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Repercussion effects of consumption by domestic tourists in Tokyo and Kyoto estimated using a regional waste input–output approach

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Abstract

As the economic importance of tourism increases, it is important to consider the effects that tourism has on the environment in the affected regions of the country. In our study, we selected two popular tourist destinations in Japan, Tokyo and Kyoto, for our case studies on the repercussion effects induced by the economic and environmental activities of visitors. As waste generation and landfilling are two of the most important environmental loads in Japan, a regional waste input–output approach was considered to be an effective method for evaluating these issues. The estimated direct effects of visitors' consumption activities in Tokyo and Kyoto amounted to approximately 434 billion yen and 209 billion yen, respectively. The tendencies of visitor consumption in both prefectures were similar, as were the repercussion effects on the production value, which accounted for approximately 434 billion yen and approximately 260 billion yen in Tokyo and Kyoto, respectively. Value added amounted to 276 billion yen in Tokyo and approximately 108 billion yen in Kyoto. Waste generation induced by tourists in Kyoto accounted for approximately 22,690 t, which was similar to that induced in Tokyo at 20,655 t. Regarding the repercussion effect of the area of landfill consumption, Kyoto tourists consumed 1479 m^2 of landfill in contrast to 7369 m^2 in Tokyo. The results of our study reveal the importance of considering the regional characteristics of the target region when conducting environmentally sound campaigns directed at stimulating tourism.

Keywords: Regional waste input–output approach, Tourism in Tokyo, Tourism in Kyoto

1 Background

The importance of tourism around the world is increasing. In 2014, direct, indirect, and induced economic effects of tourism amounted to 9% of global GDP (United Nations World Tourism Organization (UNWTO), Tourism Highlights 2015). Moreover, the contribution of newly developing countries in the tourism market to this figure increased from 30 to 45% over the last 25 years, which means that tourism has been effective in improving economic well-being in these countries (UNWTO 2015). Hardy et al. (2002) reported that the three key factors in the development of sustainable tourism are environment vision, economic development, and community involvement. More recent

studies have begun to examine the environmental loads induced by tourism (Ko 2005; Kytzia et al. 2011; Cernat and Gourdon 2012), although most early tourism studies evaluated only the economic benefits associated with tourism (Archer and Fletcher 1996; Fletcher 1989; Dwyer et al. 2000, 2004; Cai et al. 2006).

Investigating the economic and environmental effects of tourism is important, particularly in certain regions, because the priority associated with reducing environmental loads differs between regions. Economic repercussion effects are not usually limited to the target tourist site but also bring about economic benefits to other areas. However, an increase in tourism is also accompanied by an increase in waste, which is inevitably treated within the target tourist site (Lenzen 2008). Most Japanese tourist sites need to treat increased waste due to tourism because each municipality in Japan must basically treat general waste within the municipality. Moreover, it is extremely difficult to find new landfill sites in Japanese metropolitan cities, and one of the top priorities in these cities is to reduce landfill waste (Nakamura and Kondo 2002b; Sasao 2004; Tsukui et al. 2015). As such, waste generation and landfilling induced by tourists are crucial issues for sustainable tourism.

In a tourism study that considered the environment, Cernat and Gourdon (2012) developed the sustainable tourism-benchmarking tool (STBT), which they used to assess the sustainability of tourism using quantitative indicators initially proposed by Ko (2005) and Fernandez and Rivero (2009). Cernat and Gourdon (2012) conducted an input–output analysis to clarify economic linkages and leakages, which they used to investigate a variety of indicators, such as natural and cultural assets, economic activities, infrastructure, and environmental loads, including GHG emissions. Sun (2014) evaluated GHG emissions in Taiwan using the production and consumption accounting principles applied to the tourism satellite account (TSA) and environmentally extended input–output (EEIO) models. However, these authors did not quantitatively clarify the repercussion effects associated with waste generation or landfilling due to tourism. Other regional-level tourist studies have also examined the effect of tourism on waste generation. Johnson and Moore (1993) evaluated the impact of residents' and visitors' whitewater recreation activities on the Klamath River in Oregon, USA. Frechtling and Horvath (1999) estimated the direct, indirect, and induced impacts of tourism consumption on production and value added around Washington DC using the Regional Input–Output Modeling System (RIMSII). Specifically, they estimated the multiplier effects associated with tourist expenditure on the local regional economy. However, neither of these studies investigated the environmental loads induced by tourism.

