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Impact of Biodiversity on International Tourism: A Cross Country Analysis

Apsara Karki Nepal[1] and Mani Nepal[2]

Abstract

Using cross country data from 134 countries around the world, this research investigates the impact of biodiversity on tourist arrivals and earnings from the international tourism. Our results indicate that the biodiversity index is a significant determinant of the international tourist arrivals and earnings from international tourism. The access to the Internet is equally important for attracting international tourists in a country. These results remain robust when we include lagged value of biodiversity index.

Introduction

People travel from one country to the other for different reasons. Tourism is one of the leading industries in the world, and for most of the developing countries. The income generated from this industry is a significant source of their foreign currency earnings. In 2008, tourism industry generated over $945 billion in exports earnings, and there were about 920 million inbound tourists (arrival) worldwide in that year. However, due to the global financial crisis, the international tourist arrival declined by 4 percent in 2009 (UNWTO, 2010).

Why do visitors travel different countries? Do site specific characteristics play a significant role in attracting international visitors? In this paper, we investigate the impact of biodiversity on international tourism expecting that biodiversity may promote international tourism. Here the international tourism is measured by the number of tourist arrivals. While analyzing such impact on tourism, we also consider other variables, such as, exchange rate with USD, percentage of population that has Internet access, and some other control variables, such as corruption perception index, and violent conflict in the country. Violent conflict, level of pollution, and business-unfriendly environment, such as corruption, may distract international travelers. We control for these variables in our analysis.

Controlling for internet access, business friendly environment and aggregate level of pollution, we find that the biodiversity index is a significant determinant of international

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1 Ms Nepal is a Ph. D. Scholar at the University of Otago, New Zealand.

2 Dr. Nepal is an Associate Professor at Central Department of Economics, Tribhuvan University, Nepal. Email: mani.nepal@bus.illinois.edu

tourist arrivals and earnings from international tourism. Following section reviews some of the related literature on tourism followed by an analytical framework. Rest of the paper discusses about the data and variables, econometric specification and issues, results and we also offer discussions.

Biodiversity and Tourism – A Brief Review

Existing literatures indicate that tourism negatively affects biodiversity through the introduction of exotic species, waste disposals, water and air pollution, spread of pathogens, habitat disturbances and damages, and fires hazards (Vaughan, 2000). These negative consequences would be the results of off road driving, use of critical habitat for hiking, camping, disposing wastes, constructing roads, and cutting down trees for energy and construction of hotels and lodges for accommodations. For example, Stevens (2003) reports widespread forest thinning and degradation in the Khumbu region, the home of the highest mountain in the world (the Mount Everest – 8848 m), due to the tourism related activities in Nepal. The forest degradation in the Everest area has been continued despite the establishment of conservation area, the Sagarmatha National Park, a world heritage site.

There are very few studies (e.g., Carter, 1995; Huybers & Bennett, 2003; Naidoo & Adamowicz, 2005) that analyze the impact of environment on tourism. In the tourism demand model, site characteristics, such as quality of the natural environment, can play a significant role to attract tourists – a superior condition of the environment might give the destination country's tourism industry a competitive edge. Using a choice experiment for a tourism demand model, Huybers and Bennett (2003) estimate that when the environmental quality in Tropical North Queensland is expected to change from 'unspoilt' to 'somewhat spoilt', the estimated decline in the visitors number and the visitor expenditure are close to 30 percent. Their estimated negative effect on the number of visitors and visitor expenditure is almost doubled when the quality of the environment is expected to change from 'unspoilt' to 'very spoilt' indicating that the site quality matters significantly when it comes to the number of visitors and their spending.

Naidoo and Adamowicz (2005) conducted a choice experiment to understand the effect of elevated levels of biodiversity, measured by the number of bird species, on tourist visitation in Uganda. They find that the number of bird species likely to be seen as a strong predictor of choosing a particular park to visit, indicating that biodiversity contributes to nature based tourism by enhancing the attractiveness of the protected areas.

The value of biodiversity can be estimated through the demand for (eco) tourism. Geist (1994) estimates that the total economic benefit resulting from the protection of wildlife in all North American national parks for tourism is more than $70 billion, and recreation provides more jobs and higher income than mining, timber and ranching combined in greater Yellowstone area (Power, 1991). The existing literature investigate the impact of biodiversity in local, or regional tourism, but this paper analyzes the effect of biodiversity on international tourism using cross country data for over 130 countries.

