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INTERNATIONAL TOURISM DEMAND AND CO_2 EMISSION: A COMPARISON BETWEEN DEVELOPED AND DEVELOPING ECONOMIES OF THE WORLD

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Abstract: This study investigates the relationship between tourism demand and CO_2 emissions using the sample of 180 economies from the world. Data from 1995 until 2013 are selected. Fixed effect approach is applied in the regressions. This study categorises the sample into high income-, upper middle income-, lower middle income- and low income economies. The results show that increasing international tourism demand increase CO_2 emissions in developing economies; however, a significant reduction of CO_2 emissions is shown in developed economies. Further test shows that technology advancement is a significant factor leading to reduction of CO_2 emissions following increasing tourism demand, but the effect could only be significantly seen in the long-run. Robustness test using tourism receipts confirms the findings of this study.

INTRODUCTION

Confronting with the current issue of sustainable tourism, the impact of tourism development towards environmental degradation has recently been paid attention in the research. The studies associating international tourist arrivals and energy consumption have been increasing in the recent years. The underlying support on this area of research is due to the argument that increasing tourism demand has raised the supply of services either from the industry of transportation, catering, accommodation, or the development and management of tourist attractions which has significantly increased energy consumption (Gössling, 2002; Becken S, Simmons DG, Frampton, 2001; Liu, Feng & Yang, 2014). The consequence of increasing energy consumption may be the climate change for increasing of carbon dioxide (CO_2) emissions from the combustion of fossil fuels. In fact, UNWTO estimates tourism activities are responsible of about 5 per cent of global carbon dioxide emissions (UNWTO, 2008). It raises the concern about the sustainability of tourism growth if it has constituted to a significant environmental degradation.

The present literature lacks of empirical evidences to show the impact of tourism towards environmental change. This study fills the research gap by analysing cross-sectional time series data to examine the link between tourism demand and CO_2

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emissions. This study extends the model of Lee and Brahmasrene (2013) and shows several originalities to the literature. First, this study uses world sample rather than merely focusing on a regional sample as shown in the previous studies. Second, the regression model of this study additionally controls for the population size, or a representative of urbanization, which is significantly related to CO_2 emissions, as shown by Al-mulali, Fereidouni, Lee and Che Sab (2013). Third, high correlations between independent variables as shown by Lee and Brahmasrene (2013) have been tackled in the present study, so that to increase the accuracy of the estimations and reduce multicollinearity problem in the regressions. Fourth, robustness tests are performed using international tourism receipts as the dependent variable, by arguing that tourism receipts could be better to capture the activeness of tourism in one country. Fifth, causal effect of the model is tested using generalized method of moment (GMM), while controlling for dynamic effect of the variables.

This study provides a good comparison on the influence of increasing tourism demand towards CO_2 emissions between economies in the world according to the countries' income status, upon the categorisation of high income-, upper middle income-, lower middle income-, and low income economies. Each of the economies' income status is represented by dummy variables. The dummy variables are then interacted with the number of tourist arrivals, and the interaction terms regresses against CO_2 emissions. The estimates of the interaction terms enable us to view a pattern of relationship for each level of economy. As previous studies show mixed findings on the relationship between tourism development and CO_2 emissions, the present study provides a solid evidences on whether the economies' income status is a matter towards the relationship. In fact, this study adds to the body of existing literature by showing that only developed economies have significantly reduced CO_2 emissions following increasing of tourism demand in the economies, but middle low- and low income economies do not show this pattern of relationship.

This study further examines whether technology advancement in the economies could be a key factor leading to the reduction of CO_2 emissions following increasing of tourism demand. The rationale of incorporating the interaction term is that, high technology skills and knowledge facilitate energy-savings or green technologies are applied in producing tourism products to fulfil the increasing tourism demand. With that, the amount of high-tech exports is used to represent technology advancement in the country. Interaction of high-tech exports and tourism demand is incorporated into the regressions. The findings show a positive result that the present high-tech skills and knowledge significantly facilitate to reduce CO_2 emissions following increasing tourism demand using generalized method of moment (GMM) approach, but not in fixed effect approach. It has demonstrated that the effect from technologies advancement could only be significantly seen in the long-run. It however implies that technologies may be the key factors to drive sustainable development of tourism in the future.

