbound tourists except Korean C_p^{JI} and that by Korean tourists C_p^{JK} can be calculated by the same manner.

Each tourism product is allocated into one specific industry. Under the assumption that production is equal to consumption, monetary production of tourism-related products by all travelers excluding Korean in industry *i* in Japan, PT_i^J and that by Korean, PT_i^{JK} is calculated by the following equations,

$$PT_i^J = \sum_{p=1}^{P_i} \left(C_p^{JJ} + C_p^{JI} \right) \tag{2}$$

$$PT_i^{JK} = \sum_{p=1}^{P_i} C_p^{JK} \tag{3}$$

where, P_i is the number of tourism-related products in *i*. The proportion of tourism-related production by all travelers excluding Korean in *i*, S_i^J and that by Korean, S_i^{JK} is calculated by the following

equations,

$$S_i^J = PT_i^J / y_i^J \tag{4}$$

$$S_i^{JK} = PT_i^{JK} / y_i^J \tag{5}$$

where, y_i^J is the total production of *i*.

National Travel Survey and Travel Survey for Foreign Visitors also report product-based monetary travel consumption in Korea annually. In the same manner as the case of Japan, the proportion of tourism-related production by all travelers excluding Japanese in *i*, S_i^K and that by Japanese, S_i^{KJ} is calculated by the following equations,

$$S_i^K = PT_i^K / y_i^K \tag{6}$$

$$S_i^{KJ} = PT_i^{KJ} / y_i^K \tag{7}$$

$$PT_i^K = \sum_{p=1}^{P_i} \left(C_p^{KK} + C_p^{KI} \right) \tag{8}$$

$$PT_i^{KJ} = \sum_{p=1}^{P_i} C_p^{KJ} \tag{9}$$

$$C_p^{KK} = \sum_{c=1}^{3} N^{Kc} B_p^{Kc} M_p^{Kc} \tag{10}$$

The explanation of variables in the equation above is abbreviated because suffixes *J* (Japan) is just replaced to *K* (Korea).

In the Japanese I-O table with 25 industries, the monetary production of industry *i*, is y_i^J $\left(i = 1, \cdots, 25\right)$ expressed by the following equation,

$$y_i^J = \sum_{j=1}^{25} w_{ij}^J + g_i^J \tag{11}$$

where, w_{ij}^J $\left(j = 1, \cdots, 25\right)$ is inter-industry sales by *i* to industry *j*, and g_i^J is the total final monetary demand of *i*. Here, tourism industry for those except Korean is set as the 26th industry and that for Korean is set as the 27th industry in the converted I-O table. The matrix expression of the equation (11) is the following,

$$\mathbf{y}^J = \mathbf{W}^J \mathbf{i} + \mathbf{g}^J \tag{12}$$

where, **i** is a column vector of 1's. We define the following conversion matrix.

$$\mathbf{\Sigma}^J = \begin{pmatrix} 1 - S_1^J - S_1^{JK} & \cdots & 0 & \cdots & 0 \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ 0 & \cdots & 1 - S_i^J - S_i^{JK} & \cdots & 0 \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ 0 & \cdots & 0 & \cdots & 1 - S_{25}^J - S_{25}^{JK} \\ S_1^J & \cdots & S_i^J & \cdots & S_{25}^J \\ S_1^{JK} & \cdots & S_i^{JK} & \cdots & S_{25}^{JK} \end{pmatrix} \tag{13}$$

The inter-industry sales matrix in Japanese I-O table with tourism industries $\mathbf{Z}^J$ (27×27) is expresses as follows,

$$\mathbf{Z}^J = \mathbf{\Sigma}^J \mathbf{W}^J \mathbf{\Sigma}^{JT} \tag{14}$$

where, suffix T means transposed matrix. The monetary production vector $\mathbf{x}^J$ and the total final monetary demand vector $\mathbf{f}^J$ are expressed as follows,

$$\mathbf{x}^J = \mathbf{\Sigma}^J \mathbf{y}^J \tag{15}$$

$$\mathbf{f}^J = \mathbf{\Sigma}^J \mathbf{g}^J \tag{16}$$

The following input output model is expressed by $\mathbf{Z}^J$, $\mathbf{x}^J$ and $\mathbf{f}^J$.

$$\mathbf{x}^J = \mathbf{Z}^J \mathbf{i} + \mathbf{f}^J \tag{17}$$

In order to make Korean I-O table with tourism industries, the same process can be undertaken, by providing the following conversion matrix,

$$\mathbf{\Sigma}^K = \begin{pmatrix} 1-S_1^K-S_1^{KJ} & \cdots & 0 & \cdots & 0 \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ 0 & \cdots & 1-S_i^K-S_i^{KJ} & \cdots & 0 \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ 0 & \cdots & 0 & \cdots & 1-S_{25}^K-S_{25}^{KJ} \\ S_1^K & \cdots & S_i^K & \cdots & S_{25}^K \\ S_1^{KJ} & \cdots & S_i^{KJ} & \cdots & S_{25}^{KJ} \end{pmatrix} \tag{18}$$

Finally, we get the same shape of input output model.

$$\mathbf{x}^K = \mathbf{Z}^K \mathbf{i} + \mathbf{f}^K \tag{19}$$

The monetary production-based input-output coefficient matrices are given by the following equations,

$$\mathbf{A}^J = \begin{pmatrix} z_{11}^J / x_1^J & \cdots & z_{1,27}^J / x_1^J \\ \vdots & \ddots & \vdots \\ z_{27,1}^J / x_{27}^J & \cdots & z_{27,27}^J / x_{27}^J \end{pmatrix} \tag{20}$$

$$\mathbf{A}^K = \begin{pmatrix} z_{11}^K / x_1^K & \cdots & z_{1,27}^K / x_1^K \\ \vdots & \ddots & \vdots \\ z_{27,1}^K / x_{27}^K & \cdots & z_{27,27}^K / x_{27}^K \end{pmatrix} \tag{21}$$

2.3 Making of CO_2 emission-based I-O tables

National Institute for Environmental Studies, Japan, published Embodied Energy and Emission Intensity Data for Japan Using Input－Output Tables (3EID). This provides emission volume data on greenhouse gas including CO_2 of 403 industries in 2005. If this data can be converted to 2010's data, CO_2 emission factor of each industry in 2010 can be estimated.

