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Evaluation of environmentally conscious tourism industry: Case of Croatian counties

Abstract

Tourism industry is very important in Croatia, due to its contribution to employment and GDP. In the last couple of years, there is an ongoing debate on how to further develop this sector of the economy, its supply and opportunities in order to fully utilize its potential. On the other side, discussions on sustainable business in general and sustainable tourism are getting louder every year. The purpose of this study was empirically evaluate the efficiency of environmentally conscious tourism industry of 21 Croatian counties over the period 2011-2015 by using Data Envelopment Analysis methodology. This is the first research of this kind in Croatia, and Balkan region as well; where environmental and economic features are observed in evaluating tourism industry. Static models, as well as window analysis were employed in order to evaluate economic and environmental features of tourism. On average, the majority of the counties had an increase of efficiency scores over time. This means that combination of waste management with growth of tourist arrivals has, on average, improved over the observed period. Finally, some recommendations of improvements are given based upon the results for the most inefficient counties, which had problems with waste management in the past.

Key words: sustainable tourism; Data Envelopment Analysis; efficiency evaluation; tourism industry; environment and tourism; Croatia

Introduction

Measuring and comparing efficiency of many different industries has been gaining increasing importance over the last couple of decades. Tourism industry is one of the fastest growing industries in the world today. Finding good practices, learning from and implementing them can result with outstanding outcomes (regarding total employment, contribution to GDP and other socio-economic benefits). However, the sustainable businesses paradigm has gotten a lot of attention over the last 20 years. Waste and other environmental pressures which arise with growing tourism industry could have a negative feedback on it, if not managed well. In that way, it is important to evaluate sources of (in)efficiencies of bad and good practices in tourism industry today. Cracolici, Nijkamp and Rietveld (2006) define sources of (in)efficiencies of tourist destinations as governmental regulations, global forces (including increasing attention for the natural environment), as well as physiography, culture and social forces.

The main hypothesis of this study is that when evaluating the results in tourism industry, it is important to include both economic and environmental variables in the analysis. In that way, sustainable tourism industry can be evaluated properly. If degradation of natural resources due to tourism activity causes a destination to be unattractive, it could lose its sources of income. The results and main conclusions from this study could be a starting point for those countries or regions in which the importance of tourism is great with respect to total employment and development of the economy. In that way, policy makers on all levels can make needed adjustments in order to achieve environmentally conscious

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tourism supply, as well as desirable economic results. Thus, main goals of the paper include objectively evaluating the efficiency of sustainable tourism in practice, by including relevant variables. Moreover, goals include giving recommendations in general for all levels of tourism supply, in order to achieve environmentally conscious tourism industry in the future.

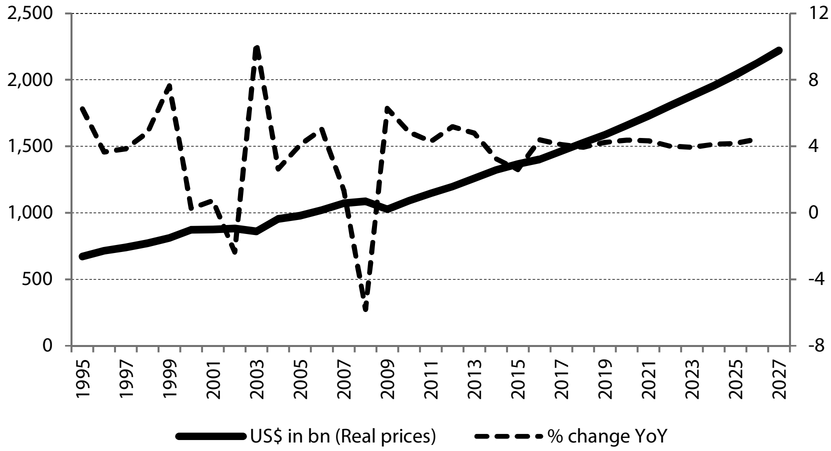
Main focuses of this paper were 21 Croatian counties over the period from 2011 to 2015. Since tourism plays an important role in Croatia regarding the total economy, data on this country is appropriate to fulfill the goals of this paper. Moreover, in the last decade, Croatia has been dealing with adjusting its environment legislation with European Union, as well as sanitation of many waste landfills. In that way, Croatian data is suitable to explore in such manner. Data envelopment analysis (DEA henceforward), as a special field of operations research, has focused and developed many models which are adjusted accordingly to different types of industries and units of observation. DEA models are used to evaluate efficiency of firms, counties, hospitals, restaurants, etc. In the last couple of years, this methodology has become one of the main approaches in measuring efficiency and sources of inefficiencies in many different fields. This paper utilized DEA methodology as well. Only three papers in total have been found which combine economic and environmental component in evaluating efficiency of tourism industry in period of writing this research. Thus, there exist opportunities for expansions of evaluation and benchmarking in this field of research.

