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THE EMPIRICAL EVIDENCE ON TOURISM-URBANIZATION-CO2 EMISSIONS NEXUS

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ABSTRACT

This study explores the tourism-urbanization-CO2 emissions nexus in the top 10 touristic destination over the period 1995-2016. Panel VAR methodology is employed. The findings of bivariate VAR models suggest the urbanization (UP) to have a significant positive response to the tourism receipts per capita (TR) as well as the negative response of the UP to the emissions of CO2. The outcome of trivariate model suggests a significant positive response of UP to its lagged value. However, tourism receipts per capita are found to respond negatively to the urbanization. The significant negative coefficient of -0.032 with UP suggests a negative response of urbanization to CO2 emissions. IRFs (Impulse Response Functions) suggest a negative response of CO2 to TR in the short-run. The impact is not found to be significant in the long-run. Besides that, the results suggest a positive decreasing response of urbanization to emissions of CO2. The results of this paper advocate the great environmental-awareness of citizens in the top 10 tourist destination suggesting that sustainable tourism has no alternative and key decision makers should develop strategies and do necessary steps in order to promote the development of sustainable tourism since the environment-friendly tourism is suggested to be the only acceptable one.

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INTRODUCTION

Climate changes are one of the most demanding issues nowadays. These changes are strongly associated with the greenhouse gasses (GHG) emissions. A great concern among policy makers is the fact that GHG emissions have significantly contributed to the global warming, have increased the sea level worldwide as well as the average temperatures. An important question here is whether or not the consequences are disproportionate in terms of developed countries taking into account the fact that these countries are leaders in terms of CO2 emissions. This research focuses on CO2 emissions since it accounts for more than 82% of total GHG emissions in countries that are in the group of developed (Zarzoso, 2008).

In terms of GHG emissions, Cunanan (2018) gives an overview of carbon intensive industries. Among these, the leader is energy consumption. UNDP suggests that 75% of all CO2 emissions at global level is associated with the usage and supply of fossil fuels (UNCFCCC, 2000). The second ranked in terms of top 5 carbon intensive industries are various kinds of land use such as agriculture. The impact of this sector on GHG emission is found to be twofold: 1. in order to obtain lands suitable for agriculture there is a need to clear many hectares of the forests, hence the number of CO2 absorbers has significantly reduced; 2. agriculture connected with animals emits not only CO2 but also the other kinds of GHG. The third sector is displayed to be the industry. In the year 2014, this sector is found to release about 21% of the total emission of CO2. This arose from the strong association of this sector with the fossil fuels necessary to operate many processes in industry. The fourth sector, very important for the topic of this paper, is transportation. In terms of the overall sector, the leader in terms of CO2 emission is road transport (72%). Besides this, Cunanan (2018) highlights the need to take into account the indirect emission connected with the cargo in transportation devices. Lastly, residential sectors are found to be ranked as fifth. Residential sectors produce CO2 by consuming energy intensively.

In terms of tourism industry, it is important to emphasize its significant positive externalities connected with the improvements in infrastructure, increasing new employment opportunities, increasing foreign direct investments, creating significant amount of revenue and enhancing the economic growth of the touristic destinations (Isik et al., 2018; Satrovic & Muslija, 2017). This sector is also rising exponentially in last decades and becoming the largest industry globally. UNWTO

Tourism Highlights from 2017 record the highest value of tourist arrivals to date. It has increased by 7% compared to the year 2016. In the line with positive externalities, it is essential to emphasize the negative externalities associated with tourism industry. Due to its reliance on transportation, tourism industry is found to be one of the leaders in terms of CO2 emissions (Isik et al., 2017). Apart from the transportation, many services provided by the host countries to tourists are considered to be energy-consuming. This energy is in general produced from non-renewable resources and thus releases significant amounts of GHG (Scott & Becken, 2010). Hence, tourism industry alone is found to release 8% of the total GHG globally in Lenzen et al. (2018). In addition, tourism industry has increased urbanization especially in very popular touristic destinations since many working places have been opened which has increased the demand of locals for residential sectors. As indicated before, residential sectors are one of the leaders in terms of CO2 emission.

With regard to the relationship between urbanization and emission of CO2, Wang and Li (2017) suggest that CO2 is determined by diverse factors. Urbanization is found to be one of them. In terms of urbanization, a great attention is given to the population growth. The population growth in urban areas is closely related to the increase in energy consumption which directly leads to the increase in GHG emission. Moreover, the demand for food increases, as well as for the agricultural land, decreasing the number of CO2 absorbers. Urbanization also leads to an increase in demand for residential sectors in urban areas. As indicated before, these sectors significantly contribute to the CO2 emission. Thus, studies to date in general agree that there is a positive link between GHG emissions and the urbanization movement of the society (Satterthwaite, 2009). However, Wang and Li (2017) indicate that urbanization might have positive results, too, such as increasing the efficiency of public transport and hence decreasing the consumption of energy as well as CO2 emissions.