Our study examines the impact of tourist consumption on tourist attractions in urban areas within the context of waste treatment using a regional waste input–output (WIO) approach. As mentioned previously, the scarcity of landfill sites in large cities is one of the most serious environmental problems affecting these areas. We therefore selected two popular metropolitan tourist destinations in Japan, Tokyo and Kyoto, as target regions for our case studies. We considered the effects of domestic tourism in these target regions, focusing on tourists from other parts of Japan. In the case of Tokyo, we used the interregional WIO (IR-WIO) table for Tokyo compiled in 2000 by Tsukui et al. (2015) to analyze the economic and environmental effects of domestic tourists from other regions. We clarified the tourism consumption in Kyoto and Tokyo as

direct effects and estimated the resulting indirect effects in both regions. In our study, we define the combined direct and indirect effects as the repercussion effects. The WIO analysis (WIOA) developed by Nakamura and Kondo (2002a) is one of the most effective approaches for evaluating the interdependence between the flow of goods and waste. Case studies employing the WIOA have been conducted in a variety of countries and regions, including Japan (Nakamura and Kondo 2009), Australia (Reynolds et al. 2014; Fry et al. 2015), Taiwan (Liao et al. 2015), France (Beylot et al. 2016), and the UK (Salemdeeb et al. 2016). However, none of these studies evaluated the repercussion effects of tourism. For the Kyoto case study, we used the regional WIO table for Kyoto compiled in 2000 by Ichikawa et al. (2011). We then compared estimates of the direct and indirect effects of domestic tourism in these two regions on production value, value added, waste generation, waste transportation, landfilling, and GHG emissions.

The remainder of the present paper is structured as follows. Section 2 describes the regional WIO models used in the analysis. Section 3 presents the expenditure results estimated using a non-survey method for domestic tourists in Tokyo and Kyoto. Section 4 presents a comparison between the two regions with estimates of the repercussion effects for each region. Finally, conclusions and issues for future consideration are presented in Sect. 5.

2 IR-WIO analysis model and tables

In our study, we compared the repercussion effects for Tokyo and Kyoto in terms of domestic tourist expenditure using an IR-WIO approach. As mentioned in Sect. 1, the advantage of using an IR-WIO analysis to analyze the repercussion effects of consumption in a specific region is that economic and environmental effects, such as waste generation, transportation, and landfilling, can be considered simultaneously.

In our study, we applied the same two-region IR-WIO model that we applied in Tsukui et al. (2015). Briefly, the model is based on Kagawa and Kondo (2007) and Kagawa et al. (2007), which is an expansion of the conventional regional IO model of Isard (1951) and the WIO model of Nakamura and Kondo (2002a). A detailed description of this model has been provided in Tsukui et al. (2015). We estimated the repercussion effects of visitors' consumption on industrial sectors, waste generation, waste treatment sectors, and the environmental loads of each sector in Tokyo and Kyoto, respectively. Environmental loads, such as GHG emissions, can be estimated by multiplying generation coefficient matrices.

For the case study of Tokyo, we used an IR-WIO table for Tokyo for the year 2000, which we compiled in a previous study (Tsukui and Nakamura 2009; Tsukui et al. 2010, 2011a, b, c, 2015) and which was based on "The Interregional Input–Output Table in the Year 2000 in Tokyo" published by Tokyo Metropolitan General Affairs (TMGA 2007). In the Kyoto case study, we used a regional WIO table for the year 2000 in Kyoto (KWIOT2000), which was compiled by Ichikawa et al. (2011). To compile this table, Ichikawa et al. used the "Year 2000 Kyoto Prefecture Input–Output Table," published by Kyoto Prefecture (2004). We also referred to the industrial waste data published by the Ministry of the Environment Secretariat, Waste/Recycling Measures Department (2002) and NEDO (2005) for the estimation of waste generation from industrial sectors in both Tokyo and Kyoto. In order to apply the IR-WIO model described in Tsukui et al. (2015)

to our study, we extended the KWIOT2000 to produce a two-region IR-WIO table (KIR-WIOT2000) using Nakamura (2010). In the WIOTs for both Tokyo and Kyoto, estimating the activities of waste treatment sectors was based on Matsuto (2005). Estimates of the GHG emissions for each sector were based on the Embodied Energy and Emission Intensity Data for Japan Using Input–Output Tables (3EID) database (Nansai et al. 2008).

Since we had already developed a multi-regional WIO table for 47 prefectures of Japan (47WIOT) (Tsukui et al. 2014), we herein compare the advantages of each table before adopting a two-region IO framework in the case study. Using the 47WIOT, we can confirm the consistency of the data sets for investigating both Tokyo and Kyoto. However, the 47WIOT has only 46 industrial sectors and the two important sectors for investigating tourism, "Hotels and other lodging places" and "Eating and drinking places," are treated as belonging to the same sector, "Other personal services." Upon careful consideration of the advantages and disadvantages of the 47WIOT and WIO tables for Tokyo and Kyoto, we decided to adopt the WIO tables for use in our study.

3 Domestic tourism consumption in Tokyo and Kyoto Prefectures

Before presenting the results for the repercussion effects associated with tourist consumption in Tokyo and Kyoto, in this section, we clarify the differences in tourist expenditure between Tokyo and Kyoto.

We defined "tourists" as visitors from regions in Japan outside the target region who stayed overnight. While the primary objective of overnight visitors is tourism and shopping, the main purpose of day visitors (i.e., shopping or tourism) is more difficult to clarify.

For the analysis of Tokyo, we used the tourist expenditure data specified in the inter-regional input–output table (IR-IOT) for Tokyo 2000 (TMGA 2007), which we used to estimate the goods and services sector of the IR-WIO table for Tokyo in 2000 (Tsukui et al. 2015).