LITERATURE REVIEW

Sustainability of tourism development has been highly concerned by the scholars. Brown and Essex (1997) and Simpson (2001) document that sustainability-based tourism development should be accompanied with the balance between social, environment and economy. As there is a large pool of evidences indicating the positive impact of tourism to economic growth, the current research starts to focus on the impacts of tourism development towards the society, including the environmental change. The study like Tovar and Lockwood (2008) reveal that tourism is related to environmental degradation, negative social and cultural impact and habitat fragmentation. It is especially critical for high energy consumption in tourism sectors following increasing of international tourism demand in the present, leading to the increase of CO_2 emissions, as evident by Gössling (2002), UNWTO-UNEP-WMO (2008), and Wu and Shi (2011). Even though rural tourism may be one of the survivorship for sustainable tourism development which has less energy consumption, it is constrained by regional instability (Hall, 1998).

The recent studies focus on the impact of tourism sector development and CO_2 emissions which could affect climate change. For example, Martín-Cejas and Sánchez (2010) focus on the impact of road transport usage and its implication for sustainable tourism development, in terms of environmental impact of climate change. Scott et al. (2010) depict the link between tourism and CO_2 emissions, and report that tourism could become a global source of greenhouse gases in the future. Katircioglu, Feridun and Kilinc (2014) show that increasing tourism activities consume greater energy and increase CO_2 emissions, in the case of a small island, Cyprus. In contrast, Tang et al. (2014) use bottom-up approach show that CO_2 emissions from tourism industry increase by approximately 12.6 per cent per annum, in the case of China. The study further shows that CO_2 emissions from the tourism industry in China are mainly driven by tourism transport, which accounts for 80 per cent of total CO_2 emissions. Meng et al. (2016) show that the total indirect carbon emissions from the other tourism sectors excluding transportation sector is 3-4 times higher than direct carbon emissions. Meng et al. (2016) further show that carbon emissions from transportation, food and accommodation are the highest among the other tourism sectors.

However, Lee and Brahmasrene (2013) show that increasing the number of tourist arrivals significantly reduce CO_2 emissions, using the sample of European Union. Robaina-Alves et al. (2016) which focus on Portugal find that increasing of tourism demand increases CO_2 emissions, but the study finds that sub-sectors of tourism have managed to reduce CO_2 emissions by replacing fossil fuels with renewable energy as well as reducing total energy consumption. However, Zaman et al. (2016) which use developed countries in European region find that tourism sector development associates with environmental hazards, by using period random effect two-stage least square regression. Nonetheless, the study of Lee and Brahmasrene

(2013) and Robaina-Alves et al. (2016) may imply that developed and developing countries show differences in terms of promoting sustainable tourism, in which the former has effectively reduced CO_2 emissions when increasing international tourism demand in the countries, while the latter fails to mitigate CO_2 emissions following increasing of international tourism demand. However, the research in this area is still new, and no studies are found by this study that a thorough investigations using world sample is analysed.

Hypothesis 1: The impact of increasing international tourism demand on CO_2 emissions differs across high income, middle income and low income economies.

Adopting the findings from the literature, this study even looks into detail of the economies' income status, by further classifying developed and developing economies into high income-, middle income- and low income economies. The ultimate findings of Zaman et al. (2016) conclude that countries' policies setting is important in tourism development, and the stakeholders' realization on carbon free policies to strengthen tourism sector is significant. Continuing the findings of Zaman et al. (2016), this study claims that the stakeholders in high income economies have greater realization on promoting sustainable tourism than low income economies, which may be due to better educational and culture of the publics in high income economies.

Hypothesis 2: High income economies show greater significant effect of CO_2 emissions reduction if compared to middle income- and low income economies.

In fast developing global tourism industry, technological and operational improvements are vital to counter the increase of carbon emissions while sustaining the growth of tourism sectors. In fact, with technologies, energy efficiency can be improved including replacing older machines and facilities, as well as using clean energy (Gossling, 2011; Peeters, Williams & de Haan, 2009). Sun (2016) provides evidences showing that the present stage of tourism development does not efficiently utilise the knowledge of technologies to offset tourism-based carbon emissions in the case of Taiwan. It implies that with the increasing of international tourism demand without an efficient mitigation option on reducing CO_2 emissions is critical for tourism sector sustainability concern.