With regards to findings presented by Wang and Li (2017), urbanization is found to play a significant role in the reduction of CO2 emissions. This is since it significantly increases the efficiency of public transport, which is an important service of tourism industry. Thus, urbanization can play an important role in sustainable tourism. In the light of sustainable tourism, it is important to emphasize that ecotourism is not expected to have a disruptive impact on environment; it ought to support the conservation aims of the tourist destination and has a minor negative effect to the culture of the destination. In addition, it is expected to increase the income and job opportunities in the local economy (Gossling, 2000). Besides that, the author suggests the necessity to limit the non-renewable resources. This limit is determined by the potentials to supply the renewable resources based energy. Moreover, the amount of wastes should not over range the assimilation capacity of the ecosystem of interest. Thus, the overall conclusion of Gossling (2000) is the necessity to replace fossil fuels based energy for renewable one which is found to be more appropriate, especially in developing countries. Besides that, the replacement is a key determinant of the development of the sustainable tourism (Satrovic, 2018b).

In terms of renewable energy, Işik and Radulescu (2017) stress the need to explore the tourism-renewable energy-growth nexus in the long run in order to develop the sustainable growth strategy. However, the authors emphasize that this is still an open question among research community suggesting that it is not clear whether or not renewable energy contributes to the economic growth and tourism industry or it is rather a consequence of these two phenomena. Therefore, this link has not been explored quite intensively in the long-run. The empirical findings by Işik and Radulescu (2017) suggest that renewable energy has a positive impact on economic growth in the long-run, which was the important insight for policy implications.

Taking into account previous paragraphs, it can be concluded that tourism-urbanization-CO2 emissions nexus is a topic that receives much attention among research community nowadays. Yet, a consensus is not achieved since the results strongly differ by regions and the level of development of the countries. Most of the studies analyze the link between variables of interest but do not pay much attention to the link in short- and long-run, which was the motivation to conduct this research. Besides that, most of the studies use time-series data and do not analyze the panel of the countries.

The objective of this paper is to examine the tourism-urbanization-CO2 emissions nexus in top 10 touristic destinations while applying the panel VAR. Moreover, the research aims to investigate separately tourism-urbanization nexus and CO2-urbanization nexus. Apart from these, a trivariate model will also be estimated analyzing the link between tourism-urbanization-CO2 emissions, representing the third objective of this research. The results of this paper suggest policy makers that sustainable tourism and development has no alternative. Thus, key policy makers need to make necessary efforts in order to promote both sustainable tourism and development, taking into account the fact that population increases exponentially as well as CO_2 emissions.

The contribution of this paper to the literature can be summarized as following. First, it is believed that this is a first work to give empirical evidence on the tourism-urbanization-CO_2 emissions nexus in the top 10 touristic destinations worldwide. Second, this study also differs from previous studies since it takes into account the latest available data (1995-2016) and considers the short- and long-run effects. Lastly, contrary to previous studies, the panel VAR is employed together with IRFs - impulse response Functions and FEVD - forecast-error variance decomposition.

The rest of this paper outlines the literature on the tourism-urbanization nexus as well as on CO_2 emissions- urbanization nexus. Besides that, a comprehensive overlook of methodology is given, together with the interpretation of the variables. The analysis moves forward to the interpretation of the results of empirical research. The concluding remarks are presented in the last section together with the recommendations for policy makers.

LITERATURE REVIEW

This paper is interested to examine the bivariate models treating tourism-urbanization nexus and CO_2 emissions-urbanization nexus as well as to provide empirical evidence on the trivariate model considering all variables of interest. Hence, this section provides empirical evidence on all relationships of interest to date.

Qian et al. (2012) used the case of China to explore the urbanization that is driven by tourism industry. The authors highlight the fact that consumption-based tourism tends to contribute to the urbanization. Apart from this, authors suggest that it will significantly change the economic structures. Urbanization based on tourism brought in significant changes such as the increase in service sectors as well as the increase in residential sectors. This urbanization is defined as an action that leads to the exclusively built or regenerated cities for the purpose of tourism e.g. pleasure (Mullins, 2003). Thus, urbanization is found to have a strong link with the industries related to tourism (Mullins, 1991).

Luo and Lam (2016) have used the case of China to investigate the link between hotel development and urbanization. They have collected primary data using the interviews. The empirical research suggests, economic dimension to be of the great importance. Besides that, population as well as cultural dimension is found to have a significant impact. The development of hotel industry represents a key element of the tourism in the case of China. In early 90's, the development of China was essentially focused on the development of hotel industry (Yu, 1992). With regard to urbanization, it is important to emphasize that China does not only face an exponential economic and the growth of the population, it also faces a rapid urbanization (Li &Yao, 2009). Moreover, urbanization is considered to be a critical factor to modernize rural societies. Zhang et al. (2013) has suggested a positive link between hotel development and urbanization in terms of China.