However, in the case of Kyoto, there was no category in the regional IO table for Kyoto 2000 showing consumption by visitors from other regions staying overnight, which was the basis for the WIO table for Kyoto compiled in our study, even in the most detailed version of the table, which included 104 sectors. We considered that the expenditure of visitors was incorporated into the "Household consumption expenditure" of the final consumption sector in the regional IOT of Kyoto. Thus, tourist consumption in Kyoto by residents of other regions was estimated by non-survey-based methods, as described in Sect. 3.2.

3.1 Consumption by overnight stays by domestic tourists in Tokyo

As mentioned in Sect. 3, estimates of the consumption by tourists staying overnight in Tokyo were used in the IR-IOT for Tokyo in 2000 (TMGA 2007). In the final demand sectors of the IR-IOT for Tokyo, "P9121-21 Expenditure by residents of other prefectures (commuting)," "P9121-22 Expenditure by residents of other prefectures (daytrip shopping excursions)," and "P9121-23 Expenditure by residents of other prefectures (overnight-stay shopping excursions)" were taken to correspond to the visitors' expenditure. We used "P9121-23" to indicate the expenditure of tourists from outside the target prefecture. Table 1 shows the expenditure by the visitors (i.e., "P9121-23") on individual

Table 1 Consumption amounts induced by domestic tourists in Tokyo (TMGA 2007) (unit: million yen)

Code	Sector Classification for IR-WIO table for Tokyo in 2000	Overnight-stay tourist consumption by residents of other regions	Code	Sector Classification for IR-WIO table for Tokyo in 2000	Overnight-stay tourist consumption by residents of other regions
1	Crop cultivation	124	73	Electronic computing equipment and accessory equipment	223
3	Agricultural services	33	77	Electronic components	6
5	Fisheries	3	79	Other electrical equipments	9
12	Foods	1860	84	Precision instruments	606
13	Beverage	606	85	Miscellaneous manufacturing products	3197
15	Tobacco	448	95	Wholesale trade	486
16	Textile products	2	96	Retail trade	456
17	Wearing apparel and other textile products	3587	97	Financial and insurance services	1412
18	Timber and wooden products	3	101	Rail transport	42,087
19	Furniture and fixtures	18	102	Railway transport	22,298
21	Paper and paperboard	1	104	Road transport (except transport by private cars)	33
23	Paper products	255	105	Air transport	7817
24	Publishing and printing	2805	108	Services relating to transport	2161
31	Medicaments	9	109	Communication	596
32	Chemical final products (excluding medicaments)	332	110	Broadcasting	591
33	Petroleum refinery products	47	112	Education	732
36	Plastic products	6	118	Other public services	1891
37	Rubber products	35	120	Goods rental and leasing services	261
38	Leather, fur skins, and miscellaneous leather products	1020	121	Repair of motor vehicles	3406
39	Glass and glass products	4	124	Amusement and recreational services	33,436
43	Pottery, china, and earthenware	9	125	Eating and drinking places	79,124
57	Other non-ferrous metals	65	126	Hotels and other lodging places	204,251
72	Household electronic and electric appliances	442	127	Other personal services	17,241

industrial products in Tokyo. In Sect. 4, the repercussion effects of visitors from regions other than Tokyo staying overnight are estimated based on the results of direct effects shown in Table 1.

3.2 Estimated consumption by overnight stays by domestic tourists to Kyoto Prefecture

We estimated the consumption induced by overnight stays by domestic tourists visiting Kyoto Prefecture based on the Kyoto City survey. The center of tourism in Kyoto Prefecture is the city of Kyoto. In 2000, which is the reference year for our study, consumption by tourists in Kyoto City comprised 90% of the tourist consumption in the entire prefecture (City of Kyoto 2011). Kyoto City published the "Kyoto City Annual Tourism Survey Report" based on a random-sample questionnaire survey (City of Kyoto 2011), which examined aspects such as the type of transportation facilities used, number of day/overnight tourists, point of departure, duration of stay, breakdown of tourist consumption amounts, and souvenir purchases. In our study, we assumed that the consumption activities of tourists to Kyoto Prefecture were equivalent to those for Kyoto City. In this way, we expanded our analysis to Kyoto Prefecture in its entirety (Table 2).

The method used to estimate the number of overnight stays by domestic tourists in Kyoto Prefecture (i.e., Kyoto City) was as follows. The "2001 Kyoto City Annual Tourism Survey Report" (Kyoto City 2002) was published by Kyoto City in 2002, which is very close to the base year of our study (i.e., 2000). The number of foreign visitors was deducted from the total of 9423 million tourists who stayed overnight in Kyoto. The number of domestic tourists visiting Kyoto Prefecture was estimated to be 7.9 million people, based on the point of departure information contained in the "2001 Kyoto City Annual Tourism Survey Report."

In the Kyoto City survey, tourist consumption was classified as "Travel expenses within the city," "Lodging expenses," "Souvenir expenses," "Dining expenses," or "Other expenses." With regard to "Travel expenses within the city," the Kyoto City survey revealed that the percentages of tourists using Japan Railways (JR), private rail, buses, and passenger vehicles were 33.3, 27.6, 9.0, and 30.1%, respectively. The statistics for JR and private rail were used to estimate the demand for "78 Rail transport" in KIRWIOT2000, and the statistics for buses were used to estimate the demand for "79 Road transport." According to the Kyoto City survey, private automobiles, rental cars, and taxis/hired cars were also used, and these means of transportation were grouped under "Automobile." Since these categories were not specified in the Kyoto City survey, their proportions were estimated by referencing the "Travel and Tourism Consumption Trends Survey" [Ministry of Land, Infrastructure, Transport and Tourism (MLITT) 2004]. As a result, we hypothesized that "Automobile" could be subdivided as follows: private automobile, 95.6%; rental car, 3.9%; and taxis/hired cars, 0.6%.