Here, d_i^{J2005} $(i=1,\cdots,25)$ is CO_2 emission volume in industry i in 2005. Using the data of i's monetary production in 2005, y_i^{J2005} and 2010, y_i^J, i's CO_2 emission volume in 2010, d_i^J is estimated by the following equation,

$$d_i^J = d_i^{J2005} + \frac{\left(e^J - e^{J2005}\right)\left\{\left(y_i^J - y_i^{J2005}\right) - \sum_{j=1}^{25}\left(y_j^J - y_j^{J2005}\right)\right\}}{\sum_{i=1}^{25}\left\{\left(y_i^J - y_i^{J2005}\right) - \sum_{j=1}^{25}\left(y_j^J - y_j^{J2005}\right)\right\}} \tag{22}$$

where, e^{J2005} is the total CO_2 emission volume from Japan in 2005, and e^J is that in 2010. The emission factor of *i* in 2010, δ_i^J is calculated as follows,

$$\delta_i^J = d_i^J / y_i^J \tag{23}$$

Then, CO_2 emission volume in tourism industry for those except Korean (26th industry), e_{26}^J and that for Korean (27th industry), e_{27}^J are calculated as follows,

$$e_{26}^J = \sum_{i=1}^{25} S_i^J d_i^J y_i^J \tag{24}$$

$$e_{27}^J = \sum_{i=1}^{25} S_i^{JK} d_i^J y_i^J \tag{25}$$

CO_2 emission volume of the rest of industries are calculated as follows,

$$e_i^J = \left(1 - S_i^J - S_i^{JK}\right) d_i^J y_i^J \tag{26}$$

The emission factor for 27 industries I-O table, γ_i^J is calculated as follows,

$$\gamma_i^J = e_i^J / x_i^J \tag{27}$$

The inter-industry CO_2 emission volume by *i* to industry *j*, v_{ij}^J and the total final demand in CO_2 emission volume based, h_i^J are calculated as follows,

$$v_{ij}^J = z_{ij}^J / \gamma_i^J \tag{28}$$

$$h_i^J = f_i^J / \gamma_i^J \tag{29}$$

Finally, we get the following input output model for CO_2 emission,

$$\mathbf{e}^J = \mathbf{V}^J \mathbf{i} + \mathbf{h}^J \tag{30}$$

The CO_2 emission volume-based input-output coefficient matrix is given by the following equation,

$$\mathbf{B}^J = \begin{pmatrix} v_{11}^J / e_1^J & \cdots & v_{1,27}^J / e_1^J \\ \vdots & \ddots & \vdots \\ v_{27,1}^J / e_{27}^J & \cdots & v_{27,27}^J / e_{27}^J \end{pmatrix} \tag{31}$$

However, it should be noted that $\mathbf{B}^J$ becomes same as $\mathbf{A}^J$ by the method undertaken in this study.

The Korean Bank reported An Analysis of Recent GHG Emission by Sector in Korea in 2008. This provides emission volume data on greenhouse gas including CO_2 of 20 industries in 2004. The emission factor for 27 industries Korean I-O table including tourism industries, γ_i^K is also derived as the same manner above. The Korean input output model for CO_2 emission is derived as the followings,

$$\mathbf{e}^K = \mathbf{V}^K \mathbf{i} + \mathbf{h}^K \tag{32}$$

3. ANALYSIS

3.1 Monetary production-based I-O tables

Table 1 shows the parameters, S_i^J, S_i^{JK}, S_i^K and S_i^{KJ} derived by the consumption databases mentioned in the Section 2.2. It is obvious that transport sub-industry is one of the major players in tourism industry because of its higher parameter value. And it should be noted that the composition of sub-industries in Japanese tourism industry is different from that in Korean tourism industry due to the difference of consumption survey method.

Table 2 and 3 show the Japanese and Korean monetary production-based I-O tables with two tourism industries in 2010, derived by the method undertaken in this study. The monetary production of Japanese tourism industry is 293 billion US dollars (USD), and that of Korean is 40 billion USD. These productions are 2.88% and 1.48% of the total productions, respectively. It is easily understood that the economic contribution of Korean tourism industry is not large enough compare with that of Japanese. The share of production by Korean visitors in Japanese tourism industry is 0.68%, but on the contrary, that by Japanese visitors in Korean tourism industry is 5.82%. It is obvious that the contribution of Japanese visitors may have certain impact on Korean tourism industry.

3.2 CO_2 Emission factors

Table 4 shows the emission factors of Japanese and Korean industries. The Japanese and Korean national emission factors are calculated as 117 ton/million USD and 223 ton/million USD, respectively. It is obviously understood that the Korean factor is double of the Japanese factor.

The emission factor of Japanese tourism industry is calculated as 222 ton/million USD, which is double of the national factor. It is understood that Japanese tourism industry may be the large CO_2 producer. On the contrary, that of Korean tourism industry is calculated as 204 ton/million USD, which is less than the national factor. However, the value is almost same as the Japanese factor.

The emission factor of tourism industry for Korean visitors in Japan is smaller than that of whole tourism industry, mainly because consumptions for log-haul transport services (access transport cost to airports or seaports, and international flight or vessel cost) is not included in the Japanese I-O table (but included in the Korean I-O table). This phenomenon is also observed in case of the emission factor of tourism industry for Japanese visitors in Korea.

Figure 1 shows the proportion of inter-industry demand by tourism industries. “Real estate and business services (23)”, “transport (19)” and “food and beverage (3)” are major three suppliers to the tourism industry for those except Korean (J26), and “petroleum and coal products (6)”, “transport (19)” and “food and beverage (3)”are major suppliers to the tourism industry for Korean (J27) in Japan. To the tourism industry for those except Japanese (K26) and that for Japanese (K27), tendency of the proportion is similar.

3.3 CO_2 emission-based I-O tables

Table 5 and 6 show the Japanese and Korean CO_2 emission-based I-O tables with two tourism industries in 2010, derived by the method undertaken in this study. The annual CO_2 emission volume of Japanese tourism industry is 67.2 million ton, and that of Korean is 8.2 million ton. These volumes are 5.64% and 1.35% of the total volumes, respectively. These results can be easily understood from the results in the previous section.