These results are confirmed by McCroskey (1990) in the case of USA, Shakouri et al. (2017) in the case of Asia-Pacific countries, and Isik et al. (2018) in the case of Greece. With regards to the Greece, authors suggest that tourism is one of the leading economic sectors but also one of the leaders in term of CO_2 emissions. Thus, it is of great importance for decision makers to take these facts into account while creating the tourism development strategies. These findings of Isik et al. (2018) are partially supported by Sghaier et al. (2018) in the case of Egypt.

Zhang et al. (2018) have utilized the gravity model to explore the impact of urbanization on the emission of CO_2 in the case of China. The results of this paper suggest no significant impact of urbanization. Moreover, the energy consumption is found to be a significant determinant of CO_2 emissions. Hence, the authors highlight the need for policy makers to introduce the environment friendly policy standards. The results of this paper should be seriously taken into consideration given that China is leader in terms of GHG emissions at the global level. Moreover, Han et al. (2018) suggests the urbanization to be one of the major producers of CO_2 in China. Hence, in addition to the consumption of energy, urbanization brings in a great concern in terms of environmental degradation in China (Du et al., 2016). Jebli and Hadhri (2018) employ the Granger causality technique to explore the link between tourism, CO_2 emissions due to the transport sector, real GDP and energy. This paper suggests a bidirectional causal link between tourism and real GDP as well as between the tourism and energy. Zaman et al. (2017) suggest that CO_2 emissions are intensified due to the tourism development and income. Thus, the authors stress the need to stimulate tourism sector to use green energy and thus decrease the environmental depletion.

Sadorsky (2014) have employed panel data to explore the link between urbanization and CO2 emission. The findings suggest both positive and negative effects of urbanization on environmental degradation. The author also highlights the drawback in research to data that do not take into account the link between urbanization and CO2. Hence, those environmental policies that do not take into account the aforementioned link, will discourage the sustainable development. Moreover, many of the cities have increased their wealth by increasing the manufacturing. On one hand, this tends to increase the environmental concerns but on the other hand, wealthier cities may reduce the CO2 emissions via innovations in technology or better regulations of the environment (McGranahan et al., 2001).

With regard to the case of China, the empirical evidence reported by Wang et al. (2018) is presented. The data are collected in the time span between 1990 and 2013. The findings of this paper outline two opposing impacts of urbanization on CO2 emissions. The population rise is found to have a negative impact on CO2 emissions while land and economic urbanization are found to contribute positively to the CO2 emissions. Special attention is given to the energy efficiency advocating that CO2 emissions increase in the case when the efficiency of energy decreases. The positive impact is also reported in the case of FDI – foreign direct investments.

Shahbaz et al. (2016) have explored the link between urbanization and CO2 emissions in the case of Malaysia at the quarter level. The findings of this paper suggest economic growth to be the leader in terms of CO2 emissions. Besides this, the consumption of energy as well as trade openness are found to release significant amounts of CO2. Urbanization is found to have negative impact on CO2 emissions initially. However, it is found to have a negative impact after the threshold level. Solarin and Shahbaz (2013) provide supportive evidence to this research in the case of Angola.

Most of these papers analyze the link between urbanization and CO2 emissions or urbanization and tourism while collecting the time-series data. Taking into account the fact that tourism significantly contributes to the urbanization as well as CO2 emissions, there is a need to explore the link between these three variables of interest. Thus, the present paper aims to fill in the gap in literature by analyzing the tourism-urbanization-CO2 emissions nexus in the top 10 touristic destinations by using the panel VAR model.

METHODOLOGY AND VARIABLES

VAR (Vector Autoregression) models are used for decades in time-series data. However, VAR models for panel data were proposed in 1980s (Sims, 1980). The advantage of panel VAR compared to time-series VAR is that it first enables to deal with the difference among units. Thereby it easily deals with both, static and dynamic, interdependencies (Canova & Ciccarelli, 2013). One of the most important features of panel VAR models is their ability to control for the heterogeneity and dynamics in the coefficients. The methodology applied in this paper follows Love and Zicchino (2006).

With respect to variables, it is important to emphasize that panel VAR consider all variables endogenous. To formalize the PVAR (Panel Vector Autoregression), there is a need to introduce the general form of the VAR model. Hence, Canova and Ciccarelli (2013) suggest the following form of the general VAR model (Eq. 1):

$$Y_t = A_0(t) + A(lag)Y_{t-1} + u_t \ (1)$$

where Y_t denotes the variables that are endogenous, u_t are assumed to be IID (independent and identically distributed). In addition, lag operator is denoted by $A(lag)$. As indicated above, panel VAR differs from the general VAR by introducing the difference among units. Hence, equation 2 formalizes panel VAR model:

$$y_{it} = A_{0i}(t) + A_i(lag)Y_{t-1} + u_{it} \ \ (2)$$

where $i = 1, \ldots, N$ and $t = 1, \ldots, T$, u_{it} denotes the vector of disturbance. This paper will empirically test the tourism-urbanization-CO2 emissions nexus. Thus, Eq. 3 summarizes the models of interest as following:

$$\boldsymbol{UP_{it}} = \sigma + \sum_{i=1}^{k} \boldsymbol{\beta_i} \boldsymbol{UP_{t-1}} + \sum_{j=1}^{k} \theta_j TR_{t-j} + \sum_{m=1}^{k} \varphi_m CO2_{t-m} + u_{1t}$$

$$\boldsymbol{TR_{it}} = \alpha + \sum_{i=1}^{k} \beta_i UP_{t-1} + \sum_{j=1}^{k} \boldsymbol{\theta_j} \boldsymbol{TR_{t-j}} + \sum_{m=1}^{k} \varphi_m CO2_{t-m} + u_{2t}$$

$$CO2_{it} = d + \sum_{i=1}^{k} \beta_i UP_{t-1} + \sum_{j=1}^{k} \theta_j TR_{t-j} + \sum_{m=1}^{k} \varphi_m CO2_{t-m} + u_{3t} \quad (3)$$

Where every dependent variable is estimated as a function of its lagged value as well as the other variables (lagged). The shocks are denoted by u. The annual data are collected in the time-span between 1995 and 2016. The criterion to select a time-frame was the availability of the statistics on the variables of interest. UP (urban population (% of total)) is used as a proxy of urbanization. Moreover, international tourism, receipts (current US$) is considered appropriate as a proxy of tourism. This variable is suggested by Satrovic and Muslija (2017; 2018). Lastly, CO2 emissions (metric tons per capita) are denoted by CO2. Since CO2 variable is expressed per capita, we have calculated international tourism, receipts per capita in order to make data comparable and to ease the interpretation. Besides panel VAR, this paper will use 200 Monte Carlo simulations to calculate the confidence bounds assigned with IRF. Lastly, forecast-error variance decomposition will be calculated following the propositions of Abrigo and Love (2016). Hence it is important to summarize the selection of panel VAR model, the estimations as well as the inference within the GMM - generalized method of moments framework. Abrigo and Love (2016) have formalized the k – variate fixed effects panel VAR that has p order as following (Eq. 4):

$$Y_{it} = Y_{it-1}A_1 + Y_{it-2}A_2 + \cdots + Y_{it-p+1}A_{p-1} + Y_{it-p}A_p + X_{it}B + u_{it} + e_{it} \quad (4)$$

where the vector of independent variables $(1xk)$ is denoted by Y_{it}; vector of exogenous covariates $(1xl)$ by X_{it}; fixed effects have the dimension of $(1xk)$ and are denoted by e_{it}; coefficients to be estimated are denoted by $A_1 \ldots A_p, B$. The rest is explained above. With regards to the GMM framework, various estimators have been proposed to estimate the panel VAR. However, many drawbacks are assigned to these frameworks. For instance, in the case of unbalanced panel, the first-difference transformation enlarges the gap. Taking into account these disadvantages, forward orthogonal deviation is proposed but it may not include the last available observations (Abrigo & Love, 2016). Equation-by-equation estimation may provide the consistent estimation but at the cost of efficiency. However, Eq. 4 is estimated using this approach and explained in detail in Abrigo and Love (2016).

In terms of the model selection, it is important to select the lag order. This paper follows the criteria proposed by Andrews and Lu (2001). With regards to the IRF, it can be calculated by rewriting the aforementioned model as an infinite VMA (vector moving-average), where the parameters may be denoted by φ_i (Abrigo&Love, 2016).

$$\varphi_i = \begin{cases} I_k, & i = 0 \\ \sum_{j=1}^{i} \varphi_{t-j} A_j, & i = 1, 2, \ldots \end{cases} \quad (5).$$

At last, shocks are orthogonalized by isolating the contribution of every variable to the FEVD. As in IRF, it is important to determine the confidence intervals. These can be determined using analytics or some of the resampling techniques.

RESULTS OF THE RESEARCH

To present the results of empirical section it is important to emphasize that the top 10 touristic destinations are selected using the data on number of arrivals of tourists in the year 2016. The first row in the Table 1 indicates the ranking. The empirical findings of this research are first presenting the most important measures of summary statistics for all countries of interest. With regards to the tourism receipts per capita, significant differences among countries are reported indicating the maximum average value in terms of Spain. The minimum average value of tourism receipts per capita is reported for China. Standard deviations are also confirming the significant differences among countries. In terms of CO2 emissions (metric tons per capita), the highest reported value on average is in the case of United States. The least country in terms of CO2 emissions (metric tons per capita) is reported to be Thailand. Lastly, the ratio of urban to total population is found to be the highest (on average) in the case of United Kingdom. The lowest ranked country in terms of urbanization is Thailand. The measures of descriptive statistics suggest significant differences among these top 10 touristic destinations in terms of all variables of interest. The statistics on CO2 emissions is very concerning suggesting that those countries with the highest value of tourism receipts are in the same time the leaders in terms of CO2 emissions which leads to growing concerns about the sustainable tourism.