Analytical Framework

This section develops a simple analytical framework based on utility maximizing traveler's behavior. A representative traveler derives utility from number of trips (*TN*) to foreign countries and also derives utility from other consumer goods and services (*X*). The traveler's objective is to maximize the utility given the budget constraint. A utility function is given by:

$$U = U(TN, X) \quad (1)$$

Subject to

$$P_{TN}.TN + X \leq M \quad (2)$$

Here, *TN* is the number of trips to foreign country, P_{TN} is the relative price per trip, X is the basket of all other goods and services with normalized price, and M is the income of the traveler. Then the demand for foreign trips is given by

$$TN = TN(P_{TN}, M) \quad (3)$$

The traveler can visit places in different countries depending on the availability of attractive destinations, such as, sandy beaches, snow capped mountains, or lush green forests, for example. International tourist arrivals also depend on relative exchange rate, availability of information regarding the characteristics of the destinations, such as cleanliness and safety in addition to the biodiversity. Therefore, equation (3) can be extended as

$$TN = TN(P_{TN}, M; E, e, INT, PM10, Z) \quad (4)$$

where, *E* is environmental variables, such as biodiversity, *e* is effective exchange rate, *INT* is the access to the Internet that works as a information gateway to the world, *PM10* is the cleanliness of the overall environment of the destination countries, and Z is other control variables. The main hypothesis here is that the biodiversity may have positive impact on international tourism. Other hypotheses are that wider coverage of Internet may also have positive impact thorough information flow, while *PM10*, a measure of pollution, may have negative impact on tourism.

Data Sources and Variables

Most of the data for this study are obtained from the World Bank's World Development Indicators (WDI). The tourist arrival data is available since 1995, but the main explanatory variable of concern, the biodiversity index, is available for some selected years only, e.g., 2005 and 2008. However, the tourists arrival data is not available for 2008. So, we limit our work to a cross country analysis for 2005 given the data availability. The main explanatory variable, biodiversity index, is termed as Global Environment Facility (GEF) benefit index for biodiversity and defined as: GEF benefits index for biodiversity is a composite index of relative biodiversity potential for each country based on the species represented in each country, their threat status, and the

diversity of habitat types in each country. The index has been normalized so that the value runs from 0 (no biodiversity potential) to 100 (maximum biodiversity potential) (Pandey et al., 2006). In that sense, we can interpret the biodiversity index in percentage term as well. The conflict related variable is from a source other than the World Bank's World Development Indicators. The conflict data is from the Uppsala Conflict Data Program (UCDP) at the Department of Peace and Conflict Research, Uppsala University and Centre for the Study of Civil War at the International Peace Research Institute, Oslo (PRIO). The corruption perception index is obtained from the Transparency International.

Table 1: Variables and Descriptive Statistics

Variable	Definition	Mean	Std. Dev.
TOURIST ARRIVAL	# tourists arrival in 2005	4,827,327	1.07E+07
RECEIPT FROM ROURISM	Receipt from international tourism in 2005 (current USD)	5.00E+09	1.33E+10
BDINDEX	Biodiversity index (1 to 100 scale defined below)[a]	8.57344	18.20462
EXRATE	Official exchange rate in terms of USD	552.3355	1887.051
INTERNET	% of population with Internet access in the country	19.59613	22.76628
PM10	PM10, a measure of pollution in the country[b]	48.28838	34.40031
CORR_INDEX	Corruption index, 10: least corrupt, and 1: the most corrupt[c]	4.087421	2.111504
VIOLENCE	Measure of violence, a binary variable[d]	0.238994	0.427816

Notes: a Biodiversity Index: this is an index that ranges from 1 to 100, available online in World Development Indicator of the World Bank. This is also called Global Environment Facility (GEF) benefit index. The GEF is defined as follows: GEF benefits index for biodiversity is a composite index of relative biodiversity potential for each country based on the species represented in each country, their threat status, and the diversity of habitat types in each country. The index has been normalized so that the values run from 0 (no biodiversity potential) to 100 (maximum biodiversity potential) (Pande et al., 2006).

b Particulate matter or particles of 10 micrometers or less in diameter; a measure of country level pollution (micrograms per cubic meter).

c Corruption perception index of Transparency International. It ranges from 1 to 10: 1 indicates the most corrupt country and 10 indicates the least corrupt country.

d It is a dummy variable that codes whether the conflict since it started (the onset) has exceeded 1,000 battle-related deaths. A conflict is coded as 0 as long as it has not over time resulted in more than 1,000 battle-related deaths. Once a conflict reaches this threshold, it is coded as 1

Sources: CORR SCORE is from the Transparency International, VIOLENCE is from the Uppsala Conflict Data Program (UCDP) at the Department of Peace and Conflict Research, Uppsala University and Centre for the Study of Civil War at the International Peace Research Institute, Oslo (PRIO). Rest of the variables are from the World Bank's World Development Indicators.