We also referred to the "Travel and Tourism Consumption Trends Survey" (MLITT 2004) to estimate the visitors' expenditure per person in Kyoto. We estimated "Travel expenses within the city" using the Kyoto City survey data by multiplying the number of users of each transportation mode by the unit purchase price provided by "Travel and Tourism Consumption Trends Survey" and then allotting the "Travel expenses within the city" to the corresponding industrial sectors in Table 2. "Lodging expenses" were taken as the demand for "101 Inns and other lodgings," and "Dining expenses" were taken as "100 Eating and drinking places." "Souvenir expenses" were estimated after referencing the standard classifications used in the national IO table compiled by the Ministry of Internal Affairs and Communications (MIC 2004), based on survey results concerning souvenir purchase conditions in Kyoto City and the research of Hamada (2009). "Other

Table 2 Estimated consumption amounts induced by domestic tourists in Kyoto Prefecture

Kyoto City classification	Breakdown	Details	Code	KIRWIOT2000 sector classification	Consumption amount (10,000 yen)
Travel expenses within the city	JR		78	Rail transport	730,724
	Private rail		78	Rail transport	607,101
	Bus		79	Road transport	146,112
	Taxi/hired car		79	Road transport	2518
	Private automobile	Gasoline cost	31	Petroleum refinery products	710,952
		Parking/toll road fee	85	Services relating to transport	871,211
	Rent-a-car	Rent-a-car expenses	96	Goods rental and leasing services	74,060
		Gasoline cost	31	Petroleum refinery products	28,684
		Parking/toll road fee	85	Services relating to transport	35,150
Lodging expenses			101	Hotels and other lodging places	10,084,494
Souvenir expenses	Confectioneries		10	Foods	257,137
	Pickled vegetables		10	Foods	95,159
	Dried bean curd		10	Foods	6426
	Pickled sliced radishes		10	Foods	6426
	Salted chopped pickled vegetables		10	Foods	5438
	Uji tea		12	Japanese tea	12,276
	Other flavored goods		10	Foods	32,626
	Ornaments/arts and crafts		38	Pottery, china, and earthenware	3536
	Pottery and porcelain		38	Pottery, china, and earthenware	17,680
	Picture postcards		22	Publishing and printing	1176
	Accessories		64	Miscellaneous manufacturing products	9019
	Apparel/furnishings, etc.		19	Furniture and fixtures	72,753
	Purses/handbags		17	Wearing apparel and other textile products	16,177
	Nishijin fabrics		17	Wearing apparel and other textile products	6844
	Dyed fabrics, etc.		17	Wearing apparel and other textile products	23,021
Dining expenses			100	Eating and drinking places	5633,912
Other expenses	Shoes/bags		35	Leather, fur skins, and miscellaneous leather products	232,316

Table 2 continued

Kyoto City classification	Breakdown	Details	Code	KIRWIOT2000 sector classification	Consumption amount (10,000 yen)
	Medicinal products/cosmetics/oral hygiene products, etc.		30	Final chemical products	58,079
	Film		30	Final chemical products	58,079
	Cameras/watches/glasses		63	Precision instruments	58,079
	Other manufactured goods (stationary/toys, etc.)		64	Miscellaneous manufacturing products	290,395
	Hot spring visits/hot spring facilities/beauty salons		99	Amusement and recreational services	232,316
	Theme parks/amusement parks, etc.		102	Other personal services	522,712
	Art galleries/museums, etc.		89	Education	290,395
	Golf courses/tennis courts, etc.		99	Amusement and recreational services	348,474
	Ski slopes		99	Amusement and recreational services	58,079
	Watching sports/art appreciation		99	Amusement and recreational services	116,158
	Exhibitions/conventions		89	Education	58,079
	Tour guide costs		102	Other personal services	58,079
	Massage		102	Other personal services	116,158
	Photography expenses		102	Other personal services	58,079
	Postal services/telephone communication costs		86	Communication	116,158
	Delivery services		79	Road transport	232,316
	Other		102	Other personal services	871,186

expenses" in the Kyoto City survey were estimated based on the breakdown of corresponding categories of tourist expenditures in the "Travel and Tourism Consumption Trends Survey" (MLITT 2004). Then, we allocated each category of MLITT (2004) to the corresponding IOT industrial sector. Estimates were expanded to Kyoto Prefecture using these results based on the aforementioned assumptions. Table 2 shows the results estimated for each industrial sector, and the purchaser price was converted into the producer price based on the national IO table of the MIC. The final estimation results are shown in Table 3.