Table 1. *Descriptive Statistics*

	Measur.	China (4)	France (1)	Germany (7)	Italy (5)	Mexico (8)	Spain (3)	Thailand (9)	Turkey (10)	United Kingdom (6)	United States (2)	Total
TR	mean	23.13	780.75	485.72	630.83	107.68	1081.91	322.78	272.72	666.02	496.77	486.83
	sd	10.41	190.95	160.41	98.34	23.91	246.58	209.89	138.61	164.88	144.04	341.13
	max	37.14	1062.50	728.40	793.10	161.54	1413.04	753.62	506.49	969.23	781.25	1413.04
	min	7.25	450.00	292.68	473.68	72.34	675.00	129.03	83.87	440.68	344.83	7.25
CO2	mean	4.88	5.69	9.79	7.25	3.99	6.61	3.68	3.78	8.27	18.49	7.24
	sd	1.97	0.49	0.56	0.91	0.23	0.98	0.67	0.63	1.09	1.40	4.34
	max	7.56	6.28	10.86	8.22	4.35	8.10	4.75	5.08	9.48	20.18	20.18
	min	2.65	4.57	8.82	5.27	3.54	5.03	2.67	2.94	5.93	16.30	2.65
UP	mean	43.36	77.28	75.93	67.96	76.45	77.53	38.41	68.12	80.22	79.89	68.52
	sd	8.23	1.58	1.13	0.87	1.95	1.32	6.52	3.80	1.55	1.32	14.92
	max	56.74	79.92	77.22	69.86	79.58	79.84	48.45	74.13	82.89	81.86	82.89
	min	30.96	74.91	73.92	66.92	73.37	75.86	30.28	62.12	78.35	77.26	30.28

Note: TR: international tourism, receipts (current US$); CO2: CO2 emissions (metric tons per capita); UP: urban population (% of total)

In addition to the measures of descriptive statistics, this empirical research proceeds to the panel VAR model. Beforehand, there is a necessity to test for unit-root of the variables in levels and first differences. This empirical analysis suggests three commonly used tests for the stationary properties. Table 2 shows the results.

Table 2. *Unit-root Tests in Level and First Difference*

Trend included in the model	lnTR		D.lnTR		lnCO2		D.lnCO2		lnUP	
Method	Stat.	p-value	Stat.	p-value	Stat.	p-value	Stat.	p-value	Stat.	p-value
ADF – Fisher inverse chisquare	14.06	0.827	86.70	0.000	17.00	0.653	60.59	0.000	66.08	0.000
Im–Pesaran–Shin test	2.08	0.981	-8.35	0.000	1.10	0.864	-10.86	0.000	-1.97	0.024
Levin–Lin–Chu (LLC) t* test	-0.35	0.362	-9.46	0.000	-1.48	0.069	-11.23	0.000	-2.94	0.002

With regards to the tourism receipts variable per capita as well as CO2 emissions (metric tons per capita), it is important to emphasize that all of the tests suggest the presence of unit-root in levels. Hence, the null on the unit-root cannot be rejected indicating the non-stationary series. However, these tests suggest that first differences are stationary rejecting the null hypothesis assuming the unit-root. These results are approved for a 1% significance level. Additionally, we have tested for the stationary properties of the urbanization proxy variable. Im–Pesaran–Shin test suggests that this variable is stationary in the level for a 5% level of significance. However, the stationary properties are also confirmed by ADF (Augmented Dickey–Fuller) – Fisher inverse chisquare and Levin–Lin–Chu (LLC) t* test for a 1% significance level assuming the stationary series in the first difference. Due to the fact that all of the variables are reported to be stationary in the first difference, this research proceeds to the estimation of panel VAR.

Table 3. *The order of PVAR*

Order	CD	J	J p-value	MBIC	MAIC	MQIC
1	0.999918	39.61991	0.055584	-97.4098	-14.3801	-48.0956
2	0.999963	16.71587	0.542715	-74.6373	-19.2841	-41.7611
3	0.999969	10.61476	0.303042	-35.0618	-7.38524	-18.6237

Table 4. *VAR Models (Bivariate – GMM Estimation)*

Independent variables	Dependent variables	
Model 1: UP and TR		
	lnUP	D.lnTR
$lnUP_{t-1}$	0.998	-0.204
	(0.009)***	(0.202)
$D.lnTR_{t-1}$	0.012	0.221
	(0.006)*	(0.151)
Model 2: UP and CO2		
	lnUP	D.lnCO2
$lnUP_{t-1}$	0.977	-0.054
	(0.009)***	(0.065)
$D.lnCO2_{t-1}$	-0.034	0.039
	(0.018)*	(0.107)
Model 3: TR and CO2		
	D.lnTR	D.lnCO2
$D.lnTR_{t-1}$	0.130	0.011
	(0.083)	(0.035)
$D.lnCO2_{t-1}$	0.260	0.097
	(0.221)	(0.101)

Note: ***, **, * significant at 1%, 5% and 10% respectively.