Hypothesis 3: Technology advancement does not facilitate reduction of CO_2 emissions following increasing of international tourism demand.

Theoretical Setting

The main theoretical model is to find the link between international tourist arrivals and CO_2 emissions, as shown by equation 1. Model (1) controls for the effect of economic growth, foreign direct investment, population towards CO_2 emissions. All of the variables are taken in natural logarithm.

$$CO_{2it} = \alpha_{it} + \beta_1 \text{ Economic\_Growthi} + \beta_2 \text{ FDI}_{it} + \beta_3 \text{ Population}_t + \beta_4 \text{ Arrivals}_{it} + \varepsilon_{it} \quad (1)$$

where CO_{2it} is represented by CO_2 emissions as the percentage of total fuel combustion from electricity and heat production in year t of economy i*. Economic_ $Growth_{it}$ is total gross domestic products (GDP) in US$ in year t of economy i. $Population_{it}$ is total population based on the de facto definition of population in year t of economy i, which counts all residents regardless of legal status or citizenship; FDI_{it} is net of Balance of Payment of foreign direct investment in US dollars in year t of economy i; $Arrivals_{it}$ is the number of arrivals of the international inbound tourists in year t of economy i.

Unbalanced fixed effect panel regression is performed in the analysis. A total of 180 economies are selected from the world, according to data availability from Datastream, of the source of World Development Indicator. Also, due to data availability on the number of tourist arrivals, this study is restricted to investigate from years 1995 until 2013. Prior to analysis, preliminary tests on the correlations between independent variables demonstrate that the regression may contain multicollinearity issue for high correlations are found between gross domestic products (GDP) and other variables including foreign direct investment and population size (*POP*). High correlations between independent variables are also shown in Lee and Brahmasrene (2013). Variance Inflation Factors (VIF) test is performed, showing a possible multicollinearity problem exists in the regression. With that, univariate regression is performed for GDP and variables, and the residuals of the regression are used in the multivariate regressions. Lastly, GMM approach is applied to examine the dynamic effect of the variables, while controlling for causal effect between GDP and CO_2 emissions.

Results and Discussion

Table 1 presents descriptive statistics of the variables, for high income economies and low income economies individually. High income economies is defined according to World Bank, while low income economies is defined for the economies labelled as upper middle income, lower middle income and low income economies according to World Bank. CO_2 emissions in high income economies has mean percentage of about 46 per cent while CO_2 emissions in low income economies has mean percentage of about 34 per cent. It indicates that CO_2 emissions in high income economies are higher compared to low income economies, of which the difference in mean between two sub-samples is statistically significant at 1 per cent

* CO_{2it} is the sum of three IEA categories of CO_2 emissions: (1) main Activity Producer Electricity and Heat which contains the sum of emissions from main activity producer electricity generation, combined heat and power generation and heat plants. (2) unallocated autoproducers which contain the emissions from the generation of electricity and/or heat by autoproducers, in which autoproducers are defined as undertakings that generate electricity and/or heat, wholly or partly for their own use as an activity which supports their primary activity. (3) other energy industries contains emissions from fuel combusted in petroleum refineries, for the manufacture of solid fuels, coal mining, oil and gas extraction and other energy-producing industries.

level. GDP in high income economies have mean value of US$1100,000 million and median of US$150,000 million, while GDP in low income economies have mean of US$140,000 million and median of US$13,000 million, with the difference in mean of both sub-samples is statistically significant at 1 per cent level. It is found that population in low income economies has higher mean value than high income economies, and the difference in mean is statistically significant. Foreign direct investment in high income economies has mean and median value of US$24000 million and US$2800 million respectively, while foreign direct investment in low income economies has mean and median value of US$32000 million and US$260 million respectively, and the difference in mean is statistically significant at 1 per cent level. A small conclusion can be made from Table 1 that although the population in low income economies is larger than high income economies, but high income economies have higher GDP and FDI; this may show a rough idea that higher CO_2 emissions in high income economies are driven by the economic growth and foreign direct investment rather than its population size.