Figure 2 shows the proportion of inter-industry CO_2 load by tourism industries. The tendency is quite different from the proportion shown in Figure 2. "Essential utility (16)" and "transport (19)" are the two major industries which emit much CO_2 for their supply activities.

3.4 Derivation of total requirements matrices

In the standard analysis of input output model, total requirements matrix is derived. In this study, $[I-(I-M)A]^{-1}$ type inverse matrix is used as the total requirements matrix. Using the matrix of $\mathbf{A}^J$ and $\mathbf{A}^K$ total requirements matrices are derived in Table 7 and 8.

In these tables, index of power of dispersion (PDI) which is one of the indices of backward linkage effect, and index of sensitivity of dispersion (SDI) which is one of the indices of forward linkage effect are derived. PDI of tourism industry for those except Korean and that for Korean in Japanese market are 0.881 and 0.501 respectively those are lower than average PDI of 1.00. That for those except Japanese and that for Japanese in Korean market are 0.688 and 0.493 respectively those are also lower than 1.00. These results suggest that both Japanese and Korean tourism industries buy less products of other industries for their service provision.

SDI of tourism industry for those except Korean and that for Korean in Japanese market are 0.902 and 0.861 respectively those are lower than average SDI of 1.00. That for those except Japanese and that for Japanese in Korean market are 0.955 and 0.954 respectively those are also lower than 1.00. These results also suggest that both Japanese and Korean tourism industries provide less products to other industries by their service provision.

Here, power of dispersion and sensitivity of dispersion of industry i in CO_2 emission base are defined. These are expressed by power of dispersion and sensitivity of dispersion of i in monetary production base and emission factor of i. The equation (33) and (34) are the examples of the calculation in case of Japanese index of power of dispersion.

$$PDC_i^J = \gamma_i^J PDM_i^J \tag{33}$$

$$PDIC_i^J = \frac{27 PDC_i^J}{\sum_{i=1}^{27} PDC_i^J} \tag{34}$$

where, PDC_i^J is power of dispersion of i in CO_2 emission base, PDM_i^J is power of dispersion of i in monetary production base, and $PDIC_i^J$ is index of power of dispersion of i in CO_2 emission base.

In Korean case, the capital *J* is replaced to capital *K* in these equations. As well, in case of sensitivity of dispersion, the capital *P* is replaced to *S*.

Table 9 shows the comparison of PDI and SDI in monetary production and CO_2 emission base. PDI and SDI in CO_2 emission base of the tourism industry for those except Korean is more than 1.00 although these in monetary production base is less than 1.00. This means that the promotion of Japanese tourism industry may contribute to increase CO_2 emission not only through its own production activity but also through production activities of other industries.

4. CONCLUSIONS

This study analyzed monetary consumption and CO_2 emission from tourism industries in Japan and Korea based on input output model framework. Firstly, Japanese national I-O table and Korean national I-O table were converted into those with common 25 industries. Secondly, two tourism industries were newly set in both tables using tourism consumption databases, and finally I-O tables with 27 industries were produced. Thirdly, monetary production-based I-O tables were converted into CO_2 emission-based I-O tables using official CO_2 inventory databases.

Findings of the study are listed as follows: 1) in both countries, transport sub-industry is one of the major players in tourism industry, 2) the economic contribution of Korean tourism industry is not large enough compare with that of Japanese, 3) the contribution of Japanese visitors may have certain impact on Korean tourism industry, 4) both Japanese and Korean tourism industry are the large CO_2 producer, 5) both Japanese and Korean tourism industries buy less products of other industries for their service provision, as well, provide less products to other industries by their service provision, 6) the promotion of Japanese tourism industry may contribute to increase CO_2 emission not only through its own production activity but also through production activities of other industries.

Further trials can be the followings: 1) creation of multi-region input output table, 2) in depth analysis of the effect of transport services on CO_2 emission structure in Japanese and Korean tourism market, 3) implementation of the same consumption survey both in Japan and Korea.

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ANNOTATIONS

*1: downloaded from the webpage of Ministry of Economy, Trade and Industry of Japan, http://www.meti.go.jp/statistics/tyo/entyoio/result/result_14.html (as of September 30, 2014)

*2: downloaded from the webpage of the Bank of Korea, http://www.bok.or.kr/contents/total/eng/boardView.action?menuNaviId=634&boardBean.brdid=10926&boardBean.menuid=634 (as of September 30, 2014)

*3: Consumption Trend Survey (旅行・観光消費動向調査), downloaded from the webpage of Japan Tourism Agency, http://www.mlit.go.jp/kankocho/siryou/toukei/shouhidoukou.html (as of September 30, 2014), and Consumption Trend Survey for Foreigners Visiting Japan (訪日外国人消費動向調査), downloaded from the webpage of Japan Tourism Agency, http://www.mlit.go.jp/kankocho/en/siryou/toukei/syouhityousa.html (as of September 30, 2014)

*4: National Travel Survey (국민여행실태조사), downloaded from the webpage of Korea Tourism Organization, http://kto.visitkorea.or.kr/kor/notice/data/statis/tstatus/natstatus/board/view.kto?id=295701&isNotice=false&instanceId=296&rnum=4, Travel Survey for Foreign Visitors (외래관광객실태조사), downloaded from the webpage of Korea Tourism Organization, http://kto.visitkorea.or.kr/kor/notice/data/statis/tstatus/forstatus/board/view.kto?id=295754&isNotice=false&instanceId=295&rnum=5 (as of September 30, 2014)

*5: Embodied Energy and Emission Intensity Data for Japan Using Input－Output Tables, downloaded from the webpage of National Institute of Environmental Studies, Japan, http://www.cger.nies.go.jp/publications/report/d031/jpn/datafile/embodied/2005/403.htm (as of September 30, 2014)

*6: An Analysis of Recent GHG Emission by Sector in Korea (최근우리나라의산업별온실가스배출구조분석), The Korean Bank, 2008.