Table 1 provides the variables used in the analysis and their definition. There were about 4.83 million tourist arrivals per country in 2005. This distribution, however, is very dispersed with a minimum of 3000 arrivals in Kiribati and maximum of 75.9 million in France. The average per country receipt form international tourism revenue is 5.0

billion USD in 2005. The average biodiversity index is 8.57 with standard deviation of 18.2 indicating that biodiversity is relatively at the lower end of the potential 100. About 20 percent population worldwide has Internet access, and the PM10 pollution index is

48.3, just a borderline of US Environmental Protection Agency's national standard of 50 $\mu g/m^3$ (annual mean).[3] The average per country corruption index is 4.09 (2005), and about 24 percent countries worldwide have experienced over 1000 battle related deaths since the start of such violence by 2005.

Econometric Model and Estimation Issues

We use equation (4) as a basis of our empirical work. Linearization of equation (4) gives the following empirical model:

$$TN_i = \beta_0 + \beta_1.E_i + \beta_2.INT_i + \beta_3.PM10_i + \beta_4.P_{TN} + \beta_5.M_i + \delta.Z + u_i \qquad (5)$$

Where the variables are as defined earlier (E is biodiversity index, *INT* is Internet access, *PM10* is a measure of pollution, P is the price of tourism, M is income of the visitors, and Z indicates some other control variables). In order to estimate the demand for international tourism, we need information on the cost of the trip from the country of origin to the destination (travel cost), and income of the traveler. Here, we are interested in analyzing the impact of the biodiversity (E) on number of tourists arrival in country i, and we do not have information on travel cost and the income of the travelers. Here, we are mostly concerned about the pull factors of international tourism, not the demand side analysis. Therefore, while estimating the equation (5) we exclude the price and income variables as our focus is not the analysis of tourism demand.

Another issue is the count nature of the dependent variable. Therefore, we use count data estimation method, namely the Negative Binomial (NB) model instead of the Ordinary Least Squares (OLS) method. The NB model requires maximum likelihood estimation method. While estimating the model, we also control for a proxy of corruption intensity using the corruption perception index of the Transparency International (TI). This index measures the business environment, the higher the index the better the business environment of a country. We expect that better business environment could attract more international visitors.

Results and Discussions

While estimating the models, we use two different measures of international tourism: number of tourist arrivals, and expenditure made by the foreign travelers measured in US dollars. Explanatory variables are biodiversity index (*BDINDEX*), official exchange rate (*EXRATE*), percentage of population covered by Internet (*INTERNET*) network, a measure of pollution (*PM10*), corruption index (*CORRINDEX*), and a measure of violence (*VIOLENCE*). For each dependent variable four different models are estimated

3 The PM-10 standard includes particles with a diameter of 10 micrometers or less.

in order to observe how stable the results are from different specifications. In Table 2, the first two models are mostly the same except that in column two we add one more explanatory variable, the measure of violence (*VIOLENCE*). Results in the last two columns differ from the first two as the dependent variable in the last two columns is the log of the number of tourist arrivals. The set of explanatory variables is the same.

Table 2: Negative Binomial and OLS Estimates of Tourist Arrivals

Variables	NB Regression (Dep Var: ARRIVALS)		OLS Regression (Dep Var: log(ARRIVALS))	
	Model-I	Model-II	Model-III	Model-IV
BDINDEX	0.027***	0.028***	0.028***	0.027***
	(0.007)	(0.007)	(0.008)	(0.008)
EXRATE	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
INTERNET	0.039***	0.039***	0.028**	0.027*
	(0.012)	(0.012)	(0.014)	(0.014)
PM10	-0.006*	-0.006	-0.001	-0.001
	(0.004)	(0.004)	(0.005)	(0.005)
SCORE	0.093	0.094	0.203	0.244
	(0.116)	(0.116)	(0.146)	(0.148)
VIOLENCE		0.090		0.505
		(0.290)		(0.363)
CONSTANT	13.791***	13.757***	12.226***	11.961***
	(0.401)	(0.414)	(0.505)	(0.538)
lnalpha	0.558***	0.558***		
	(0.103)	(0.103)		
Observations	132	132	132	132
R-squared			0.373	0.383

Note: Standard errors in parentheses; *, **, *** indicate significant at 10%, 5% and 1% respectively.

