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Tourism Development Vs CO2 Emissions in Thailand

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Abstract

To develop a leading travel industry has been considered as a strategy for economic development of Thailand in recent years. The challenge of this empirical study is to investigate the causal relationship between tourism development and CO2 (carbon dioxide) emissions in Thailand over the period of January 1986 to May 2010. Considering foreign tourist, energy consumption, and CO2 emissions from transportation and whole economic sectors, a multivariate vector autoregressive (VAR) model and the diagnosis of unit root, causality and forecast of generalized variance decomposition are analyzed to demonstrate a long-run relationship and the future shock effects for 24 month-period ahead. Results of empirical examination show that tourism development increases energy consumption and CO2 emissions through transportation and economic activities. More interesting, transport sector is a strong relative shock on CO2 emissions throughout the time prediction. These findings imply that tourism development causes a causal effect of CO2 emissions in the long-run relationship through energy and transport consumptions. Therefore, policy-makers should pay attention to the relationship of transport and energy sectors altogether with environmental issues for tourism development concerns.

Keywords: Thailand; CO2 emissions; tourism development; environment; time series analysis

1. Introduction

Tourism usually is considered as an "environmental friendly industry without chimneys" (Mirbabayev and Shagazatova, 2006). But is it purely a gift from heaven without any burden to the local environment? Relationship between tourism and environmental concern by using time series analysis has not been widely debated in the empirical studies. The challenge of this research is to explode the indeed tourism development affects environment in terms of CO2 emissions. If the impacts are proved that increasing of CO2 pollutions are caused by tourism development, some policy remedies should be considered as the responsibility from tourism. As the study of Beladi *et al*. (2009), they investigated a small open economy concerning with tax responded from tourism using pollution taxes. In line of their results, the taxes can reduce the pollution emissions, but also cause the tourism costs. As the previous study, Palmer and Riera (2003) pointed out that the taxes have to be compensated from tourism development as well.

The linkages of tourism development to CO2 emissions are basically defined as transportation and economic activities through domestic energy consumption. Transport sector is a key factor of tourism development that is facilitated the movement of tourists from their sources to the destination (Yeoman *et al*, 2007). Whether the air, sea or land approaches, its routes are depended on the energy as a fuel source and it also becomes the sources of the CO2 emissions. In recent study, Mayor and Tol (2010) researched on the pollution effect from tourism expansion in the future scenarios by employing the international flows of tourists as the key indicator. Based on their results, the demand of transport trips is required for the development of tourism in the future, particularly Asian countries, which the fuel burning in traffic facilities is the major sources on the pollution emissions. Turing to the economic activities, Dritsakis (2004), Durbarry (2005) and Kim *et al*. (2006) supported that tourism expansion is led whereby the growth of economic activities, and feedback. Later, the research of Chang (2010) introduced that economic growth leads increasing of CO2 emissions in terms of energy consumption which is consistency to Zhang and Cheng's (2009) findings.

CO2 emissions are considered to be the main causes of global warming through oxidized processes. The emissions are generated from the outcome of energy oxidization, whether transportation or economic activities during the leisure activities. Many empirical studies proved that CO2 emissions have captured in a long-run relationship with energy consumption. Because the growth of economic activities is the main factor in increasing energy usage (Soytas *et al*., 2007; Zhang and Cheng, 2009; Chang, 2010), and more energy usage also leads to more CO2 emissions which reported in Ang (2007) by utilizing the time series analysis based on the data from 1960 to 2000 in the case of France. In addition, Halicioglu (2009) confirmed that energy usage is the major contribution on the CO2 emissions in the long-run relationship of the Turkey's case, over the period of 1960 to 2005 by employing the Granger causality and vector error correction model (VECM). Likewise, Apergis and Payne's (2009) findings found the positive long-run relationship on the CO2 emissions, energy usage and output in the Central America over the time of 1971 to 2004 by using the Engle-Granger two stage approaches.

Therefore, this study aims to examine the linkages between tourism development and CO2 emissions in Thailand. The energy consumption is included as the variable in analyzing because it is indicated as the linker between tourism development and CO2 emissions. Moreover, CO2 emissions both from transportation and whole economic sectors are considered as the major pollution sources of tourism development. Hence, a multivariate vector autoregressive (VAR) model and the diagnosis of unit root, Granger causality and variance decomposition, are performed to analyze the integrated order of integration, the long-run causal relationship among tourism development, CO2 emissions through transportation and economic activities, and energy consumption, and the future risk effect from exogenous and endogenous shocks of the innovation throughout 24 months prediction ahead. The remaining contents of this study are organized as follow. Section 2 is the data, variables and methodology including the tests of ADF unit root, Granger causality through Toda and Yamamoto (1995) and generalized of forecast variance decomposition. Then, the empirical results are shown in Section 3. Lastly, Section 4 is the conclusions that there are provided the related policy implications.