Table 1. Parameter values for S_i^J, S_i^{JK}, S_i^K and S_i^{KJ}

indusrty		S_i^J	S_i^{JK}	S_i^K	S_i^{KJ}
1	agriculture, forestry and fishing	0.0292	0.0000	0.0000	0.0000
2	mining	0.0000	0.0000	0.0000	0.0000
3	food and beverage	0.0739	0.0002	0.0261	0.0000
4	pulp, paper and wood products	0.0043	0.0000	0.0000	0.0000
5	chemical products	0.0481	0.0003	0.0000	0.0000
6	petroleum and coal products	0.0000	0.0000	0.0228	0.0000
7	ceramic products	0.0108	0.0000	0.0000	0.0000
8	steel and non-ferrous metal	0.0000	0.0000	0.0000	0.0000
9	metalic products	0.0000	0.0000	0.0000	0.0000
10	machinery	0.0000	0.0000	0.0000	0.0000
11	electric machinery	0.0114	0.0006	0.0000	0.0000
12	transport machinery	0.0000	0.0000	0.0000	0.0000
13	precision machinery	0.0717	0.0035	0.0000	0.0000
14	other engineering products	0.0758	0.0009	0.0000	0.0000
15	construction	0.0000	0.0000	0.0000	0.0000
16	essential utilities	0.0000	0.0000	0.0000	0.0000
17	commerce	0.0000	0.0000	0.0245	0.0108
18	fainance and insurance	0.0021	0.0000	0.0000	0.0000
19	transport	0.2233	0.0005	0.1681	0.0011
20	telecommunication	0.0029	0.0001	0.0000	0.0000
21	public services	0.0034	0.0000	0.0000	0.0000
22	medical and social welfare services	0.0019	0.0000	0.0000	0.0000
23	real estate and business services	0.0000	0.0000	0.0011	0.0005
24	retail sarvices	0.0079	0.0003	0.0810	0.0000
25	others	0.3481	0.0058	0.0261	0.0124

Table 2. Japanese monetary production-based I-O table with tourism industries in 2010

Japan I-O table (27 sectors, million USD)			producers as consumers						final demand	total
	industry		1	2-16	17-25	26	27	total		
producer	1	primary industry	16,395	76,734	14,661	8,266	36	116,093	23,401	139,494
	2-16	secondary industry	32,687	1,947,380	626,830	62,362	550	2,669,808	1,461,239	4,131,047
	17-25	tertiary industry (except tourism)	16,093	709,687	1,324,127	64,615	464	2,114,986	3,507,190	5,622,176
	26	tourism (except Korean/Japanese)	3,601	66,783	69,392	9,551	0	149,327	141,989	291,315
	27	tourism (by Korean/Japanese)	11	450	477	0	0	938	1,064	2,002
	total		68,788	2,801,033	2,035,486	144,794	1,051	5,051,152	5,134,883	10,186,034
value added	28	employees	14,542	717,654	1,959,825	83,513	542	2,776,076		
	29	capital	51,670	433,691	1,454,071	48,461	327	1,988,220		
	30	government	4,495	178,668	172,794	14,547	82	370,586		
	total		70,706	1,330,013	3,586,690	146,521	951	5,134,883		
total			139,494	4,131,047	5,622,176	291,315	2,002	10,186,034		

Table 3. Korean monetary production-based I-O table with tourism industries in 2010

Korean I-O table (27 sectors, million USD)			producers as consumers						final demand	total
	industry		1	2-16	17-25	26	27	total		
producer	1	primary industry	2,988	29,103	5,569	1,380	38	39,078	6,667	45,744
	2-16	secondary industry	14,096	980,684	153,394	12,331	382	1,160,886	424,811	1,585,697
	17-25	tertiary industry (except tourism)	4,216	176,714	293,346	8,867	645	483,788	546,901	1,030,689
	26	tourism (except Korean/Japanese)	346	7,012	12,077	910	0	20,344	17,412	37,756
	27	tourism (by Korean/Japanese)	18	588	562	0	1	1,169	1,166	2,334
	total		21,664	1,194,101	464,947	23,487	1,066	1,705,265	996,956	2,702,221
value added	28	employees	3,063	162,823	281,918	6,904	512	455,220		
	29	capital	20,237	171,076	247,719	5,673	595	445,300		
	30	government	781	57,698	36,104	1,788	65	96,436		
	total		24,081	391,596	565,742	14,365	1,172	996,956		
total			45,744	1,585,697	1,030,689	37,853	2,238	2,702,221		

Table 4. Emission factors (ton/million USD) in Japan and Korea in 2010

ID	industry	Japan	Korea
1	agriculture, forestry and fishing	117.77	640.36
2	mining	200.47	1883.15
3	food and beverage	37.96	96.58
4	pulp, paper and wood products	143.29	370.45
5	chemical products	141.37	175.11
6	petroleum and coal products	203.85	175.11
7	ceramic products	954.09	140.53
8	steel and non-ferrous metal	420.87	257.05
9	metalic products	34.78	1157.18
10	machinery	12.08	140.53
11	electric machinery	19.15	54.84
12	transport machinery	17.40	54.84
13	precision machinery	34.66	901.25
14	other engineering products	19.36	140.53
15	construction	23.95	43.93
16	essential utilities	1478.94	2621.35
17	commerce	18.31	131.12
18	fainance and insurance	4.60	56.37
19	transport	445.51	299.48
20	telecommunication	6.41	299.48
21	public services	40.35	87.01
22	medical and social welfare services	26.14	83.16
23	real estate and business services	5.63	42.86
24	retail sarvices	39.78	134.54
25	others	51.45	134.54
26	tourism (except Korean/Japanese)	230.20	207.92
27	tourism (by Korean/Japanese)	88.38	135.92
total		116.92	223.30

Table 5. Japanese CO_2 emission-based partial I-O table with tourism industries in 2010

Japan I-O table (27 sectors, thousand ton)			producers as consumers						final demand	total
	industry		1	2-16	17-25	26	27	total		
producer	1	primary industry	1,931	9,037	1,727	973	4	13,672	2,756	16,428
	2-16	secondary industry	4,694	465,328	207,720	17,972	139	695,852	178,471	874,323
	17-25	tertiary industry (except tourism)	1,392	44,147	52,254	6,450	36	104,278	130,752	235,030
	26	tourism (except Korean/Japanese)	829	15,374	15,974	2,199	0	34,375	32,686	67,061
	27	tourism (by Korean/Japanese)	1	40	42	0	0	83	94	177
	total		8,846	533,925	277,716	27,594	179	848,260	344,759	1,193,019