In the case of the first two columns, the dependent variable is the number of tourist arrivals. Therefore, we use negative binomial estimation that takes care of the account nature of our dependent variable. The results are mostly expected in terms of the signs of the explanatory variables. The coefficient of *BDINDEX* is positive and significant. In terms of marginal effect, one percent increase in the *BDINDEX* leads to increase international tourist arrivals by 91,300, about 1.9 percent increase compared to the average tourist arrivals. Access to the Internet (*INTERNET*) also has positive and significant effect. As expected, the impact of exchange rate and the measure of pollution (*PM10*) on the tourist arrivals is negative, but the coefficients are insignificant in all cases. The corruption perception index (*CORRINDEX*) is measured in 1 -10 scale where 1 indicates highest corruption and 10 means low or no corruption or business friendly environment. The positive sign of the coefficient of *CORRINDEX* indicates that the more tourists tend to come in a country where business environment is good. But the coefficient is not significant in statistical terms. Finally, the intensity of violence (*VIOLENCE*) has

no significant impact on tourism, a surprising result as we generally expect that more violence may result into less foreign travelers. An explanation for this insignificant effect of the measure of violence on tourist arrivals is that the measure of violence is cumulative. It mostly represents the historical information and that may not represent the existing situation of the country, and it has no effect on the tourist arrivals.

The results from Model-III and IV indicate that tourist arrival is highly elastic that a 10 percent increase in BDINDEX leads to increase in tourist arrivals by at least 27 percent. Other results from these two models are comparable with the results discussed above.

Table 3 presents the results where the dependent variable is the receipt form international tourism. Other than such alternative measure of tourism, all the explanatory variables are the same as in the case of Table 2. The results are mostly similar to what we have in the previous case. Biodiversity index and the Internet access are two variables with significant positive impact on receipts from tourism. Other control variables, such as *EXRATE*, *PM10* (a measure of pollution), *CORRINDEX* (a measure of business environment), and the *VIOLENCE* have no significant effect on receipt from tourism.

Table 3: OLS Estimates of Receipt from Tourism

Variables	Dep Var: RECEIPTS		Dep Var: log(RECEIPTS)	
	Model-V	Model-VI	Model-VII	Model-VIII
BD INDEX	2.704e+08***	2.688e+08***	0.036***	0.036***
	(52794248.971)	(52959707.665)	(0.008)	(0.008)
EXRATE	-530,183.445	-596,646.456	-0.000	-0.000
	(526,321.926)	(536,771.869)	(0.000)	(0.000)
INTERNET	2.773e+08***	2.748e+08***	0.042***	0.041***
	(96211603.421)	(96488255.737)	(0.014)	(0.014)
PM10	-3948797.604	-2753409.089	0.002	0.002
	(32188471.569)	(32307986.216)	(0.005)	(0.005)
SCORE	-4.638e+08	-3.323e+08	0.243	0.267*
	(1.026e+09)	(1.047e+09)	(0.152)	(0.155)
VIOLENCE		1.693e+09		0.301
		(2.535e+09)		(0.375)
CONSTANT	-3.931e+08	-1.330e+09	18.070***	17.903***
	(3.517e+09)	(3.793e+09)	(0.520)	(0.561)
Observations	134	134	134	134
R-squared	0.332	0.335	0.485	0.488

Note: Standard errors in parentheses; *, **, *** indicate significant at 10%, 5% and 1% respectively.

Results from Model-V indicate that a one percent increase in biodiversity index leads to increase receipts from international tourism by 270 million USD, an increase over 5.4 percent from the average receipt. This number is mostly stable when additional explanatory variable is added in Model-VI. The effect of Internet access to additional 1

percent population also leads to increase tourism receipt by 277 million USD. From Model-VII and VIII, we can see that one unit increase in biodiversity leads to increase international tourism related earnings by 3.6 percent. The average earning is 5 billion USD and the 3.6 and increase in tourism related earning means an additional 180 million USD, a significant amount. This change in tourism related receipts from one percent increase in the Internet coverage translates into 200 million USD.

Table 4: Negative Binomial and OLS Estimates of Tourist Arrival with lagged value of Biodiversity Index

Variables	NB Regression (Dep Var: ARRIVALS)		OLS Regression (Dep Var: log(ARRIVALS)	
	Model-IX	Model-X	Model-XI	Model-XII
LAG BDINDEX	0.029***	0.029***	0.027***	0.026***
	(0.007)	(0.007)	(0.007)	(0.007)
EXRATE	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
INTERNET	0.052***	0.052***	0.047***	0.047***
	(0.011)	(0.011)	(0.013)	(0.013)
PM10	-0.006	-0.006	-0.001	-0.002
	(0.004)	(0.004)	(0.005)	(0.005)
CORR SCORE	-0.060	-0.063	-0.007	0.020
	(0.117)	(0.117)	(0.143)	(0.144)
VIOLENCE		0.099		0.422
		(0.276)		(0.348)
CONSTANT	14.014***	13.984***	12.706***	12.525***
	(0.398)	(0.404)	(0.490)	(0.511)
Inalpha	0.488***	0.488***		
	(0.105)	(0.105)		
Observations	128	128	128	128
R-squared			0.406	0.413

Note: Standard errors in parentheses; *, **, *** indicate significant at 10%, 5% and 1% respectively.