To estimate the panel VAR, it is necessary to determine the order of the model. Andrews and Lu (2001) suggests that the selection criterion is based on the R square, as well as the Hansen's (1982) J statistics with the level of significance. The sum of moment conditions is assumed to be higher than the number of endogenous variables. Table 3 displays the measures used to determine the order of the model. The findings suggest the lowest values of MBIC (Modified Bayesian Information Criterion) and MQIC (Modified Quasi Akaike Information Criterion) in terms of the first- compared to second- and third-order panel VAR. MAIC (Modified Akaike Information Criterion) suggests that the lowest values are displayed for the second-order panel VAR. Due to the fact that MBIC and MQIC suggest the first-order panel as optimal, we continue our analysis by applying GMM (Generalized Method of Moments) to obtain the coefficients for the first-order panel VAR (Satrovic, 2018a).

The results of panel VAR models (bivariate) are displayed in Table 4. The urbanization is found to have a significant positive response to the tourism receipts per capita in model 1. In addition, a significant positive response of UP to UP is also found. Other responses are not found to be significant. With respect to the second model, it is important to underline a negative response of the urbanization to the emissions of CO2. Additionally, a response of UP to UP is found to be significant and positive. All other influences in model 2 as well as those in model 3 are not reported to be significant.

Table 5. *VAR based Granger causality (bivariate models)*

Equation	Excluded	chi2	p-value
lnUP	D.lnTR	3.358	0.067
D.lnTR	lnUP	1.013	0.314
lnUP	D.lnCO2	3.523	0.061
D.lnCO2	lnUP	0.700	0.403
D.lnTR	D.lnCO2	1.385	0.239
D.lnCO2	D.lnTR	0.106	0.744

The eigenvalues are calculated for these three models. The values <1 suggest the stability of the models. This finding is also supported by graph suggesting that all eigenvalues are within the unit circle. To present results on causality, Granger causality test was employed. Table 5 shows that tourism receipts per capita Granger cause urbanization. However, UP is not found to cause TR. Model 2 suggests that CO2 emissions Granger cause urbanization, while urbanization is not found to have a causal impact on CO2 emissions. Lastly, there is no evidence on the Granger causality in the link between CO2 and tourism.

Since this paper is interested in the link between all three variables of interest, this research proceeds to the estimation and interpretation of trivariate model. Table 6 presents these results.

Table 6. *VAR Model (Trivariate – GMM Estimation)*

Independent variables	Dependent variables lnUP	D.lnTR	D.lnCO2
$lnUP_{t-1}$	0.988	-0.311	-0.088
	(0.008)***	(0.167)*	(0.059)
$D.lnTR_{t-1}$	0.006	0.156	-0.002
	(0.005)	(0.120)	(0.035)
$D.lnCO2_{t-1}$	-0.032	-0.376	0.033
	(0.014)**	(0.333)	(0.094)

The outcome of this model suggests a significant positive response of UP to its lagged value. However, tourism receipts per capita are found to respond negatively to the urbanization. This result is very promising suggesting the great environmental-awareness in the top 10 tourist destination. Hence, the tourism that differs from sustainable tends to decrease with the level of urbanization. The significant negative coefficient of -0.032 with UP suggests a negative response of urbanization to CO2 emissions confirming the previous notation of great environmental-awareness of citizens in top 10 tourist destination indicating that sustainable tourism and development has no alternative. With respect to the results of Wald test, Table 7 displays a unidirectional Granger causal link running from CO2 emissions to urbanization as well as of urbanization to TR confirming the results of the trivariate panel VAR model.

Table 7. *Results of the Granger causality tests*

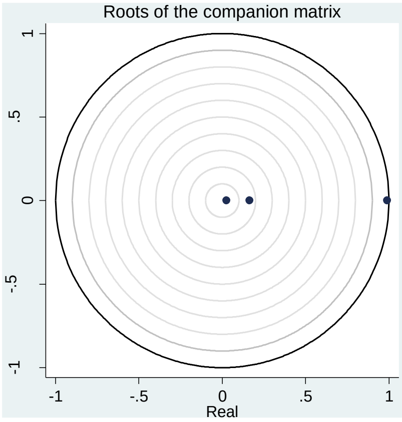
Equation	Excluded	
	D.lnTR	D.lnCO2
lnUP	1.568	5.150
	(0.211)*	(0.023)
	lnUP	D.lnCO2
D.lnTR	3.473	1.275
	(0.062)	(0.259)
	lnUP	D.lnTR
D.lnCO2	2.216	0.004
	(0.137)	(0.947)

Note: * p-value

In order to increase the effectiveness of the result' interpretation, panel VAR is in general accompanied with the forecast-error variance decomposition (FEVD) and IRFs. Before estimating and graphing these measures, there is a need to test for the stability of trivariate PVAR model. Table 8 (eigenvalues) and Graph (1) confirm the assumption of the stability of these models.