Table 6. Korea CO_2 emission-based partial I-O table with tourism industries in 2010

Korean I-O table (27 sectors, thousand ton)			producers as consumers						final demand	total
	industry		1	2-16	17-25	26	27	total		
producer	1	primary industry	1,913	18,637	3,566	884	24	25,024	4,269	29,293
	2-16	secondary industry	2,819	495,434	71,626	6,425	185	576,489	-128,421	448,068
	17-25	tertiary industry (except tourism)	546	19,379	36,858	1,473	94	58,351	59,535	117,885
	26	tourism (except Korean/Japanese)	72	1,458	2,511	189	0	4,230	3,620	7,850
	27	tourism (by Korean/Japanese)	2	80	76	0	0	159	158	317
	total		5,353	534,987	114,637	8,971	304	664,252	-60,839	603,414

Table 7. Total requirements matrix of $\mathbf{A}^J$

	industry	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	SD	SDI
1	agriculture, forestry and fishing	1.136	0.000	0.560	0.036	0.016	0.001	0.002	0.007	0.002	0.006	0.013	0.015	0.001	0.034	0.021	0.005	0.019	0.007	0.007	0.018	0.006	0.057	0.016	0.142	0.004	0.080	0.000	2.213	1.103
2	mining	0.017	1.003	0.035	0.022	0.110	0.543	0.032	0.360	0.036	0.048	0.060	0.106	0.004	0.034	0.112	0.295	0.076	0.012	0.064	0.026	0.035	0.091	0.045	0.047	0.009	0.047	0.000	3.270	1.630
3	food and beverage	0.048	0.000	1.183	0.004	0.012	0.001	0.001	0.005	0.002	0.004	0.008	0.009	0.001	0.008	0.008	0.003	0.014	0.006	0.005	0.013	0.004	0.040	0.011	0.137	0.002	0.041	0.000	1.570	0.782
4	pulp, paper and wood products	0.034	0.001	0.103	1.347	0.073	0.002	0.020	0.031	0.012	0.027	0.066	0.060	0.005	0.121	0.266	0.024	0.124	0.036	0.039	0.125	0.025	0.122	0.091	0.057	0.078	0.050	0.000	2.941	1.466
5	chemical products	0.031	0.001	0.045	0.027	1.378	0.003	0.012	0.029	0.009	0.023	0.059	0.082	0.004	0.161	0.037	0.014	0.023	0.010	0.009	0.026	0.012	0.331	0.037	0.028	0.009	0.048	0.000	2.448	1.220
6	petroleum and coal products	0.026	0.005	0.041	0.015	0.160	1.054	0.012	0.110	0.015	0.025	0.036	0.060	0.003	0.037	0.093	0.076	0.092	0.013	0.103	0.028	0.037	0.100	0.045	0.044	0.011	0.066	0.000	2.309	1.150
7	ceramic products	0.007	0.000	0.030	0.017	0.033	0.002	1.087	0.075	0.015	0.047	0.154	0.146	0.024	0.026	0.455	0.020	0.025	0.007	0.010	0.015	0.014	0.049	0.062	0.022	0.010	0.018	0.000	2.371	1.181
8	steel and non-ferrous metal	0.003	0.001	0.018	0.012	0.017	0.001	0.007	1.872	0.156	0.176	0.163	0.345	0.010	0.023	0.165	0.008	0.016	0.005	0.010	0.009	0.013	0.022	0.045	0.009	0.007	0.013	0.000	3.125	1.557
9	metalic products	0.008	0.002	0.072	0.021	0.036	0.003	0.010	0.018	1.065	0.125	0.102	0.113	0.009	0.034	0.495	0.019	0.047	0.008	0.015	0.017	0.029	0.036	0.066	0.028	0.007	0.024	0.000	2.407	1.199
10	machinery	0.001	0.000	0.002	0.002	0.002	0.000	0.001	0.003	0.002	1.196	0.019	0.044	0.002	0.004	0.019	0.004	0.009	0.004	0.003	0.007	0.003	0.007	0.081	0.005	0.003	0.004	0.000	1.427	0.711
11	electric machinery	0.001	0.000	0.003	0.001	0.003	0.000	0.001	0.003	0.002	0.039	1.265	0.091	0.013	0.005	0.018	0.003	0.010	0.004	0.004	0.010	0.009	0.010	0.040	0.004	0.002	0.006	0.000	1.548	0.772
12	transport machinery	0.003	0.000	0.004	0.001	0.002	0.001	0.001	0.002	0.001	0.002	0.003	1.721	0.000	0.002	0.005	0.002	0.007	0.003	0.023	0.005	0.025	0.006	0.058	0.003	0.002	0.011	0.000	1.894	0.944