The rest of the paper is organized as follows. Second section describes the importance of sustainable tourism in general, with a special focus on Croatia in order to give readers insights on current state in this country. Third section presents the results from previous relevant research, which dealt with environmental issues in tourism industry. Fourth section provides the methodology used in this study, while fifth section presents the results from the empirical research, along with detailed commentary. Final chapter concludes the paper by stating the advantages and pitfalls of this study, along with recommendations not only for the observed region, but for other regions where tourism plays an important role as well.

Importance of sustainable tourism (in Croatia)

In general, world tourism is one of the fastest growing industries today. Figure 1 shows growing foreign visitor spending in the whole world, its rate of growth and their forecasts up until 2027. As it can be seen, a steady rate of 4% yearly growth is predicted to continue in the future. However, in order to obtain such high growth rates, tourism industry must match continuously changing tourism demand. Sustainable tourism is a concept which is used extensively over the last couple of years. Sustainable economic development in general gained popularity since 1987, with the Brundtland Report from UN. World Tourism Organization (2017) defines sustainable tourism as "*Tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities*". Other definitions can be seen in Blackstock, Scott, White and McCrum (2006). Common factors in all of them are environmental, economic and social values. European Commission (2017) states that "*The success of tourism is, in the long-term, closely linked to its sustainability, with the quality of destinations often influenced by their natural and cultural environment and/or integration into the local community*." Year 2017 was declared as International year of sustainable tourism for development by UN (2016). The pressure of making concrete actions in order to achieve and maintain sustainability in tourism is highest possible today. Focusing mostly on economic expansion of tourism industry in the past has contributed to this pressure as well.

Figure 1
Foreign visitor spending

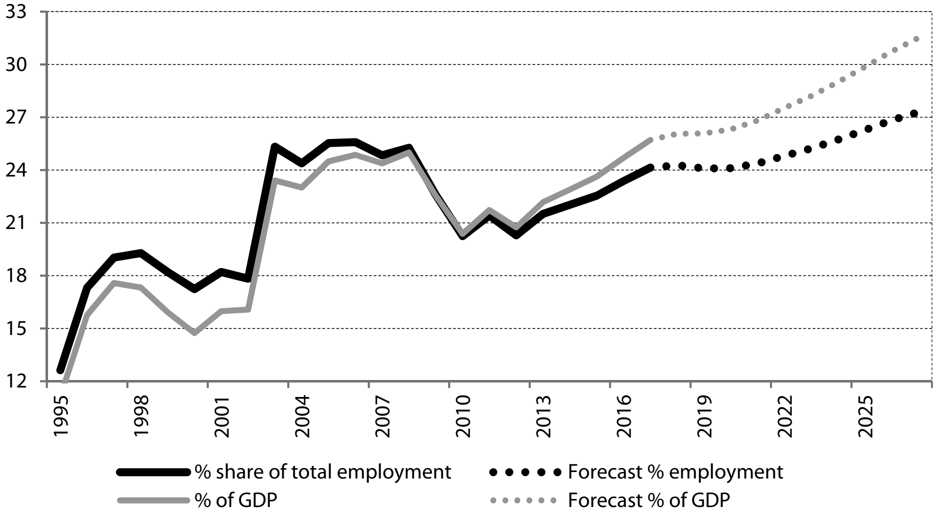


Note: US dollars left axis, percentage change right axis.
Source: WTTC (2017).