Table 8. *Stability of the model*

Eigen value		
Real	Imaginary	Modulus
0.989	0.000	0.989
0.163	0.000	0.163
0.025	0.000	0.025



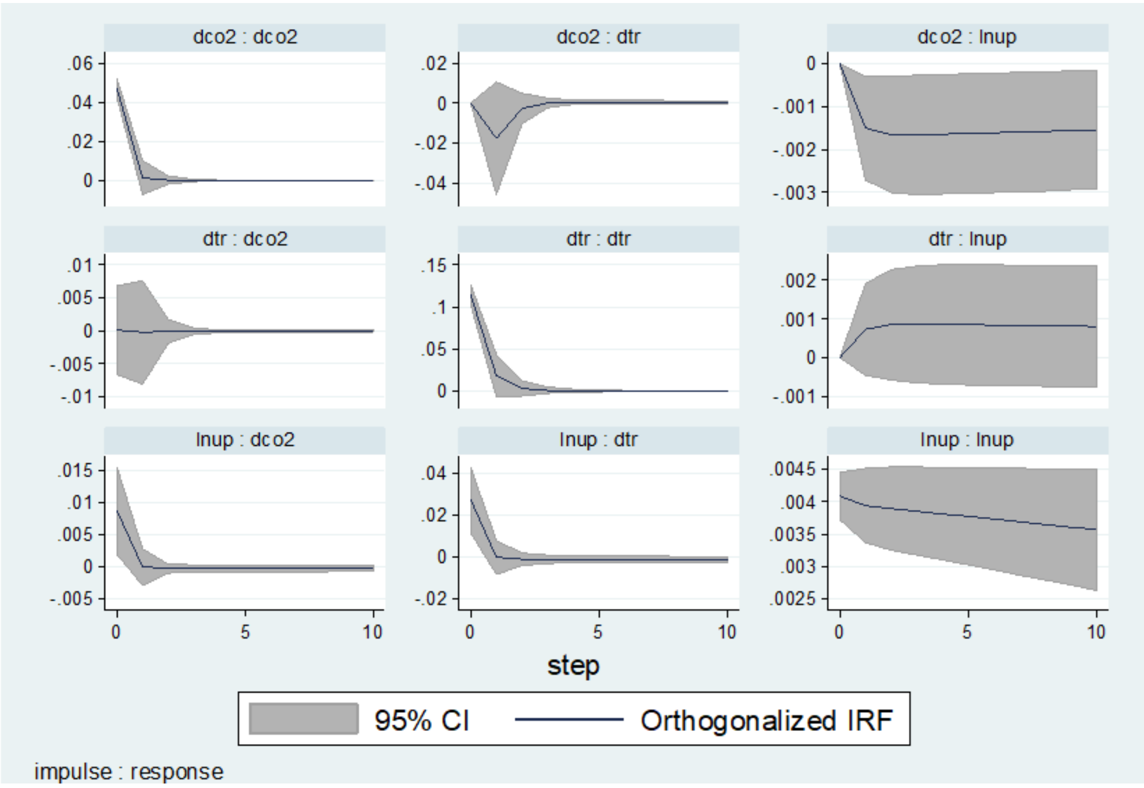
Graph 1. *Stability of the model*

Since panel VAR is interested to explore the impact of potential shocks assigned to exogenous variables (Abrigo&Love, 2016), this analysis moves forward to FEVD and IRF. The results are displayed in the Table 9 advocating that urbanization, tourism and CO2 proxy variables are found to interpret the 83.1%, 3.6% and 13.3% of the of the variation in urbanization. In addition, these variables are found to explain respectively about 5.3%, 92.5% and 2.2% of the variation in the proxy variable of tourism. At last, the variables of interest are found to interpret the 3.3%, 0% and 96.7% of the variability of CO2 emissions.

To conclude the empirical analysis, we display and interpret IRFs. Graph 2 shows a negative response of CO2 to TR in the short-run. The impact is not found to be significant in the long-run. Besides that, the results suggest a positive decreasing response of urbanization to emissions of CO2. The response of tourism to CO2 emissions is not found to be different from zero. Apart from these results, it is important to emphasize an increasing positive response of TR to the urbanization supporting the idea of great environmental-awareness of citizens in top 10 touristic destinations. Urbanization is found to react positively to the emissions of CO2 but only in the short-run. This response is decreasing and becomes zero in the long-run. This holds true for the link between UP and TR.

Table 9. *Forecast-Error Variance Decomposition*

Response variable	Impulse variable			Response variable	Impulse variable			Response variable	Impulse variable		
lnUP	lnUP	D.lnTR	D.lnCO2	D.lnTR	lnUP	D.lnTR	D.lnCO2	D.lnCO2	lnUP	D.lnTR	D.lnCO2
0	0.000	0.000	0.000	0	0.000	0.000	0.000	0	0.000	0.000	0.000
1	1.000	0.000	0.000	1	0.054	0.946	0.000	1	0.033	0.000	0.967
2	0.920	0.016	0.065	2	0.052	0.926	0.022	2	0.033	0.000	0.967
3	0.883	0.024	0.093	3	0.052	0.926	0.022	3	0.033	0.000	0.967
4	0.864	0.028	0.108	4	0.052	0.926	0.022	4	0.033	0.000	0.967
5	0.853	0.031	0.116	5	0.052	0.926	0.022	5	0.033	0.000	0.967
6	0.846	0.032	0.122	6	0.052	0.926	0.022	6	0.033	0.000	0.967
7	0.840	0.034	0.126	7	0.052	0.925	0.022	7	0.033	0.000	0.967
8	0.837	0.035	0.129	8	0.052	0.925	0.022	8	0.033	0.000	0.967
9	0.834	0.035	0.131	9	0.053	0.925	0.022	9	0.033	0.000	0.967
10	0.831	0.036	0.133	10	0.053	0.925	0.022	10	0.033	0.000	0.967