13	precision machinery	0.001	0.000	0.002	0.001	0.004	0.000	0.001	0.002	0.001	0.027	0.014	0.017	1.010	0.003	0.004	0.002	0.024	0.002	0.001	0.006	0.006	0.091	0.013	0.005	0.001	0.003	0.000	1.240	0.618
14	other engineering products	0.013	0.001	0.057	0.026	0.039	0.002	0.007	0.045	0.010	0.041	0.085	0.150	0.008	1.165	0.060	0.024	0.077	0.042	0.018	0.075	0.047	0.092	0.091	0.037	0.019	0.038	0.000	2.271	1.132
15	construction	0.003	0.000	0.006	0.004	0.009	0.001	0.003	0.012	0.004	0.006	0.011	0.012	0.001	0.006	1.012	0.028	0.022	0.007	0.011	0.013	0.016	0.027	0.072	0.011	0.002	0.008	0.000	1.307	0.651
16	essential utilities	0.011	0.002	0.042	0.029	0.057	0.011	0.013	0.089	0.018	0.033	0.055	0.080	0.004	0.038	0.049	1.072	0.104	0.017	0.038	0.039	0.055	0.135	0.051	0.094	0.010	0.041	0.000	2.186	1.089
17	commerce	0.009	0.001	0.039	0.014	0.020	0.002	0.004	0.026	0.008	0.025	0.036	0.052	0.003	0.024	0.045	0.010	1.037	0.008	0.009	0.020	0.011	0.055	0.033	0.039	0.007	0.017	0.000	1.555	0.775
18	fainance and insurance	0.015	0.003	0.037	0.017	0.033	0.006	0.009	0.039	0.012	0.031	0.041	0.057	0.005	0.033	0.066	0.032	0.198	1.115	0.049	0.054	0.018	0.089	0.236	0.045	0.073	0.037	0.000	2.350	1.171
19	transport	0.014	0.001	0.046	0.019	0.034	0.018	0.010	0.049	0.013	0.026	0.044	0.065	0.003	0.042	0.070	0.024	0.077	0.023	1.087	0.037	0.030	0.063	0.043	0.040	0.010	0.052	0.000	1.940	0.967
20	telecommunication	0.005	0.001	0.016	0.008	0.025	0.002	0.004	0.018	0.007	0.020	0.035	0.032	0.002	0.017	0.036	0.025	0.120	0.066	0.020	1.146	0.043	0.084	0.166	0.039	0.010	0.021	0.000	1.966	0.980
21	public services	0.002	0.000	0.003	0.001	0.001	0.000	0.001	0.003	0.001	0.002	0.003	0.003	0.000	0.002	0.005	0.002	0.008	0.002	0.002	0.005	1.001	0.009	0.007	0.003	0.041	0.002	0.000	1.108	0.552
22	medical and social welfare services	0.002	0.000	0.006	0.003	0.032	0.001	0.003	0.011	0.003	0.016	0.050	0.047	0.003	0.011	0.008	0.007	0.009	0.003	0.003	0.011	0.003	1.025	0.011	0.005	0.003	0.006	0.000	1.280	0.638
23	real estate and business services	0.006	0.001	0.022	0.009	0.025	0.003	0.005	0.020	0.007	0.021	0.036	0.044	0.003	0.019	0.058	0.027	0.100	0.048	0.030	0.078	0.025	0.073	1.094	0.032	0.007	0.023	0.000	1.816	0.905
24	retail sarvices	0.003	0.001	0.012	0.006	0.015	0.002	0.003	0.013	0.005	0.012	0.021	0.021	0.001	0.013	0.021	0.010	0.042	0.018	0.012	0.048	0.012	0.046	0.038	1.029	0.003	0.013	0.000	1.419	0.707
25	others	0.039	0.002	0.073	0.026	0.037	0.005	0.016	0.067	0.018	0.059	0.068	0.073	0.005	0.042	0.119	0.041	0.196	0.058	0.058	0.136	0.032	0.219	0.165	0.070	1.010	0.050	0.000	2.683	1.337
26	tourism (except Korean)	0.018	0.001	0.059	0.016	0.046	0.008	0.007	0.030	0.008	0.021	0.039	0.054	0.003	0.048	0.047	0.016	0.057	0.020	0.043	0.037	0.021	0.074	0.042	0.047	0.008	1.041	0.000	1.810	0.902
27	tourism (by Korean)	0.009	0.001	0.032	0.011	0.037	0.003	0.005	0.021	0.006	0.027	0.057	0.069	0.004	0.047	0.038	0.015	0.052	0.023	0.026	0.046	0.021	0.072	0.054	0.035	0.007	0.009	1.000	1.728	0.861
	PD	1.465	1.027	2.546	1.693	2.258	1.677	1.274	2.960	1.439	2.088	2.541	3.567	1.129	1.997	3.331	1.810	2.584	1.569	1.697	2.051	1.555	3.023	2.716	2.057	1.354	1.768	1.006		
	PDI	0.730	0.512	1.269	0.844	1.125	0.836	0.635	1.475	0.717	1.040	1.266	1.778	0.563	0.995	1.660	0.902	1.288	0.782	0.845	1.022	0.775	1.506	1.353	1.025	0.675	0.881	0.501		