2. Data, variables and methodology

2.1 Data and variables

Monthly time series are employed in this study covering the period of January 1986 to May 2010, which 293 samples are observed, to analyze the linkages among tourism development, CO2 emissions through transportation and economic activities, and energy consumption. The Tourism Authority of Thailand, and the Energy Policy and Planning Office of Thailand, both are accessed to utilize the data sources. While the variables are identified as: 1) the total arrival numbers of foreign tourists is served as the representative for international development (LITA) such as the study of Lim and Pan (2005), Kim *et al*. (2006) and Katircioglu (2009); 2) the total amounts of CO2 emissions in terms of 1,000 tons from transport sector and whole economic sectors are served as the representative for the CO2 emissions through transportation (LTCO2) and all of the economic activities (LECO2), and 3) the sale of petroleum products in terms of million liters are served as the representative for energy consumption (LENG).

Table 1: Descriptive statistics

	LITA	LTCO2	LECO2	LENG
Mean	13.363	8.116	9.258	7.857
Median	13.379	8.280	9.428	8.010
standard deviation	0.483	0.385	0.469	0.352
Skewness	-0.259	-1.076	-0.957	-1.237
Kurtosis	2.313	3.000	2.790	3.306
Jarque-Bera	9.027	56.642	45.281	75.896
Probability	0.010	0.000	0.000	0.000

Table 2: Correlation coefficient matrix

	LITA	LTCO2	LECO2	LENG
LITA	1.000			
LTCO2	0.866	1.000		
LECO2	0.902	0.983	1.000	
LENG	0.835	0.991	0.975	1.000

The descriptive statistics of the variables are reported in Table 1. All the variables are taken in the national logarithm transformation. The correlation coefficients summarized in Table 2 indicate the strong positive correlation between the variables which explain the nature of the time series in used of this study that have close association in each pairwise relationship.

2.2 Methodology

Since the outcomes from such *t*-value and R-square, cannot be relied on the stochastic process being non-stationary (Granger and Newbold, 1974), this study used the Augmented Dickey-Fuller (ADF) unit root to display the properties of time series in four variables (Dickey and Fuller, 1979, 1981), LITA, LTCO2, LECO2 and LENG, if their integrated order of integration, I(d) can be proved. The general ADF unit root model is completed with constant and time trend, which can be presented as Eq. (1):

$$\Delta Z_t = \alpha_1 + \delta T + \beta_1 Z_{t-1} + \sum_{i=1}^{p} \beta_{2i} \Delta Z_{t-i} + \varepsilon_{1t} \quad (1)$$

where Δ is the different order, Z is the time series, α is the constant term, T is the time trend, p is the optimal lag value which is selected based on the lowest value of Schwartz information criterion (SIC), ε is the error term, the subscript t is the current time, and α, δ, β_1 and β_2 are the parameters to be estimated. The null and alternative hypotheses for the unit root test are:

H_0: $\beta_1 = 0$ (Non-stationary property)

H_1: $\beta_1 < 0$ (Stationary property)

The study aims to seek the long-run relationship among the four variables using Granger causality test. Based on the alternative long-run Granger causality approaches, the variables have to be integrated in the same order and, then cointegrated (Engle and Granger, 1987; Granger, 1988). The past disequilibriums of error correction term (ETC_{t-1}) are obtained from the cointegrating equilibrium (Johansen, 1988, 1991; Johansen and Juselius, 1990), and then there are used to reveal the long-run Granger causality (Engle and Granger, 1987; Granger, 1988). However, Toda and Yamamoto (1995) applied the Granger causality (Hereafter: TY Granger causality) without any requiring of stationary and cointegration requirements among the variables before performing for the causality. In addition, the maximal order of integration (d_{max}) and the VAR optimal lag value are combined in forms of the VAR with lag order ($k+d_{max}$) to reveal the long-run relationship, which can be presented as Eq. (2) and Eq.(3):

$$X_t = \alpha_2 + \sum_{i=1}^{k} \omega_{1i} X_{t-i} + \sum_{i=1}^{d.max} \omega_{2i} X_{t-i} + \sum_{i=1}^{k} \omega_{3i} Y_{t-i} + \sum_{i=1}^{d.max} \omega_{4i} Y_{t-i} + \varepsilon_{2t} \quad (2)$$

$$Y_t = \alpha_3 + \sum_{i=1}^{k} \theta_{1i} Y_{t-i} + \sum_{i=1}^{d.max} \theta_{2i} Y_{t-i} + \sum_{i=1}^{k} \theta_{3i} X_{t-i} + \sum_{i=1}^{d.max} \theta_{4i} X_{t-i} + \varepsilon_{3t} \quad (3)$$

where d_{max} is the maximal order of integration, k is the VAR optimal lag value which is selected based on the lowest value of Schwartz information criterion (SIC) and Hannan-Quinn information criterion (HQIC). The null hypothesis of ω_{3i} and θ_{3i} equals to zero.