Graph 2. *IRF Plots*

DISCUSSION AND CONCLUSION

This paper has analyzed the tourism-urbanization-CO2 emissions nexus collecting the annual panel data in the period between 1995 and 2016 for the sample of top ten touristic destinations. Panel VAR methodology is used to examine the 2- and 3-variable models. First-order panel is suggested to be optimal.

Model 1 (bivariate) shows a significant positive response of urbanization to the tourism receipts per capita in model 1. These findings are well supported by (Guo et al., 2015) suggesting that the urbanization rate has a positive correlation contribution to the development of tourism economics. Moreover, the positive link is also supported by Patty & Kuncoro (2016). In addition, a significant positive response of UP to UP is also found. Other responses are not found to be significant. With respect to the second model, it is important to underline a negative response of the urbanization to the emissions of CO2. All of the models are found to be stable. Receipts per capita are found to Granger cause urbanization. However, UP is not found to cause TR. Model 2 suggests that CO2 emissions Granger cause urbanization, while urbanization is not found to have a causal impact on CO2 emissions.

The outcome of trivariate model suggests a significant positive response of UP to its lagged value. However, tourism receipts per capita are found to respond negatively to the urbanization. The significant negative coefficient of -0.032 with UP suggests a negative response of urbanization to CO2 emissions. This evidence on the negative link is also given by Chen et al. (2018); Sharma (2011) and York et al. (2003). However, these authors suggest that the sign of the link between these variables of interest strongly depends on the level of development and can be the results of the different impact of the CO2 emission reduction policies.

With respect to the results of Wald test, a unidirectional Granger causal link running from CO2 emissions to urbanization is reported as well as of UP to TR. In terms of IRFs, a negative response of CO2 to TR in the short-run is displayed. The impact is not found to be significant in the long-run. Besides that, the results suggest a positive decreasing response of urbanization to emissions of CO2. The response of tourism to CO2 emissions is not found to be different from zero.

The findings of this paper seem to be very promising suggesting the great environmental-awareness in the top 10 tourist destination. Hence, the tourism that differs from sustainable one tends to decrease with the level of urbanization. The sustainable tourism and development is assumed to be without alternative in the examined countries. Thus, the policy implications of this paper suggest that key decision makers should develop strategies and do necessary steps in order to promote the development of sustainable tourism since the environment-friendly tourism is reported to be the only acceptable one. In order to promote the sustainable tourism, it is important to emphasize a key role of renewable energy. Thus, sustainable tourism and green energy are very closely connected. To develop the green energy, there is the key role of government to create renewable energy friendly policies. The same holds true for the sustainable tourism. It is of crucial importance to promote both green energy and sustainable tourism since those can significantly contribute to the economic growth and mitigate the emission of greenhouse gases. This is even more important since the fossil fuels based energy and tourism based on this energy can cause serious environmental issues not only in these top 10 touristic destinations but also at the global level. Moreover, it is crucial to attract the investors to support the renewable energy projects. Initially, these projects may be expensive but promise high returns in the both short- and the long-run, and thus can be very attractive for investors. Thus, countries may start with small and medium projects connected with the renewable energy. Besides these, policy implications should also include the education on the society in the whole on the positive externalities on the sustainable tourism and green economy for the economy as a whole.

The main limitations of this study are that it did not analyze the role of renewable energy in the nexus of interest. The introduction of the proxy of renewable energy is of key importance assuming the fact that it can significantly reduce the CO2 connected with the tourism services that are found to be significant energy gluttons. Moreover, the potential impact of the 2007-2008 financial crises is not observed even though this crisis has influenced significantly tourism receipts at the global level. At last, the analysis based on individual time-series has not been conducted but can provide the important insights for policy makers.

Thereby, the recommendations for future research may include the necessity to introduce the renewable energy while analyzing the nexus of interest. Besides, it is of key importance to explore the potential shocks due to the financial crisis in the years 2007-2008. In addition, there is a need to analyze and compare the dynamic in the nexus of interest for all top 10 touristic destinations individually. Despite these limitations, this paper represents the contribution to the literature to date in the sense that it gives the preliminary evidence on the tourism-urbanization-CO2 emissions nexus in the top 10 touristic destinations, and uses the last available data and presents the results in the both short- and long-run. In addition, it employs the panel VAR together with IRFs and FEVD to provide the empirical evidence.

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