Table 3 Consumption by visitors in the Kyoto case study (KIRWIOT2000 sector classification)

Code	KIRWIOT2000 sector classification	Estimated value of consumption by domestic tourists (10,000 yen)
10	Foods	220,331
12	Japanese tea	6772
17	Clothing and other textile products	19,004
19	Furniture and fixtures	29,805
22	Publishing and printing	525
30	Final chemical products	55,659
31	Petroleum refinery products	449,920
35	Leather, furs, and miscellaneous leather products	113,762
38	Pottery, china, and earthenware	9602
63	Precision instruments	30,040
64	Miscellaneous manufacturing products	130,599
74	Commerce	519,807
78	Rail transport	1,213,502
79	Road transport	544,009
81	Water transport	1580
82	Air transport	323
84	Storage facility service	2171
85	Services relating to transport	815,572
86	Communication	104,523
89	Education	313,568
96	Goods rental and leasing services	66,642
99	Amusement and recreational services	679,398
100	Eating and drinking places	5,069,574
101	Hotels and other lodging places	9,074,349
102	Other personal services	1,463,319

3.3 Comparison of the direct effects of domestic tourism consumption in Tokyo and Kyoto Prefectures

What is the difference in expenditure when visiting Tokyo or Kyoto? Comparing these two regions reveals that consumption in Tokyo amounted to 434.0 billion yen for approximately 32 million visitors in 2004, while that in Kyoto was 209.3 billion yen for approximately 11 million visitors in 2001 (City of Kyoto Industry and Tourism Bureau 2002; Tokyo Convention and Visitors Bureau 2004). However, considering that the household consumption in Tokyo is close to seven times that in Kyoto Prefecture, overnight stays by domestic tourists were extremely important for Kyoto Prefecture.

How do the consumption trends for overnight stays by domestic tourists differ between Tokyo and Kyoto? As shown in Fig. 1, tourist expenses are generally similar in both prefectures. "Hotels and other lodging places" was the largest expense, which accounted for approximately 45%, and "Eating and drinking places" accounted for approximately 20% in both regions.

However, of the differences observed, there was a slight increase in demand for "Air transport" in Tokyo. This was likely because tourism is one of the main industries on

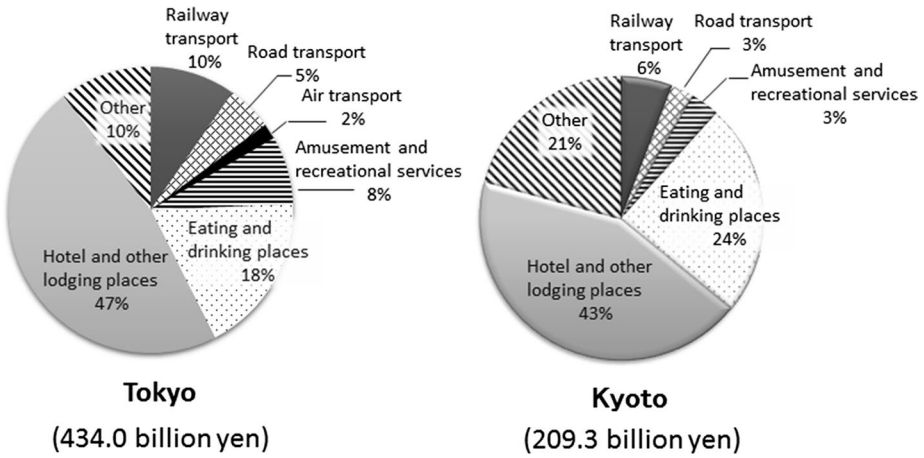

Fig. 1 Proportion of overnight stays by domestic tourists in Tokyo and Kyoto

Izu and Ogasawara islands,[1] both of which fall under the jurisdiction of Tokyo. In addition, "Rail transport" in Tokyo is slightly more important than "Road transport." "Services relating to transport" and "Petroleum refinery products" in Kyoto, which are included in the category of "Other" in Fig. 1, accounted for approximately 3.9 and 2.1%, respectively, which are much larger than the corresponding figures for Tokyo.

The expense for "Eating and drinking places" sector is proportionately larger in Kyoto Prefecture, and the "Recreational services" is larger in Tokyo. The Kyoto City survey of local attractions includes numerous scenic and historical sites, such as Kiyomizu-dera, Arashiyama, Kinkakuji, and Ginkakuji,[2] and almost no facilities are listed that correspond to "Recreational services." Differences in items, such as tourism areas, are reflected in the breakdown of tourism consumption. The expenses in Kyoto for "Other personal services" (7.0%), "Commerce" (2.5%), and "Foods" (1.1%) are also larger than in Tokyo.

Although the direct consumption trends were basically similar, the repercussion effects differed according to the industrial structures within Tokyo and Kyoto Prefectures. In addition, in our study, the waste generated by domestic tourists is categorized as business waste by the industrial sector, such as food waste from restaurants and hotels. Consequently, differences in the economic structures of Tokyo and Kyoto Prefectures are considered to be closely related to the impact of waste generation.