TABLE 1: DESCRIPTIVE STATISTICS

Panel A: High Income Economies						
Variable	*CO_2 Emissions*	*GDP (in millions of US$)*	*Population (in millions)*	*FDI (in millions of US$)*	*Arrivals (in millions)*	*D_HighTech*
No. of Obs.	912	1114	1317	1145	1272	1320
Mean	45.71	1100000.00	30.00	24000.00	10.00	0.80
Std Dev.	18.89	2800000.00	86.00	62000.00	18.00	0.40
Min	0.00	600.00	0.03	-36000.00	0.03	0.00
1st Quartile	34.81	22000.00	0.29	250.00	0.52	1.00
Median	44.48	150000.00	3.60	2800.00	2.50	1.00
3rd Quartile	59.56	510000.00	11.00	17000.00	9.30	1.00
Max	89.35	18000000.00	630.00	730000.00	92.00	1.00
Panel B: Low Income Economies						
No. of Obs.	1486	2203	2280	2218	2116	2680
Mean	34.37	140000.00	44.00	3200.00	2.50	0.60
Std Dev.	18.94	500000.00	160.00	16000.00	6.20	0.49
Min	0.00	23.00	0.01	-7100.00	0.00	0.00
1st Quartile	22.53	3600.00	2.50	40.00	0.12	0.00
Median	35.07	13000.00	9.30	260.00	0.50	1.00
3rd Quartile	47.10	53000.00	25.00	1300.00	1.80	1.00
Max	81.73	8200000.00	1400.00	290000.00	58.00	1.00
T-test	0.00	0.00	0.0034	0.00	0.00	0.00

Table 2 presents the correlations on the variables used in this study. Variance Inflation Factors test is performed to test on multicollinearity problem. Low VIF value below 5 implies no such problem exists in the regressions, even though the coefficient of correlation between Economic Growth and Arrivals are 0.8. The step of ensuring no multicollinearity problem is vital for the following regressions so that the results of the regressions would not be biased and less accurate.

TABLE 2: CORRELATIONS

		1	*2*	*3*	*4*	*5*	*6*	*VIF*
1	CO_2 Emissions	1.0000						
2	Economic Growth	0.1842	1.0000					3.7200
3	Population	0.0107	0.0772	1.0000				1.5700
4	FDI	0.0084	0.1029	0.6175	1.0000			1.5700
5	Arrivals	0.2204	0.8003	0.1459	0.1485	1.0000		3.9000
6	D_HighTech	0.2559	0.4445	0.0009	0.0119	0.4340	1.0000	1.3000

Notes: All of the variables are used in natural logarithm forms. Variables of *Population* and *FDI* are originally shown highly correlated with *Economic Growth*, with Variance Inflation Factors (VIF) test fail to show no multicollinearity problem. Two univariate regressions are run using *Economic Growth* as the dependent variable for *Population* and *FDI* as independent variables respectively, and the residuals of the regressions are taken for further analysis. After filtering the effect of population and foreign direct investment towards GDP, low VIF value implies no multicollinearity issue exists in the regressions.

Table 3 shows regression results from baseline models, using different specifications including pooled ordinary least square, fixed effect and random effect. Economic growth has positive relationship with CO_2 emissions, and the relationship is significant in fixed- and random effect specification. Population is shown to have negative relationship with CO_2 emissions, and the relationship is statistically significant in fixed- and random effect specification. FDI instead shows a positive relationship with CO_2 emissions, although the effect is not statistically significant. Pooled OLS shows a positive relationship between international tourist arrivals and CO_2 emissions although it is not statistically significant, while fixed- and random effect show a statistically significant negative relationship. The results with fixed effect and random effect indicate that increasing of international tourism demand in a country has reduced CO_2 emissions, and this finding is consistent with Lee and Brahmasrene (2013). It may depict a rough idea that the overall tourism development in the world has moved towards sustainability, through minimizing degradation of the environment such as reducing CO_2 emissions using energy-efficient technologies.