By focusing on characteristics of Croatia, as a new EU member state (since 2013), tourism plays an important role in the Croatian economy. Today, it generates about 25% of GDP and 24% of total employment. The dynamics over the past years, as well as forecasts up until 2027 are given in Figure 2. It is estimated that in 10 years, employees in tourism sector will constitute more than 27% of the labor force; tourism will have more than 31% of direct contribution to GDP and 43% of total exports. According to the WTTC (2017), Croatia holds 32nd place in the world when comparing The Travel & Tourism Competitiveness Index (an improvement of one place was made compared to 2015); 21st place in the 9th pillar of the index (environmental sustainability); and 5th place in the 12th pillar (tourist service infrastructure). However, the majority of previous developments in this sector focused on accelerated construction of hotel accommodation; concentrating it on the coastal area; lack of planning of infrastructure construction; etc. Institute for tourism in Croatia (2016) states that unresolved solid waste and wastewater management are most important issues regarding coastal settlements; as well as lack of adequate municipal infrastructure; and solid waste management is not yet solved in accordance with EU regulations. Sunara, Jeličić and Petrović (2014) emphasize that Croatian legislative and financial framework does not encourage sustainable development enough. They add that the last financial crisis from 2007-2008 fostered permissive behavior of authorities towards big polluters.

Nevertheless, the discussion on sustainability and environmental conscious tourism is getting more attention every year in Croatia. There exist a lot of case studies of specific destinations as examples of developing sustainable tourism in the long run. However, there is a lack of empirical studies which try to compare different destinations, hotels, counties, etc. by utilizing the benchmarking approach. On the other side, the legislation is continuously improved, and new strategies of developing tourism are being brought. Croatian government (2013) brought a new proposal of tourism development strategy in 2013, for tourism development up until 2020. In that proposal, they are aware of preservation of the nature and environment in Croatia; and that responsible development of tourism is the way to go. But some problems still remain: inadequate location management in accordance with sustainable development. Not many concrete measures can be found in order to fulfill future goals. That is why this research is going to compare results in all Croatian counties in order to find good practices, so the local authorities could study them and mimic their actions in the future.

Figure 2
Contribution of tourism to Croatia's GDP



Source: WTTC (2017).

Previous relevant research

Measuring efficiency in tourism industry is not a new area of research. Much previous literature has observed efficiency of hotels, restaurants, regions, countries as a whole, etc. For a comprehensive list of other applications of DEA methodology in environmental research, please see Zhou, Ang and Poh (2008), hotel applications in Barros (2004) and hospitality applications can be seen in Reynolds (2003). This section presents results from previous research relevant to this study.

Main characteristics of previous analysis mostly connected with this study are given in Table 1. It can be seen that there do not exist many studies which incorporate environmental component into evaluating tourism efficiency, although there exist many papers which stress out the importance of benchmarking in sustainable tourism (please see details in Blackstock Blackstock, Scott, White & McCrum, 2006). Models which were utilized are basic ones (BCC or CCR) and majority of researchers apply window analysis as well (dynamic analysis). Only three papers have been found which incorporated environmental components into the analysis up until writing this study. Reasons could lie upon facts that specific environment variables connected to tourism are difficult to measure. Variables used in studies can be seen in the fourth and fifth column of Table 1. They refer to tourism pressure, temporal distribution, environmental benefits and waste. Bosetti, Casinelli and Lanza (2003, 2004, 2006) found inefficient those Italian municipalities which had excess production of waste during tourism season.

Other research provided in Table 1 refers to authors who analyzed Croatia or similar countries and their regions. Rabar and Blažević (2011) compared Croatian counties by observing only economic variables, but that paper provides a starting point for this study. Soysal-Kurt (2017) included Croatia in his analysis. However, he states that Croatia had 1.5 million employees in tourism sector in 2013, but Croatia had in total 1.3 million employees in the whole economy. Although his results indicated that Croatia is among efficient countries, the results are not fully reliable. Cvetkosa and Barišić (2017) is the latest research which included Croatia in the analysis. They found that it was second best (after Albania) among Balkan countries in the observed period. Again, they used only economic variables as well. Similar results were found in Hadad, Hadad, Malul and Rosenboim (2012), where Croatia was among 10 most efficient developing countries.

At an aggregate level, Croatia was found among more efficient countries, when comparing economic variables. Rabar and Blažević (2011) found good and bad practices on a county level. However, the environmental component has yet not been observed, despite many laws, guidelines and strategies of tourism development in Croatia. In that way, this study will provide first steps towards empirically evaluating aforementioned questions.