Table 8. Total requirements matrix of $\mathbf{A}^K$

	industry	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	SD	SDI
1	agriculture, forestry and fishing	1.107	0.000	0.600	0.030	0.068	0.003	0.004	0.011	0.006	0.008	0.025	0.015	0.002	0.031	0.021	0.002	0.019	0.010	0.010	0.007	0.015	0.029	0.031	0.210	0.087	0.053	0.002	2.405	1.159
2	mining	0.016	1.002	0.026	0.013	0.224	0.641	0.048	0.329	0.049	0.048	0.115	0.081	0.005	0.029	0.086	0.265	0.045	0.015	0.092	0.012	0.017	0.048	0.047	0.047	0.021	0.040	0.001	3.363	1.620
3	food and beverage	0.098	0.000	1.224	0.006	0.033	0.003	0.003	0.010	0.005	0.007	0.019	0.011	0.001	0.020	0.013	0.002	0.018	0.010	0.010	0.008	0.012	0.021	0.032	0.254	0.093	0.050	0.002	1.968	0.948
4	pulp, paper and wood products	0.037	0.001	0.105	1.479	0.120	0.007	0.029	0.036	0.035	0.044	0.159	0.071	0.008	0.204	0.140	0.005	0.104	0.017	0.016	0.014	0.019	0.036	0.061	0.130	0.120	0.019	0.002	3.018	1.454
5	chemical products	0.026	0.001	0.038	0.017	1.502	0.019	0.012	0.027	0.023	0.032	0.178	0.114	0.011	0.062	0.053	0.010	0.015	0.005	0.013	0.005	0.009	0.087	0.027	0.035	0.023	0.008	0.000	2.352	1.133
6	petroleum and coal products	0.020	0.002	0.028	0.011	0.307	1.048	0.024	0.101	0.026	0.029	0.080	0.056	0.004	0.027	0.062	0.032	0.047	0.012	0.137	0.009	0.014	0.044	0.032	0.041	0.019	0.035	0.001	2.250	1.084
7	ceramic products	0.005	0.000	0.023	0.006	0.058	0.004	1.176	0.090	0.017	0.033	0.427	0.074	0.010	0.016	0.468	0.005	0.009	0.005	0.005	0.006	0.012	0.013	0.033	0.020	0.017	0.004	0.000	2.537	1.222
8	steel and non-ferrous metal	0.003	0.000	0.007	0.002	0.033	0.005	0.009	1.843	0.188	0.162	0.200	0.225	0.009	0.019	0.173	0.004	0.005	0.003	0.008	0.003	0.011	0.007	0.016	0.011	0.007	0.003	0.000	2.960	1.426
9	metalic products	0.006	0.001	0.027	0.006	0.056	0.016	0.012	0.035	1.160	0.139	0.150	0.190	0.014	0.042	0.295	0.007	0.012	0.007	0.013	0.004	0.016	0.012	0.027	0.024	0.019	0.006	0.000	2.297	1.107
10	machinery	0.003	0.001	0.006	0.003	0.029	0.007	0.004	0.021	0.015	1.186	0.062	0.114	0.002	0.007	0.054	0.006	0.005	0.002	0.007	0.002	0.031	0.007	0.011	0.009	0.005	0.002	0.000	1.601	0.772
11	electric machinery	0.001	0.000	0.002	0.001	0.005	0.001	0.001	0.007	0.003	0.028	1.402	0.045	0.009	0.003	0.030	0.004	0.006	0.004	0.004	0.011	0.004	0.005	0.024	0.008	0.005	0.002	0.000	1.612	0.777
12	transport machinery	0.002	0.001	0.003	0.001	0.006	0.002	0.003	0.004	0.002	0.007	0.007	1.321	0.000	0.002	0.005	0.001	0.007	0.002	0.033	0.002	0.016	0.005	0.007	0.024	0.007	0.008	0.000	1.480	0.713
13	precision machinery	0.003	0.000	0.004	0.001	0.012	0.005	0.002	0.009	0.006	0.067	0.134	0.093	1.065	0.003	0.021	0.008	0.007	0.003	0.006	0.005	0.010	0.067	0.028	0.009	0.008	0.002	0.000	1.576	0.760
14	other engineering products	0.008	0.000	0.014	0.008	0.038	0.003	0.004	0.010	0.007	0.010	0.032	0.074	0.002	1.237	0.030	0.003	0.026	0.020	0.009	0.011	0.016	0.035	0.039	0.045	0.042	0.006	0.000	1.731	0.834
15	construction	0.001	0.000	0.001	0.000	0.004	0.001	0.001	0.003	0.001	0.002	0.008	0.003	0.000	0.001	1.003	0.004	0.005	0.003	0.002	0.003	0.014	0.005	0.040	0.005	0.001	0.001	0.000	1.113	0.536
16	essential utilities	0.014	0.002	0.031	0.026	0.117	0.035	0.023	0.197	0.046	0.045	0.145	0.079	0.007	0.046	0.060	1.203	0.073	0.034	0.032	0.029	0.030	0.093	0.115	0.092	0.030	0.019	0.001	2.623	1.264
17	commerce	0.020	0.001	0.053	0.014	0.089	0.009	0.012	0.058	0.027	0.049	0.131	0.089	0.009	0.036	0.069	0.006	1.045	0.013	0.016	0.051	0.015	0.034	0.036	0.062	0.036	0.014	0.001	1.994	0.961
18	fainance and insurance	0.013	0.001	0.025	0.009	0.056	0.013	0.010	0.053	0.019	0.032	0.088	0.050	0.005	0.026	0.055	0.009	0.068	1.317	0.041	0.022	0.033	0.058	0.164	0.048	0.017	0.015	0.001	2.248	1.083
19	transport	0.011	0.003	0.040	0.014	0.072	0.017	0.027	0.067	0.022	0.031	0.074	0.045	0.004	0.026	0.045	0.005	0.101	0.022	1.156	0.013	0.018	0.023	0.038	0.030	0.017	0.039	0.001	1.966	0.947
20	telecommunication	0.011	0.001	0.023	0.008	0.048	0.010	0.009	0.035	0.015	0.026	0.085	0.043	0.005	0.023	0.042	0.008	0.182	0.100	0.025	1.178	0.029	0.044	0.182	0.057	0.034	0.015	0.002	2.240	1.079
21	public services	0.001	0.000	0.001	0.000	0.001	0.000	0.000	0.001	0.000	0.001	0.001	0.001	0.000	0.001	0.001	0.000	0.002	0.001	0.011	0.000	1.001	0.001	0.002	0.001	0.005	0.002	0.000	1.037	0.500
22	medical and social welfare services	0.002	0.000	0.004	0.001	0.010	0.002	0.001	0.006	0.003	0.004	0.008	0.006	0.001	0.003	0.010	0.002	0.007	0.004	0.003	0.002	0.004	1.020	0.011	0.008	0.003	0.002	0.000	1.130	0.545
23	real estate and business services	0.007	0.001	0.024	0.007	0.066	0.012	0.009	0.047	0.017	0.037	0.165	0.063	0.010	0.024	0.069	0.014	0.081	0.062	0.036	0.042	0.024	0.041	1.100	0.058	0.019	0.015	0.001	2.053	0.989
24	retail sarvices	0.006	0.001	0.011	0.004	0.026	0.005	0.005	0.020	0.011	0.015	0.037	0.020	0.002	0.014	0.026	0.003	0.039	0.025	0.015	0.021	0.027	0.046	0.082	1.052	0.219	0.007	0.001	1.741	0.839
25	others	0.024	0.003	0.042	0.015	0.094	0.018	0.017	0.073	0.040	0.055	0.129	0.069	0.009	0.048	0.080	0.013	0.142	0.090	0.043	0.045	0.108	0.173	0.253	0.134	1.038	0.022	0.002	2.779	1.339
26	tourism(except Japanese)	0.017	0.002	0.043	0.010	0.079	0.015	0.018	0.054	0.019	0.028	0.068	0.042	0.004	0.024	0.042	0.007	0.072	0.023	0.094	0.017	0.023	0.036	0.052	0.052	0.114	1.029	0.001	1.983	0.955
27	tourism(by Japanese)	0.015	0.001	0.041	0.011	0.071	0.009	0.011	0.049	0.023	0.039	0.106	0.067	0.007	0.030	0.056	0.006	0.051	0.021	0.028	0.039	0.022	0.040	0.054	0.059	0.117	0.007	1.001	1.979	0.954
	PD	1.477	1.024	2.448	1.702	3.224	1.910	1.474	3.198	1.788	2.165	4.039	3.060	1.207	2.006	3.011	1.632	2.195	1.831	1.865	1.560	1.550	2.032	2.542	2.525	2.123	1.427	1.022		
	PDI	0.712	0.493	1.179	0.820	1.553	0.921	0.710	1.541	0.862	1.043	1.946	1.474	0.582	0.966	1.451	0.786	1.058	0.882	0.899	0.752	0.747	0.979	1.225	1.217	1.023	0.688	0.493		