4 Comparison of the repercussion effects induced by domestic tourism consumption in Tokyo and Kyoto Prefectures

In this section, we compare the repercussion effects in Tokyo and Kyoto of the domestic tourist expenditures described in Sect. 3. As shown above, consumption by domestic tourists staying overnight in Kyoto Prefecture is less than half that for Tokyo. We

[1] Izu and Ogasawara islands are located approximately 120–1000 km south of Tokyo bay and are famous for their natural beauty. The Ogasawara islands are recognized as a natural heritage site by UNESCO. The primary means of access to these islands are by ship and by air.

[2] Kiyomizu-dera, Kinkakuji, and Ginkakuji are the most popular Buddhist temples in Kyoto and are recognized as world heritage sites by UNESCO. Arashiyama is located on the east side of Kyoto City and is famous for its superb views, especially during cherry blossom season and autumn.

considered the disparity in magnitude of the economic activities of the two prefectures when we investigated and compared the repercussion effects induced by tourist consumption in Tokyo and Kyoto.

First, the impacts were compared from an economic perspective. The repercussion effects on the production value attributed to consumption by domestic tourists were approximately 434 billion yen in Tokyo and 260 billion yen in Kyoto. Considering that the direct effects of tourism in Tokyo were twice as large as those in Kyoto, the repercussion effects on the production value in both regions were relatively similar. The value-added repercussion effects amounted to approximately 276 billion yen in Tokyo and approximately 108 billion yen in Kyoto.

The trends in repercussion effects on production and value-added effects were similar between Tokyo and Kyoto. The repercussion effects on civil services and the service industry were 62.7% in Tokyo and 68.0% in Kyoto, on traffic, telecom, and broadcasting were 17.2% in Tokyo and 13.0% in Kyoto, on commerce were 10.8% in Tokyo and 8.0% in Kyoto, and on secondary manufacturing industries were 6.3% in Tokyo and 8.5% in Kyoto. However, the impacts on certain industries differed between Tokyo and Kyoto (Table 4). The repercussion effects of the production value on "Hotels and other lodging places," "Eating and drinking places," and "Amusement and recreational services" accounted for more than 50% in both regions. The repercussion effect on "Hotels and other lodging places" was larger in Kyoto than in Tokyo. Moreover, the repercussion effect on "Amusement and recreational services" in Kyoto was half that in Tokyo. As mentioned in Sect. 3.2, regarding the direct effects of tourists' consumption of goods and services, the repercussion effect on "Amusement and recreational services" in Kyoto is smaller than that in Tokyo because, unlike in Tokyo, most of the tourists visiting Kyoto go to historical attractions, such as shrines and temples. The repercussion effect on "Financial and insurance services" was also larger in Tokyo than in Kyoto. Since most insurance companies have their headquarters in Tokyo, the repercussion effects of travel insurance are larger in Tokyo than in Kyoto. In Kyoto, the repercussion effect

Table 4 Repercussion effects on production value in Tokyo and Kyoto (million yen)

Industry	Tokyo		Kyoto	
Foods	8575	2%	5914	2%
Petroleum refinery products	99	0%	4634	2%
Commerce	19,597	4%	9993	4%
Financial and insurance services	26,948	5%	7996	3%
Railway transport	42,309	8%	12,447	5%
Road transport	23,085	4%	6432	2%
Services relating to transport	6701	1%	9005	3%
Advertising, survey, and information services	10,441	2%	1523	1%
Other business services	9153	2%	2784	1%
Amusement and recreational services	38,676	7%	7255	3%
Eating and drinking places	76,641	15%	50,696	19%
Hotels and other lodging places	152,127	29%	90,743	35%
Other personal services	20,876	4%	15,841	6%
Other	23,209	4%	11,641	4%

on "Petroleum refinery products" accounted for 4634 million yen, which is considerably larger than that in Tokyo. This disparity in repercussion effects associated with petroleum products exists because there is no petroleum industry in Tokyo. Indeed, all petroleum products are imported to Tokyo from other parts of Japan. A production value of 8032 million yen for petroleum products was induced in areas outside Tokyo. As shown in Fig. 2, the difference in the repercussion effects on the production value is caused by differences in the economic structures of Tokyo and Kyoto. Whereas the main industry in Tokyo is the service industry, in Kyoto, the main industries are manufacturing industries, including the automotive industry, the food industry, industries producing semiconductor devices and integrated circuits, and the publishing and printing industries. The difference in the economic structures of Tokyo and Kyoto also affects the amounts and types of waste generated.

Table 5 shows the repercussion effects of waste generation (considering recycling) in Tokyo and Kyoto. Although the direct and indirect effects on the production value in Kyoto are half that in Tokyo, the induced waste generation for Kyoto is as same as that for Tokyo. Business waste is generated by the service industries, such as "Hotels and other lodging places" and "Eating and drinking places," and waste generation by these industries is larger in Kyoto than in Tokyo. As shown in Fig. 2, the difference in industrial waste generation is mainly attributable to differences in the economic structure of Tokyo and Kyoto. The main industries in Kyoto are manufacturing industries, which have higher waste generation coefficients than the tertiary industries that dominate Tokyo. Kyoto is also famous for its livestock industry, and "Livestock excreta and livestock corpses" accounts for a total of 3345 tonnes of industrial waste, which is considerably larger than that generated in Tokyo.