Table 1
Summary of previous relevant DEA empirical research on tourism industry

Research	Period	Observed units	Inputs	Outputs	Model
*Bosetti, Cassinelli & Lanza (2003)	Yearly data 2001-2002	194 Italian municipalities	Number of beds; tourism pressure (tourists/surface, tourists/local inhabitants), temporal distribution (tourists in July-August/ tourists per year)	Rate of use (tourism presences/beds) Vele (proxy for environmental benefits)	BCC, CCR, input and output oriented; window analysis
*Bosetti, Cassinelli & Lanza (2004)	Yearly data 2001-2002	70 Italian municipalities	Number of beds, solid waste	Rate of use (tourism presences/beds)	BCC, output oriented; window analysis
*Bosetti, Cassinelli & Lanza (2006)	Yearly data 2001-2003	20 Italian regions	Market size, tourism development index, public expenditures in tourism, public expenditures in environmental protection	Number of tourists, homogeneity of tourism flows, index of efficiency in solid waste management, percentage of protected areas	CCR
Rabar & Blažević (2011)	Yearly data 2004-2008	21 Croatian counties	Number of beds, number of seats (in catering objects), number of employees	Number of tourists, number of nights, value of catering trade)	BCC, CCR, window analysis
Soysal-Kurt (2017)	2013	29 European countries	Number of employees in tourism sector, tourism expenses, number of beds	Tourist arrivals, tourism receipts, number of nights spent	CCR, input oriented
Cracolici, Nijkamp & Rietveld (2006)	2001	103 Italian regions	Number of museums, monuments and archaeological sites (/population), tourist school graduates/working age population, labor units (ULAs) employed in the tourism sector divided by the total regional ULA	Number of beds/ population, number of nights/population	Stochastic Production Frontier; CCR, output oriented
Barros et al. (2011)	Yearly data 2003-2007	22 French regions	Accommodation capacity	Number of nights	Two stage DEA with regression
Cvetkosa & Barišić (2017)	Yearly data 2010 - 2015	11 Balkan countires	Visitor exports, domestic travel, tourism spending	Travel and tourism total contribution to GDP, employment	BCC, output oriented, window analysis
Kosmaczewska (2014)	Yearly data 2007 - 2009	27 EU countries**	Arrivals in tourist accommodation establishments	Collective tourist accommodation establishments, GDP per inhabitant	CCR, BCC, NIRS
Hadad, Hadad, Hadad, Malul & Rosenboim (2012)	2008	34 developed and 71 developing countries	Number of employees, number of rooms, natural resources and cultural resources	Number of tourists, expenditure per tourist	Super-efficiency

Note: CCR stands for Cooper-Charnes-Rhodes model, BCC denotes Banker-Charnes-Cooper model and NIRS denotes non-increasing returns to scale.
* Denotes previous research which included environmental component into the analysis.
** Except Croatia.

Methodology used in the study

Data envelopment analysis is a common tool used in measuring efficiency of production. This is because the models developed in DEA are focused on decision making units (DMUs) by comparing their performance regarding inputs and outputs of production. Efficiency is measured as a relative term, because DMUs are compared one to another. DEA was firstly developed in production, thus terms inputs and outputs are used today as common expressions when using DEA to evaluate relative efficiency of any kind of unit (such as countries, hospitals, stocks, etc.). Inputs are used in the process of "production", while outputs are the results of the "production" process. The term production is in quotation marks due to different units which can be observed to evaluate their efficiency. There exist many advantages of DEA methodology when evaluating efficiency. It does not require assumptions on distributions of variables which are used in the analysis. Moreover, it is very flexible (e.g. incorporating variable returns to scale), it enables dynamic optimization, etc.

It is assumed that the following data on n DMUs is available (for details, see Cooper, Seiford & Tone 2006): quantities of all m inputs and s outputs; where $\boldsymbol{x} \in M_{mn}$ denotes the matrix which contains all the data on inputs used in the production process, and $\boldsymbol{y} \in M_{sn}$ denotes the matrix with all output data. $\boldsymbol{x}_j \in \mathbf{R}^m$ and $\boldsymbol{y}_j \in \mathbf{R}^s$ denote vectors of all inputs and outputs of the j-th DMU, $j \in \{1,2,\ldots,n\}$, $\boldsymbol{x}_j \geq \mathbf{0}, \boldsymbol{x}_j \neq \mathbf{0}, \boldsymbol{y}_j \geq \mathbf{0}, \boldsymbol{y}_j \neq \mathbf{0}$. Two basic models are the Charnes-Cooper-Rhodes (CCR, 1978) and Banker-Charnes-Cooper (BCC, 1984) model, i.e. model with fixed and variable returns to scale. Moreover, each model can be output or input oriented. This depends upon whether DMUs are focusing on producing as much output as possible for given inputs or to reduce inputs as much as possible for given amount of desirable outputs. Based upon previous literature, output oriented model with variable returns to scale has been chosen in this study. The first phase consists of maximizing the rate of output enlargement:

$$\left.\begin{array}{l} \max\limits_{\mu,\eta} \eta \\ s.t. \quad \boldsymbol{x}_j - \boldsymbol{x}\boldsymbol{\mu} \geq \mathbf{0} \\ \qquad \eta \boldsymbol{y}_j - \boldsymbol{y}\boldsymbol{\mu} \leq \mathbf{0} \\ \qquad \boldsymbol{\mu} \geq \mathbf{0} \\ \qquad \sum\limits_{j=1}^{n} \mu_j = 1 \end{array}\right\} (BCC-O) \tag{1}$$

In the second phase, the following model is optimized, where we maximize the sum of input excesses and output shortfalls (represented with vectors $\boldsymbol{t}^+$ and $\boldsymbol{t}^-$), and include the optimal value of η^* (output enlargement rate) from the first phase:

$$\left.\begin{array}{l} \max\limits_{\mu,t^-,t^+} \boldsymbol{e}\boldsymbol{t}^- + \boldsymbol{e}\boldsymbol{t}^+ \\ s.t. \quad \boldsymbol{x}_j - \boldsymbol{x}\boldsymbol{\mu} = \boldsymbol{t}^- \\ \qquad \eta^* \boldsymbol{y}_j - \boldsymbol{y}\boldsymbol{\mu} = \boldsymbol{t}^+ \\ \qquad \boldsymbol{\mu} \geq \mathbf{0}, \boldsymbol{t}^- \geq \mathbf{0}, \boldsymbol{t}^+ \geq \mathbf{0} \\ \qquad \sum\limits_{j=1}^{n} \mu_j = 1 \end{array}\right\} \tag{2}$$

Each observed DMU$_j$ is found to be BCC efficient if and only if $\eta^* = 1$, $\boldsymbol{t}^{-*} = \mathbf{0}$ and $\boldsymbol{t}^{+*} = \mathbf{0}$. Otherwise, it is called BCC inefficient. More details can be seen in Cooper, Seiford and Tone (2006) or Cooper, Seiford and Zhu (2011).

Before performing the analysis, it is advisable to observe correlations between all inputs and outputs which are intended to be used in the optimization. Preferably, correlation between input and output should be high. On the other hand, correlations between inputs should not be significant; as well as between outputs. In that way, literature recommends that highly correlated inputs should be omitted from the analysis (as well as outputs, so the discriminatory power of model can stay high; see Rhodes & Southwick, 1993 or Avkiran, 2006). Literature also debated on how many inputs, outputs and DMUs can be observed in order to obtain reliable results. Golany and Roll (1989) recommend $n \geq 2(m+s)$; Bowlin (1998) $n \geq 3(m+s)$; whilst Dyson et al. (2001) consider $n \geq 2ms$.

In order to evaluate efficiency over time, Klopp (1985) introduced window analysis, in which previous mentioned static models can be optimized for DMUs over time. In that way, changes in efficiency over time can be observed. Changes in technology, economic, political and other types of influences affect the "production" process. Thus, it is important to observe changes over time.

If we observe waste and other pollutants which affect the environment in the tourism industry, it can be viewed as an input in the model. Although it is an output in the "production" process, one does not want to maximize the enlargement of this variable. Moreover, the reciprocal value of waste production can be viewed as an output. In that way, if we aim to increase the reciprocal value of waste production, in essence this means that we aim to reduce the denominator. Previous literature has dealt with both approaches, regarding waste as inputs, and reciprocal value as an output.