Table 9. PDI and SDI in monetary production and CO_2 emission base in Japan and Korea

	industry	PDI_M_J	PDI_C_J	PDI_M_K	PDI_C_K	SDI_M_J	SDI_C_J	SDI_M_K	SDI_C_K
1	agriculture, forestry and fishing	0.730	0.549	0.712	1.494	1.103	0.635	1.159	1.602
2	mining	0.512	0.655	0.493	3.043	1.630	1.598	1.620	6.587
3	food and beverage	1.269	0.307	1.179	0.373	0.782	0.145	0.948	0.198
4	pulp, paper and wood products	0.844	0.772	0.820	0.995	1.466	1.027	1.454	1.163
5	chemical products	1.125	1.015	1.553	0.891	1.220	0.844	1.133	0.428
6	petroleum and coal products	0.836	1.087	0.921	0.528	1.150	1.147	1.084	0.410
7	ceramic products	0.635	3.866	0.710	0.327	1.181	5.514	1.222	0.371
8	steel and non-ferrous metal	1.475	3.963	1.541	1.298	1.557	3.207	1.426	0.791
9	metalic products	0.717	0.159	0.862	3.267	1.199	0.204	1.107	2.766
10	machinery	1.040	0.080	1.043	0.480	0.711	0.042	0.772	0.234
11	electric machinery	1.266	0.155	1.946	0.350	0.772	0.072	0.777	0.092
12	transport machinery	1.778	0.197	1.474	0.265	0.944	0.080	0.713	0.084
13	precision machinery	0.563	0.125	0.582	1.718	0.618	0.105	0.760	1.478
14	other engineering products	0.995	0.123	0.966	0.445	1.132	0.107	0.834	0.253
15	construction	1.660	0.254	1.451	0.209	0.651	0.076	0.536	0.051
16	essential utilities	0.902	8.514	0.786	6.753	1.089	7.883	1.264	7.154
17	commerce	1.288	0.151	1.058	0.455	0.775	0.069	0.961	0.272
18	fainance and insurance	0.782	0.023	0.882	0.163	1.171	0.026	1.083	0.132
19	transport	0.845	2.404	0.899	0.882	0.967	2.107	0.947	0.612
20	telecommunication	1.022	0.042	0.752	0.738	0.980	0.031	1.079	0.698
21	public services	0.775	0.200	0.747	0.213	0.552	0.109	0.500	0.094
22	medical and social welfare services	1.506	0.251	0.979	0.267	0.638	0.082	0.545	0.098
23	real estate and business services	1.353	0.049	1.225	0.172	0.905	0.025	0.989	0.092
24	retail sarvices	1.025	0.260	1.217	0.536	0.707	0.138	0.839	0.244
25	others	0.675	0.222	1.023	0.451	1.337	0.337	1.339	0.389
26	tourism (except Korean)	0.881	1.295	0.688	0.468	0.902	1.016	0.955	0.429
27	tourism (by Korean)	0.501	0.283	0.493	0.219	0.861	0.372	0.954	0.280

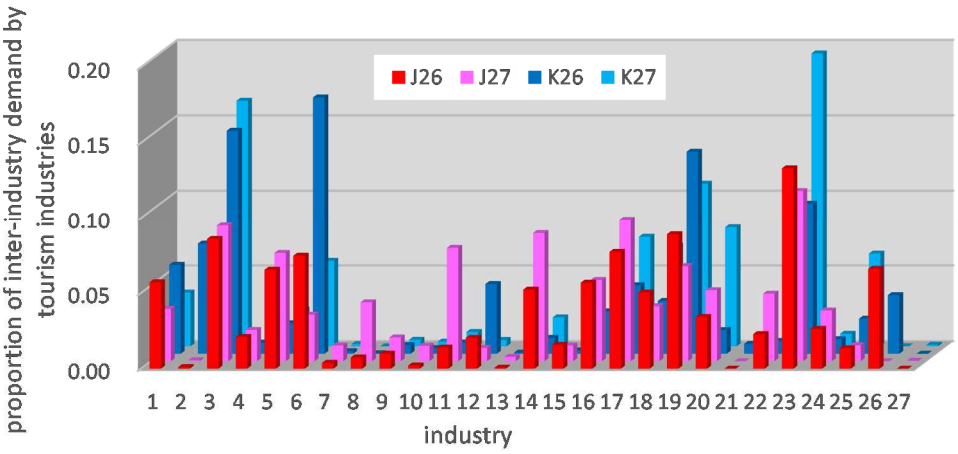

Figure 1. Proportion of inter-industry demand by tourism industries

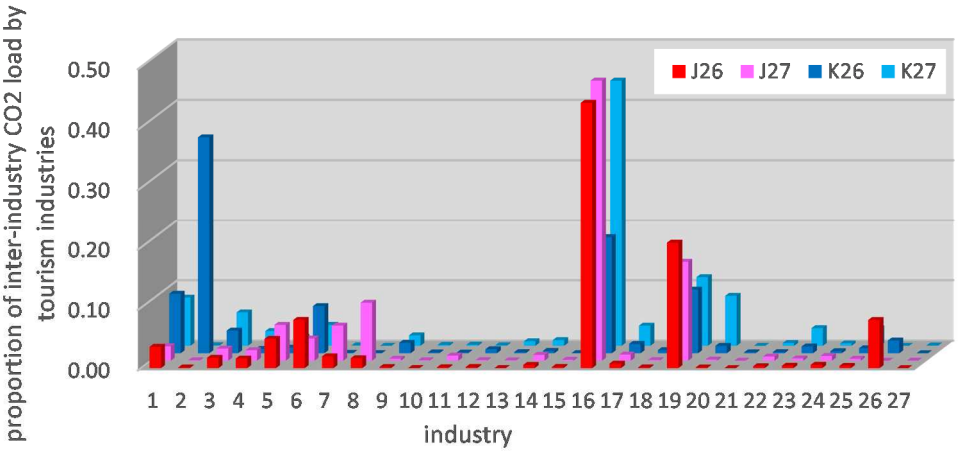

Figure 2. Proportion of inter-industry CO_2 load by tourism industries