Endogeneity Issue

In biological or ecological literature, it has been identified that the tourism affects biodiversity (e.g., Vaughan, 2000; Stevens, 2003). In that case, we may have reverse causality or endogeneity issue. In order to address the endogeneity issue, we need to find out a reasonable set of instruments for the biodiversity that is not related to tourist arrivals or earnings from tourism, but highly correlated with biodiversity. Finding such variables is always a difficulty proposition. An alternative way of addressing the endogeneity issue is to use a lagged value of the biodiversity instead of the contemporaneous value of biodiversity as an explanatory variable, expecting that the past year's biodiversity affects tourist arrivals. But this year's tourist arrivals does not affect biodiversity index of the past year. As we have biodiversity index data from 2005, we use

the 2006 data from all the variables other than biodiversity index and 2005 biodiversity data is used as the major explanatory variable. Such a lagged value of the biodiversity index helps to address the potential endogeneity issue. Tables 4 and 5 present the results where lagged biodiversity index is used as the major explanatory variable.

Table 5: OLS Estimates of Receipts from Tourism

Variables	Dep Var: RECEIPTS		Dep Var: log(RECEIPTS)	
	Model-XIII	Model-XIV	Model-XV	Model-XVII
LAG_BDINDEX	2.848e+08***	2.820e+08***	0.037***	0.036***
	(56796350.040)	(57200019.791)	(0.007)	(0.007)
EXRATE	-526,591.760	-568,466.131	-0.000	-0.000
	(550,289.993)	(557,292.359)	(0.000)	(0.000)
INTERNET	2.988e+08***	2.994e+08***	0.059***	0.059***
	(98702320.734)	(98990434.668)	(0.013)	(0.013)
PM10	-6439529.091	-6734732.432	0.001	0.001
	(36097894.010)	(36205594.851)	(0.005)	(0.005)
CORR_SCORE	-5.325e+08	-4.517e+08	0.024	0.045
	(1.070e+09)	(1.083e+09)	(0.137)	(0.138)
VIOLENCE		1.455e+09		0.393
		(2.696e+09)		(0.344)
CONSTANT	-7.363e+08	-1.403e+09	18.749***	18.569***
	(3.713e+09)	(3.924e+09)	(0.475)	(0.500)
Observations	130	130	130	130
R-squared	0.336	0.337	0.532	0.537

Note: Standard errors in parentheses; *, **, *** indicate significant at 10%, 5% and 1% respectively.

Results in Table 4 are comparable with the results reported in Table 2, Table 3 and Table 5 are also comparable. All the results after including the lagged value of the biodiversity index are consistent with what we have earlier in Tables 2 and 3. Additionally, the R-squared values are slightly improved in the case of lagged value of the biodiversity index, but the essence of the results remain the same that biodiversity is a good determinant of the international tourist arrivals as well as the earnings from the international tourism.

Concluding Remark

Tourism is an important industry in the world economy and a significant source of foreign currency earnings in several countries in the world. Studies have been done on the impact of tourism on biodiversity, and also on the impact of biodiversity on tourism in single country or regional level. Using cross country data from over 130 countries around the world, this research investigates the impact of biodiversity on tourist arrivals and earnings from the international tourism. Our results indicate that the biodiversity index is a significant determinant of the international tourist arrivals and earnings from international tourism. Alternatively, nature based or eco-tourism could be a better option

to attract more tourists and earn more foreign currency. The access to Internet is equally important for attracting international tourists in a country. Our results indicate that tourist arrivals, however, do not depend on environmental factor such as PM10 and business friendly environment.

There could be two way causations between tourist arrivals and biodiversity. More tourists may lead to deteriorating biodiversity as more biodiversity attracts more tourists. This requires a two-stage regression analysis or instrumental variable approach. An alternative way of addressing the endogeneity issue is to use the lagged value of the biodiversity and see its impact on the tourist arrivals. This alternative approach did not affect the conclusion of the main analysis indicating that the biodiversity is a good determinant of international tourist arrivals. Our results are not sensitive with the inclusion of historical violence in the countries.

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