In the last step, variance decomposition is designed to indicate the relative shocks through decomposing the error variance of its own system in each variable. Thus, a 24 month-step prediction for exogenous and endogenous shocks can be caught. The generalized of variance decomposition was mentioned by Koop *et al.*, 1996 and Pesaran and Shin (1998) which can explain the shocks momentum of exogeneity including its own shock by forecasting the proportions of variance, in this case bases on the error variance in Eqs. (2) and (3) above.

3. Empirical results

As the time series properties, the variables should be demonstrated whether the series are captured the stationarity or non-stationarity. The property of stationarity means that mean, variance and covariance of the observation series are stable even though the time changes because economic meaning can be explained and relied on the stochastic process being stationary in testing (Granger and Newbold, 1974; Ender, 2004). The ADF unit root test is employed to examine the time series properties by including both constant and time trend terms in the random walk processes as Eq. (1).

Table 3: ADF unit root tests

Integrated order	Univariate variable							
	LITA		LTCO2		LECO2		LENG	
	t-statistic	*p*	*t*-statistic	*p*	*t*-statistic	*p*	*t*-statistic	*p*
Level	-3.553*	12	-2.055	13	-2.372	13	-1.808	12
First difference	-7.150*	11	-3.608*	12	-3.950*	12	-4.419*	11
Critical value								
5% level	-3.426							

* denotes the statistical significance at 5% level.

The univariate AR processes of LITA, LTCO2, LECO2 and LENG are presented the time series properties in Table 3. The null hypothesis of non-stationary can be rejected if the *t*-statistic is less than the critical value (MacKinnon, 1996). The Schwartz information criterion (SIC) is also utilized to hold on the lowest value of the optimal lag length for the fit model. The results related to the ADF unit root are shown that the hypothesis of non-stationary is carried out on LTCO2, LECO2 and LENG because the *t*-values are greater than the critical value (-3.426) at the 5% level. Then, the three variables have to be taken for the first differencing order. However, the ADF tests in Table 3 also show that LITA is rejected the hypothesis of non-stationary in the level, which means that LITA is integrated of order zero with contains unit root $I(0)$ process. And, when the first differencing order has been taken, then LTCO2, LECO2 and LENG are integrated which the stationarity is detected because the *t*-statistic is less than the critical value at the 5% level. Hence, these three variables are contained unit root $I(1)$ processes.

Table 4: VAR optimal lag selection

Criteria	VAR lag selection					
	Lag (0)	Lag (1)	Lag (2)	Lag (3)	Lag (4)	Lag (5)
SIC	-5.116	-13.096	-13.511	-13.385	-13.206	-13.114
HQIC	-5.146	-13.249	-13.785	-13.781	-13.725	-13.754

Table 5: Granger causality tests

Independent variable (X)	Dependent variable (Y)			
	LITA	LTCO2	LECO2	LENG
LITA	-	16.805*	26.006*	18.477*
LTCO2	0.324	-	2.462	3.598
LECO2	38.707*	6.831*	-	10.962*
LENG	7.820*	8.590*	6.006*	-

* denotes the statistical significance at 5% level.

Note: Null hypothesis: X does not Granger case Y. The TY Granger causality is explained for the long-run relationship.

Once the variables have been integrated in different order, therefore, the Granger causality approach through the processes stated by Toda and Yamamoto (1995) are performed in terms of VAR with lag order (k+d_{max}) model. As the maximal order (d_{max}) is found in the unit root results of Table 3 with order one, this implies that $I(1)$ is the maximal order of its integration. Then, Table 4 shows that the VAR lag model of two is selected based on the lowest value at lag (2) for the Schwartz information criterion (SIC) and Hannan-Quinn information criterion (HQIC) with the lowest value as -13.511 and -13.785, respectively. Then, the combination of VAR (k+d_{max}) can be modeled as VAR (2+1).