However, recent developments in DEA include models with undesirable outputs, especially developed for evaluating environmental performance. Since waste and other pollutants result as outputs in the production process, they are observed as undesirable outputs. The idea is that DMUs with more good outputs and less undesirable outputs are more efficient when compared one to another. We are still observing *n* DMUs, where $\boldsymbol{x}_j \in \mathbf{R}^m$ and $\boldsymbol{y}_j \in \mathbf{R}^s$ for each DMU is defined as earlier. $\boldsymbol{y}_j^b \in \mathbf{R}^w$ is introduced, where it is defined as vector of undesirable outputs for *j*-th DMU, $\boldsymbol{y}_j^b > \mathbf{0}$. Now, the production possibility set is defined as:

$$\left\{ \left(\boldsymbol{x}, \boldsymbol{y}, \boldsymbol{y}^b \right) \mid \boldsymbol{x}_j \geq \boldsymbol{x}\boldsymbol{\mu}, \boldsymbol{y}_j \leq \boldsymbol{y}\boldsymbol{\mu}, \boldsymbol{y}_j^b \geq \boldsymbol{y}^b \boldsymbol{\mu}, \boldsymbol{\mu} \geq \mathbf{0}, \sum_{j=1}^{n} \mu_j = 1 \right\}, \tag{3}$$

$\boldsymbol{y}^b \in M_{wn}$. In order to obtain efficiency scores for each DMU, the following slacks-based measure[1] (SBM) model is optimized as follows:

$$\left. \begin{aligned} \rho = & \min_{\boldsymbol{\mu}, \boldsymbol{t}^-, \boldsymbol{t}^+, \boldsymbol{t}^b} \frac{1 - \frac{1}{m} \sum_{i=1}^{m} \frac{t_i^-}{x_{ij}}}{1 + \frac{1}{s+w} \left(\sum_{r=1}^{s} \frac{t_r}{y_{ij}} + \sum_{r=1}^{w} \frac{t_r^b}{y_{ij}^b} \right)} \\ s.t. \quad & \boldsymbol{x}_j = \boldsymbol{x}\boldsymbol{\mu} + \boldsymbol{t}^- \\ & \boldsymbol{y}_j = \boldsymbol{y}\boldsymbol{\mu} - \boldsymbol{t}^+ \\ & \boldsymbol{y}_j^b = \boldsymbol{y}^b \boldsymbol{\mu} + \boldsymbol{t}^b \\ & \boldsymbol{t}^- \geq \mathbf{0}, \boldsymbol{t}^+ \geq \mathbf{0}, \boldsymbol{t}^b \geq \mathbf{0}, \boldsymbol{\mu} \geq \mathbf{0} \\ & \sum_{j=1}^{n} \mu_j = 1 \end{aligned} \right\} \text{(SBM-undesirable)} \tag{4}$$

$\boldsymbol{t}^b$ is a vector of excess undesirable outputs. Cooper, Seiford and Tone (2006) define an efficient DMUj in the presence of undesirable outputs if and only if $\rho^* = 1, \boldsymbol{t}^{+*} = \boldsymbol{0}, \boldsymbol{t}^{-*} = \boldsymbol{0}$ and $\boldsymbol{t}^{b*} = \boldsymbol{0}$. If we want to impose weights on inputs or outputs, due to their individual importance, the objective function can be modified as follows:

$$\min_{\mu, t^-, t^+, t^b} \frac{1 - \frac{1}{m}\sum_{i=1}^{m} \frac{p_i^- t_i^-}{x_{ij}}}{1 + \frac{1}{s+w}\left(\sum_{r=1}^{s} \frac{p_r^- t_r}{y_{ij}} + \sum_{r=1}^{w} \frac{p_r^b t_r^b}{y_{ij}^b}\right)}, \quad (5)$$

where p_i^-, p_r^+ and p_r^b denote weight for input i, output r and undesirable output r, respectively $\sum_{i=1}^{m} p_i^- = m, p_i^- \geq 0 \;\; \forall i, \sum_{r=1}^{s} p_r^+ + \sum_{r=1}^{w} p_r^b = s + w, p_r^+ \geq 0 \;\; \forall r, p_r^b \geq 0 \;\; \forall r$. More details on DEA methodology can be found in Färe and Grosskopf (2005), with special focus on services sector in Avkiran (2006) and tourism and hospitality in Wober (2002). More on environment efficiency assessment can be found in Ball, Nehring and Somwaru (1994), Zhou, Ang and Poh (2008) or Kortelainen and Kousmanen (2004).