Likelihood test between pooled OLS and random effect significantly reject the null hypothesis, indicating that random effect is more appropriate if compared to pooled OLS. Even though the signs of the estimates are consistent between fixed- and

random effect, Hausman test is further performed to determine which specification is the most appropriate to be used. The result of Hausman test significantly rejects null hypothesis, indicating that fixed effect is the appropriate specification. With that, this study adopts the statistical inference by applying fixed effect in the following analysis.

TABLE 3: REGRESSION RESULTS ON BASELINE MODEL

	Pooled OLS	*Fixed Effect*	*Random Effect*
Economic Growth	0.0020	0.0336**	0.0331***
	(0.5715)	(0.0226)	(0.0000)
Population	–0.0207	–0.0386***	–0.0390***
	(0.5355)	(0.0003)	(0.0000)
FDI	–0.0261	0.0136	0.0132
	(0.3925)	(0.1437)	(0.1170)
Arrivals	0.0223***	–0.0207***	–0.0190***
	(0.0000)	(0.0000)	(0.0000)
Constant	0.0076	–0.1689	–0.1841
	(0.8972)	(0.6327)	(0.3192)
Country Dummies	No	Yes	No
Year Dummies	Yes	Yes	Yes
N	2066	2066	2066
Adjusted R^2	0.0403	0.0341	0.011

Notes: *** represents 1 per cent level of significance; ** represents 5 per cent level of significance; * represents 10 per cent level of significance.

Table 4 presents the results, using sub-samples with different economies' income status. The first column of results demonstrates the general categorization on the sample by developed and developing economies. Next, a detail categorization is performed on the sample with various income status: (1) high income, (2) upper middle income, (3) low middle income, and (4) low income. Interaction terms are incorporated into the regression models, of which the interaction terms are comprised of multiplication of the number of international tourist arrivals and economies' income status. The table shows that the signs of the control variables are consistent with baseline model in fixed effect specification.

Column (1) of Table 4 shows that there is a negative relationship between international tourist arrivals in developed economies and CO_2 emissions, although the relationship is not statistically significant. It implies that developed economies have greater concern about sustainability in terms of environmental protection when developing tourism sectors. A similar result is found in column (2) using only high income economies. This again re-confirms that the present tourism products in

developed economies, or high income economies are designed towards sustainable development, even though the effect could not be significantly seen.

Column (3) of Table 4 shows that there is a positive relationship between the interaction term and CO_2 emissions, of which the relationship is statistically significant at 5 per cent level. The interaction term is the multiplication of the number of international tourist arrivals and dummy of upper middle income economies. The result indicates that tourist activities in upper middle income economies have brought a significant increment of CO_2 emissions following tourism development. The positive effect is also shown in low income economies (column 5), of which the coefficient of the interaction term is larger than the coefficient as shown in column (3). This may justify mixed results are obtained in the literature with different sample used in individual study. A surprising result is obtained in column (4) showing that increasing international tourism demand in lower middle income economies has significantly reduced CO_2 emissions. The only justification is that lower middle income economies may highly promote rural tourism which consumes less energy while attracting to the international tourists. However, Hall (1998) gives the notion that rural tourism is volatile due to natural instability, which could not become a way out for sustainable tourism in the long run.

TABLE 4: REGRESSION RESULTS, BY ECONOMIES' INCOME STATUS

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
	Developed vs Developing Economies	*High Income Economies*	*Upper Middle Income Economies*	*Lower Middle Income Economies*	*Low Income Economies*
Economic Growth	0.0328**	0.0325**	0.0334**	0.0326**	0.0297**
	(0.0261)	(0.0293)	(0.0248)	(0.0280)	(0.0465)
Population	–0.0394***	–0.0412***	–0.0419***	–0.0374***	–0.0351***
	(0.0002)	(0.0001)	(0.0001)	(0.0005)	(0.0012)
FDI	0.014	0.0148	0.0143	0.0139	0.0151
	(0.1319)	(0.1180)	(0.1304)	(0.1419)	(0.1105)
Arrivals	–0.0203***	–0.0207***	–0.0239***	–0.0138***	–0.0231***
	(0.0000)	(0.0000)	(0.0000)	(0.0016)	(0.0000)
D_Develop Country × Arrivals	–0.0071 (0.3038)				
D_High Income × Arrivals		–0.0072 (0.3003)			
D_Upper MiddleIncome × Arrivals			0.0102** (0.0423)		