As indicated by the results shown in Table 5, the waste generation induced in Kyoto by "Waste oil," "Waste acid," "Waste alkali," and "Waste plastics" accounted for −1616, 22, 15, and −2778 t, respectively (total: −4356 t). The reason why some repercussion effects are negative is that the amount of waste that is recycled is larger than that generated in these waste categories. For example, in "Road transport" consumption by tourists induced production activity in the petroleum industry that recycled 1655 t of waste

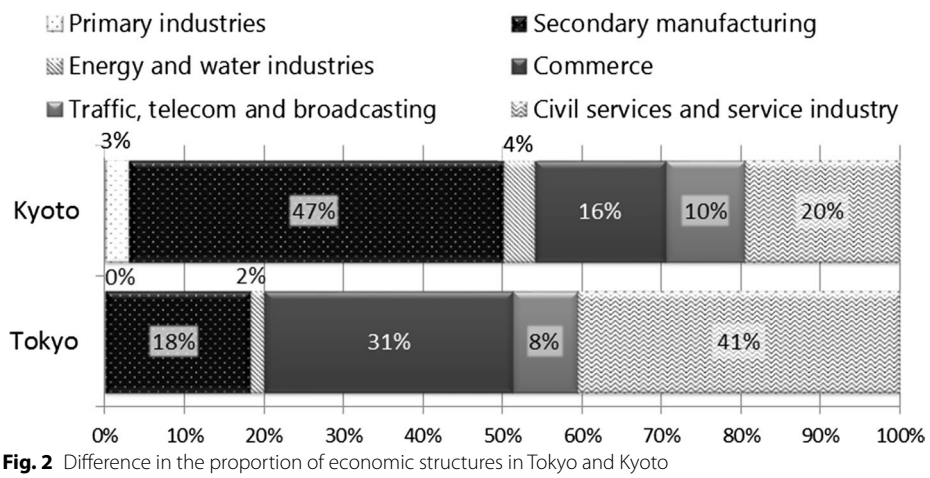

Fig. 2 Difference in the proportion of economic structures in Tokyo and Kyoto

Table 5 Repercussion effects on waste generation considering recycling (t)

Waste category	Tokyo	Kyoto
Business waste		
Food waste	6167	6960
Waste paper and waste textiles	4955	5955
Waste plastics	2058	1886
Scrap metal	1359	386
Waste bottles and waste ceramics	470	1037
Other	1078	230
Industrial waste		
Sludge	2539	1435
Waste oil, waste acid, waste alkali, and waste plastics	289	−4356
Waste paper, wood, fibers, animal and vegetable residue, and rubber	21	79
Scrap metal	29	321
Construction waste, waste glass, waste ceramics, and slag	908	1782
Livestock excreta and livestock corpses	517	3345
Cinder, dust, and molten slag	10	2680
Shredder dust	0	0
Total	20,655	22,690

oil and 3140 t of waste plastics. In KIRWIOT2000, "Waste oil" and "Waste plastics" are generated by other chemical industries, but these industries are not stimulated by tourist consumption. The relative amount of "Cinder, dust, and molten slag" from Kyoto, which accounted for 2680 t, is also much larger than that from Tokyo. In investigating which industrial sectors generate "Cinders, dust, molten slag" waste, the repercussion effect of "Dust" from the "Electricity" industry in Kyoto is 2286 t. Kyoto Prefecture has a thermal power plant at Maizuru, which uses primarily coal and crude oil as fuel (KEPCO 2011). In contrast, in 2000, most thermal power plants in Tokyo were off-line or used natural gas, which produces only small amounts of "Dust." Therefore, the quantity of "Dust" produced in Tokyo and Kyoto appears to differ markedly between the two prefectures. Since there has been a change in the usage of power plants and fuels since the Great East Japan Earthquake in March 2011, the results may differ if the analysis is performed using more recent data.

The large amounts of waste generated led to a large amount of landfill waste. Regarding the repercussion effect of landfill consumption area, Kyoto consumed 1479 m^2 of landfill compared to 7369 m^2 for Tokyo. This appears to contradict the results indicating that waste generation, which is induced by visitors' consumption in Kyoto, was the same as that in Tokyo. The reason for the observed disparity in landfill consumption area is because the waste categories associated with waste generation in Kyoto, which was larger than that in Tokyo, were mainly treated in incineration facilities. Since incineration effectively reduces the amount of residue that needs to be landfilled, Kyoto consumed less landfill than Tokyo. For example, in Kyoto, 15% of the induced waste generation belonged to the "Livestock excreta, Livestock corpses" category, which was incinerated. In contrast, in Tokyo, the induced waste generation of "Scrap metal," considering recycling, accounted for approximately 1359 tonnes, which is 3.5 times larger than that in Kyoto. Scrap metal is difficult to reduce in size and is directly landfilled (Fig. 3).