Empirical analysis

For the empirical part of the research, data on 21 Croatian counties[2] has been collected from yearly reports from Croatian Bureau of Statistics (CBS, 2017) and Ministry of Tourism of Republic of Croatia (2017) for the period 2011-2015 for each county. Based upon the previous literature and availability of data, the following data was collected: number of beds, number of rooms[3], municipal waste in tourism (in tons), current expenditures on environment protection (in thousands of HRK), total investments on environment protection (in thousands of HRK), number of tourist arrivals, number of overnight stays, total GDP (in thousands of HRK) and surface of each county (in square kilometers). Moreover, tourism pressure was calculated as a ratio of number of tourist arrivals and surface of each county; reciprocal value of municipal waste was calculated; and relative measures of current expenditures and total investments as percentages of GDP. Abbreviations and classification of inputs and outputs are depicted in Table 2.

Table 2
Abbreviations and classifications of inputs and outputs

Variable	Abbreviation	Input/Output
Number of beds	NO_B	I
Number of rooms	NO_R	I
Municipal waste	W	I
Current expenditures on environment protection	CURR_EXP	I
Total investments on environment protection	INV	I
Number of tourist arrivals	ARR	O
Number of overnight stays	NIGHT	O
Tourism pressure	PRESSURE	I
Reciprocal value of municipal waste	1/W	O
Percentage of current expenditures in GDP	CURR_%GDP	I
Percentage of total investments in GDP	INV_%GDP	I
Undesirable output municipal waste	W	Undesirable O

Source: CBS (2017); Ministry of Tourism (2017).

Next, correlation matrix was calculated for every variable, in order to eliminate correlated inputs or outputs which could distort the results. The results are shown in Table 3. Since there exists significant correlation between some inputs (e.g. current expenditures and investments on environment protection) and some outputs (number of tourist arrivals and number of overnight stays), some of the inputs and outputs have been excluded from the analysis. Main criteria of exclusion were the smallest correlations between those inputs and other outputs and vice versa. For example, since number of tourist arrivals was correlated to number of overnight stays, their correlations with inputs has been considered. Tourist arrivals were more correlated with inputs. In that way, number of overnight stays has been excluded from the rest of the analysis. The same procedure was repeated for other inputs and outputs.

Table 3
Correlations of potential inputs and outputs

	1/W	ARR	CURR_ %GDP	CURR_ EXP	INV	INV_ %GDP	NIGHTS	NO_B	NO_R	PRES-SURE	W
1/W	1										
ARR	**-0.499 (0.0214)**	1									
CURR_%GDP	-0.262 (0.2515)	0.269 (0.2375)	1								
CURR_EXP	-0.241 (0.2933)	0.227 (0.3221)	**0.553 (0.0094)**	1							
INV	-0.243 (0.2889)	0.195 (0.3966)	**0.555 (0.009)**	**0.992 (0.000)**	1						
INV_%GDP	-0.237 (0.3006)	0.125 (0.5882)	**0.621 (0.0027)**	**0.443 (0.0444)**	**0.527 (0.0141)**	1					
NIGHTS	**-0.443 (0.0441)**	**0.980 (0.000)**	0.191 (0.4074)	0.084 (0.7181)	0.050 (0.8284)	0.076 (0.7438)	1				
NO_B	**-0.444 (0.0439)**	**0.971 (0.000)**	**0.165 (0.000)**	0.054 (0.815)	0.022 (0.9232)	0.062 (0.7905)	**0.997 (0.000)**	1			
NO_R	**-0.459 (0.0365)**	**0.981 (0.000)**	0.159 (0.4906)	0.069 (0.7657)	0.041 (0.8613)	0.068 (0.7701)	**0.991 (0.000)**	**0.993 (0.000)**	1		
PRESSURE	-0.273 (0.2304)	0.343 (0.1274)	0.037 (0.8721)	0.135 (0.5591)	0.114 (0.6238)	-0.042 (0.8562)	0.265 (0.2463)	0.222 (0.333)	0.256 (0.2628)	1	
W	-0.447 (0.0421)	**0.976 (0.000)**	0.172 (0.457)	0.073 (0.7533)	0.039 (0.8671)	0.062 (0.7902)	**0.998 (0.000)**	**0.997 (0.000)**	**0.990 (0.000)**	0.287 (0.2067)	1

Note: p-values are given in parenthesis. Significant coefficients of correlation are bolded.
Source: Author's calculation.