	(1)	(2)	(3)	(4)	(5)
	Developed vs Developing Economies	*High Income Economies*	*Upper Middle Income Economies*	*Lower Middle Income Economies*	*Low Income Economies*
D_Lower Middle Income × Arrivals				–0.0128***	
				(0.0069)	
Low Income × Arrivals					0.0206**
					(0.0110)
Constant	–0.1156	–0.0983	–0.1586	–0.1991	–0.056
	(0.7463)	(0.7852)	(0.6561)	(0.5762)	(0.8758)
Country Dummies	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes
Obs	2066	2029	2029	2029	2029
Adjusted R^2	0.9367	0.9371	0.9372	0.9373	0.9373

Notes: *** represents 1 per cent level of significance; ** represents 5 per cent level of significance; * represents 10 per cent level of significance.

Robustness Test

Replacing international tourist arrivals with international tourism receipts, as shown in Table 5 to be the dependent variable in the regression, it is more significant to show a pattern that high income- and upper middle income economies have significantly reduced CO_2 emissions while international tourism activities are increasing; instead, lower middle income and low income economies have significantly increased CO_2 emissions while international tourism activities are increasing. It may raise the question on the characteristics of high income- and upper middle income economies which have significantly reduced CO_2 emissions following tourism development.

TABLE 5: THE INFLUENCE OF TOURISM RECEIPTS TOWARDS CO_2 EMISSIONS

	(1)	(2)	(3)	(4)	(5)
	Developed vs Developing Economies	*High Income Economies*	*Upper Middle Income Economies*	*Lower Middle Income Economies*	*Low Income Economies*
Economic Growth	–0.0225	–0.0244	–0.025	–0.0223	–0.0288*
	(0.1472)	(0.1204)	(0.1111)	(0.1556)	(0.0681)
Population	–0.0497***	–0.0514***	–0.0467***	–0.0484***	–0.0481***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
	Developed vs Developing Economies	*High Income Economies*	*Upper Middle Income Economies*	*Lower Middle Income Economies*	*Low Income Economies*
FDI	0.0230**	0.0242**	0.0242**	0.0253**	0.0228**
	(0.0189)	(0.0149)	(0.0149)	(0.0109)	(0.0219)
Tourism Receipts	0.0539***	0.0551***	0.0563***	0.0336***	0.0399***
	(0.0000)	(0.0000)	(0.0000)	(0.0046)	(0.0001)
D_Develop Country × Tourism Receipts	–0.0459** (0.0179)				
D_High Income × Tourism Receipts		–0.0474** (0.0156)			
D_Upper Middle Income × Tourism Receipts			–0.0279* (0.0794)		
D_Lower Middle Income × Tourism Receipts				0.0365** (0.0333)	
D_Low Income × Tourism Receipts					0.0556** (0.0135)
Constant	0.9299**	0.9763**	0.9952**	0.9274**	1.0880***
	(0.0161)	(0.0124)	(0.0109)	(0.0178)	(0.0056)
Country Dummies	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes
Obs	2146	2109	2109	2109	2109
Adjusted R^2	0.9292	0.9296	0.9295	0.9295	0.9296

Notes: *** represents 1 per cent level of significance; ** represents 5 per cent level of significance; * represents 10 per cent level of significance.

Table 6 provides evidences for hypothesis 3 on whether technologies advancement could facilitate to minimize environmental damage brought by increasing of tourism demand. Using the sub-samples in accordance with the economies' income status, new interaction terms comprising multiplication of the amount of high technology exports in one country with international tourism receipts are incorporated in the regressions of the sub-samples. It is said that, the higher the export of high-tech goods, the higher technology advancement in the economies. The results show that higher technology advancement increases CO_2 emissions in fixed effect regression. However, controlling for causality effect of the variables in

GMM approach, the lag interaction term shows significant negative relationship with CO_2 emissions. It implies that the lag of variable is a matter towards CO_2 emission reduction. This has given the notion that the effect upon influence of technologies on the negative relationship between tourism demand and CO_2 emissions is long-tern. The finding has logical sense in the way that increasing tourism demand could not immediately show a significant sign of reduction in CO_2 emissions even using high-end energy efficient technologies in servicing tourists and managing tourism destinations. Instead, the increased of tourism demand certainly enhances CO_2 emissions in the short-run, as energy usage would be higher for increasing of tourism activities. In short, Table 6 concludes that the negative effect of tourism demand on CO_2 emissions can only be significantly seen in the long-run.