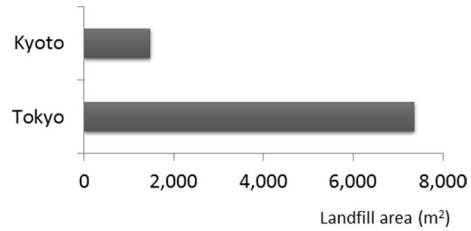

Fig. 3 Repercussion effects of landfill consumption area in Tokyo and Kyoto

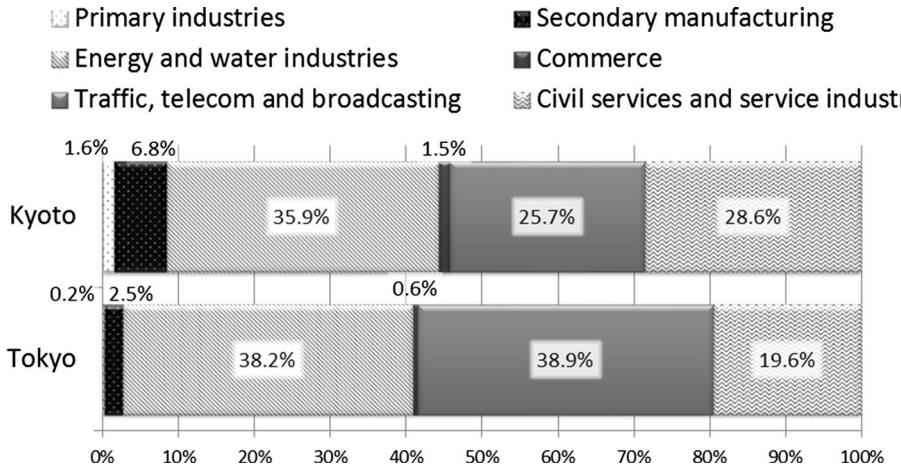

Fig. 4 Induced GHG emission from industrial sectors in Tokyo and Kyoto

For the repercussion effects of GHG emissions, a noticeable difference was observed between Tokyo and Kyoto. The repercussion effect of GHG emissions in Tokyo was 269,945 t-CO_2 (eq.), whereas that in Kyoto was 141,103 t-CO_2 (eq.). However, as shown in Fig. 4, the proportion of GHG emissions by the industries of Tokyo and Kyoto was quite different. As stated in Sect. 3.2, the direct effect of transportation and traffic-related activities is high for Tokyo, and "Road transport" and "Air transport," which have high GHG emission coefficients, also have high relative importance in Tokyo.

5 Conclusions

Our study analyzed the direct and indirect effects of consumption by domestic tourists using a regional WIO analysis, which enabled us to investigate the economic and environmental impacts of final consumption induced by tourism. As indicators of environmental loads, we focused on waste generation, landfilling, and GHG emissions. We conducted case studies in Tokyo and Kyoto and compared the direct and indirect effects induced by visitors from other parts of Japan.

The findings revealed that the economic impacts of tourism in Tokyo and Kyoto were generally similar, but the environmental impacts of domestic tourism were quite different. Although the magnitude of the direct and indirect effects was much larger in Tokyo, tourism was more important in Kyoto than in Tokyo. Similarly, although the amount of

waste induced in both regions was similar, the amount of landfill generated in Tokyo was approximately five times larger than that in Kyoto. The GHG emissions in both regions were approximately proportional to the direct effects of domestic visitors' consumption, but the industries that emitted GHGs were quite different in each area, reflecting differences in the economic structures of Tokyo and Kyoto. The results of our study also demonstrated the need for considering the regional characteristics of the target region when promoting tourism in a way that is environmentally sound.

Future research should examine the importance of the interregional relationships between different areas of a country. When a site attracts tourists, it sometimes induces large environmental loads in other parts of the country. For example, economic activities that are stimulated by tourism, such as shopping, eating in restaurants, and lodging, which generate relatively small environmental loads, tend to stimulate production activities in industries such as agriculture, the food industry, and manufacturing, which have larger environmental loads. Hasegawa et al. (2015) constructed a multi-regional IO table for 47 prefectures in Japan (47IOT) in order to evaluate the carbon footprint of each region. Expanding the 47IOT to include environmental loads other than GHG emissions would allow the direct and indirect effects of tourism to be clarified within the context of the interregional economic and environmental relationships between regions. It is also important to consider the effect of the Great East Japan Earthquake in 2011, particularly insofar as the shift in power generation methods in Japan is concerned. The model and data obtained in our study provide a powerful tool for investigating the economic and environmental impacts of tourism.

Abbreviations

EEIO: environmentally extended input–output; IR-WIO: interregional WIO; KWIOT2000: regional WIO table for the year 2000 in Kyoto; KIRWIOT2000: two-region interregional WIO table; MLITT: Ministry of Land, Infrastructure, Transport and Tourism; TMGA: Tokyo Metropolitan General Affairs; WIO: waste input–output; WIOA: WIO analysis; 3EID: Embodied Energy and Emission Intensity Data for Japan Using Input–Output Tables; 47IOT: multi-regional IO table for 47 prefectures in Japan; 47WIOT: multi-regional WIO table for 47 prefectures in Japan.

Authors' contributions

TI and MK were mainly responsible for compiling the regional WIOT for Kyoto in 2000, with technical advice from MT. MT was responsible for data collection, performing calculations, and generating the quantitative results. MT interpreted the results and drew the conclusions. All authors read and approved the final manuscript.

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Competing interests

The authors declare that they have no competing interests.

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