Based on the TY Granger causality test in Table 5, the modified Wald (χ^2) statistic is utilized to test on k parameters in the VAR(2+1) system with k degrees of freedom ($\chi^2(k)$). As the results from the tests, the bi-directional relationship is detected among LITA, LECO2 and LENG as well as uni-directional relationship of the three variables running to LTCO2, but no-response from LTCO2 side. The results imply that tourism development leads to increase of energy consumption and CO2 through transportation and economic activities, and vice versa except CO2 from transportation. In addition, energy consumption and CO2 emissions from whole economic sectors also lead to increase of CO2 emissions from transportation, but no vice versa. Furthermore, energy consumption leads to increase of CO2 emissions from whole economic sectors, and vice versa.

Table 6: Generalized of forecast variance decomposition

Dependent variable (Y)	Prediction (Month)	Independent variable (X)			
		LITA	LTCO2	LECO2	LENG
LITA	1	94.281	5.057	0.000	0.660
	6	86.132	3.214	10.081	0.571
	12	75.731	3.358	20.087	0.823
	18	69.379	4.295	25.175	1.149
	24	65.000	5.490	28.141	1.367
LTCO2	1	0.000	100.000	0.000	0.000
	6	7.201	91.071	0.698	1.028
	12	8.808	89.131	0.540	1.520
	18	9.890	86.856	0.620	2.633
	24	10.610	84.966	0.730	3.692
LECO2	1	0.385	53.331	36.889	9.394
	6	12.528	60.228	21.896	5.346
	12	16.458	61.164	17.810	4.567
	18	17.762	61.597	16.178	4.461
	24	18.373	61.933	15.180	4.512
LENG	1	0.000	84.384	0.000	15.615
	6	7.624	79.614	1.368	11.391
	12	8.348	77.590	1.023	13.037
	18	8.741	75.997	0.853	14.407
	24	8.971	74.896	0.754	15.377

The results of Table 6 are reported the generalized of forecast variance decomposition through 24 month-step prediction. As the LTCO2 shock proportions in the first month-period prediction of LITA, LECO2, LENG and its own system show that the shocks from LTCO2 have a strong relative effect on LECO2 and LENG systems including itself as 53.33%, 84.38% and 100.00%, respectively. When the time-period is forecasted to the 24th month, the momentum shocks of LTCO2 have been also kept the large effect on LECO2 and LENG systems including itself as 61.93%, 74.89% and 84.96%, respectively.

However, the shock proportion of LITA can be remained their shocks of its own system from 94.28% to 65.00% in the first to 24th month-period prediction. More interesting, LTCO2 and LITA can share the shock proportions as 61.93% and 18.37% in the LECO2 system when the 24th month-period is predicted, respectively. The results imply that transport sector is the major shock contribution effect on energy consumption and CO2 from whole economic sectors. Moreover, tourism development can also share the effect shock on the CO2 emissions through both transportation and economic activities at 10.61% and 18.37% in the next 24 months prediction, respectively. These evidences support the concerns that leisure industry has played a role in domestic CO2 emissions. And, it is also consistent with the findings of Mayor and Tol's (2010).

4. Conclusions

This empirical study presents the linkage between tourism development and CO2 emissions through transportation and economic activities including energy consumption in Thailand, over the period of January 1986 to May 2010. The Granger causality through Toda and Yamamoto (1995) is conducted with the multivariate vector autoregressive (VAR) model following the tests of ADF unit root. Moreover, the generalized of forecast variance decomposition is utilized to predict the shocks of risk effect among the variables throughout 24 months ahead.

Based on the results of TY Granger causality, energy consumption and CO2 emissions from both transportation and whole economic sectors are caused by tourism development in the long-run relationship. With strong promotions from government, Thailand has been concerned as the premier choice of the world tourism destination since 1987 (Ministry of Foreign Affairs, 2000). The findings of our results confirm that the economic activities have positive effect on transportation demand and energy consumption from promoting tourism policies.

The transportation and economic activities are indicated as the tourism expansion, thus CO2 emissions from those two sources should be considered as pollution generation source from tourism sector as well. Based on the findings, we support the issue that development in leisure industry causally connects with the growing volume in CO2 emissions from transportation and from whole economic sectors. Throughout 24 months prediction ahead, transport and tourism approaches are the major contributor effect on the future CO2 emissions. In line of the conclusions, tourism development has affected to environment through CO2 emissions which policy-makers are supposed to provide policies in terms of the responsibility such as the pollution taxes, compensations, and environmental or responded cost credits (Beladi *et al.*, 2009; Palmer and Riera, 2003) from tourism sector to reflect a friendly connection between environment and a non-smoking industry.

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