TABLE 6: SHORT- AND LONG-RUN EFFECT OF THE RELATIONSHIP BETWEEN TOURISM DEMAND AND CO_2 EMISSIONS

	Fixed Effect	*GMM*
Economic Growth	–0.0706***	3.6225***
	(0.0000)	(0.0016)
Population	0.0781***	–5.7397**
	(0.0000)	(0.0301)
FDI	0.0223**	–0.4577***
	(0.0228)	(0.0088)
TourismReceipts	0.0317***	0.0345
	(0.0097)	(0.8951)
TourismReceipts x D_HighTech	0.0318**	0.6880*
	(0.0450)	(0.0743)
L.Economic Growth		–3.4522***
		(0.0025)
L.Population		5.5800**
		(0.0353)
L.FDI		0.5648**
		(0.0192)
L.TourismReceipts		–0.2123
		(0.4681)
L.(TourismReceipts x D_HighTech)		–1.0401**
		(0.0383)
Constant	0.8590**	
	(0.0279)	
Obs	2146	1964

	Fixed Effect	*GMM*
R^2	0.9292	
Country Dummies	Yes	No
Year Dummies	Yes	Yes
AR(1)		0.0000
AR(2)		0.7160
Hansen Test		0.9980

Notes: *** represents 1 per cent level of significance; ** represents 5 per cent level of significance; * represents 10 per cent level of significance.

CONCLUSION

This study investigates the relationship between tourism demand and CO_2 emissions across economies in the world. A total of 180 economies are selected in this study, and further categorisation of the sample into five sub-samples according to the economies' income status, i.e. high income, upper middle income, low middle income and low income economies. Fixed effect is applied in the regressions to control for unobserved country characteristics which influence CO_2 emissions. Data from 1995 to 2013 is selected. This study has performed a series of robustness tests, including replacing the number of tourist arrivals with the amount of tourism receipts to represent the activeness of tourism in the economy. Also, this study performs GMM approach to account for causal relationships.

The major findings of this study show that increasing international tourism demand does not increase CO_2 emissions but reduce CO_2 emissions. This is consistent with Lee and Brahmasrene (2013) which focus on European Union only. Lee and Brahmasrene argue that country's policies on energy savings in tourism may efficiently create low-carbon economy. This study has enhanced the findings of Lee and Brahmasrene (2013) by showing that only developed economies display a reduction of CO_2 emissions while increasing tourism demand. As only developed economies show negative relationship between CO_2 emissions and tourism demand, this study further tests whether countries' technology advancement is a key factor driving this relationship from empirical point of view. In fact, the results show that the positive effect of technology advancement to reduce CO_2 emissions following tourism sector development could only be seen in the long-run, where it is captured by the dynamic effect of GMM approach. In other words, this study shows that static panel regression could not reveal any sign of reduction in CO_2 emissions following increasing tourism demand. Also, the effect of technology advancement as shown in GMM approach has filtered endogeneity issue where unobserved factors such as policies setting and culture which correlate with tourism demand and the countries' economy development have been controlled. Adopting the argument

by Robaina-Alves (2016) that not merely technologies facilitate to reduce CO_2 emissions following tourism development, but the effort of strategic setting for cleaner forms of tourism where tourists make environmentally protective decisions from the choice of accommodation, to the type of transport used.

In short, this study reveals that the effort of establishing sustainable tourism as shown by developed economies is on the right track. Technologies may be an important factor driving the global tourism towards a sustainable income generator for economic growth. The future topic of discussion in the global tourism meetings should not deviate away from the link of tourism and environmental degradation issues especially in developing economies. The cost of upgrading technologies in tourism sectors may be the challenge faced by the developing economies in promoting a sustainable tourism.

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