After comparing the correlations, the following types of models have been considered, as shown in table 4. Because window analysis is being used, as well as we observe same counties in different years as different DMUs, the criteria on number of inputs and outputs with respect to number of DMUs is met.

Table 4
DEA models considered in the analysis

Model	Inputs	Outputs
(1) BCC-O window	NO_R, CURR_EXP	ARR, 1/W
(2) Undesirable outputs	NO_R, CURR_EXP	ARR, W
(3) Undesirable outputs; weights: bad:good = 1:4	NO_R, CURR_EXP	ARR, W
(4) Undesirable outputs; weights: bad:good = 4:1	NO_R, CURR_EXP	ARR, W

Source: Author's calculation.

The first model, BCC-O window, with the length of the window 2 years was observed first. In that way, an easier comparison can be made to results in Rabar and Blažević (2011), who use only economic variables in their analysis. Efficiency scores are given in left panel of Table 5. The best county was C21, with maximum value of efficiency score of 1 in all of the observed periods, followed by C11 and C18. County C21 is the capital city of Croatia and everything is concentrated in Zagreb. Thus, this result is expected. Least efficient counties were C3, C5 and C7. With included environmental variables in the analysis, the results regarding most efficient counties are similar to Rabar and Blažević (2011). This means that these counties have good practice in tourism industry, but in waste management as well. The differences arise when comparing inefficient counties. C3, C5 and C7 realized a rapid growth in current expenditures on environment protection in the last three years (landfill sanitation), whilst tourism had a slower rate of growth in the majority of the years. Thus, attention could be directed towards most efficient and most inefficient counties: observing financial resources and their distribution in environment protection.

In order to obtain more detailed results of sources of (in)efficiency, second model – undesirable outputs has been optimized. In this first undesirable outputs model, all outputs have equal weights. Each county in each year is considered as a different DMU (in total we have 21·5 DMUs). Results are shown in the right panel of Table 5. The most efficient counties were C8, C12 and C9, and least efficient again C3, C5 and C7. On average, the majority of the counties had an increase of efficiency scores over time. This means that combination of waste management with growth of tourist arrivals has, on average, improved over the observed period.

Table 5
Efficiency scores in BCC-O window model (left panel) and undesirable outputs (right panel)

County	11-12	12-13	13-14	14-15	2011	2012	2013	2014	2015
C1	0.7299	0.6881	0.6546	0.7064	0.4601	0.4601	0.5167	0.6207	0.6220
C2	0.7027	0.8562	0.8949	0.8351	0.4438	0.6829	1	0.6627	1
C3	**0.5026**	**0.4779**	**0.4303**	**0.4149**	**0.3201**	**0.2643**	**0.3206**	**0.3251**	**0.2871**
C4	1	0.9972	0.9877	0.9625	0.8223	0.8491	1	0.8415	1
C5	**0.3909**	**0.3293**	**0.3020**	**0.3640**	**0.3005**	**0.2923**	**0.2780**	**0.2652**	**0.3990**
C6	0.8436	0.8309	0.7288	0.7165	0.6051	1	1	0.6058	1
C7	**0.4659**	**0.4428**	**0.4996**	**0.5633**	**0.3188**	**0.4673**	**0.3657**	**0.6231**	**0.4450**
C8	0.9556	0.9999	0.9942	0.9630	**0.9214**	**1**	**0.9590**	**0.9955**	**1**
C9	**1**	**1**	0.8835	0.8984	**1**	**1**	**1**	**0.5483**	**1**
C10	0.8444	0.7657	0.6898	0.6473	0.6869	0.6681	0.6848	0.7633	0.4121
C11	1	1	1	0.9645	0.6097	1	1	1	0.8161
C12	**1**	**1**	**1**	0.8882	**1**	**1**	**1**	**1**	**0.7890**
C13	0.8856	0.9299	0.9922	0.8658	0.4176	0.6222	1	0.9068	0.5448
C14	0.7417	0.6296	0.6201	0.6796	0.5324	0.5096	0.5645	0.5153	0.5724
C15	0.8881	0.7722	0.7949	0.8933	0.5029	0.5070	0.5452	0.6860	0.5534
C16	0.6718	0.6858	0.8083	0.7935	0.6455	0.6659	0.8296	0.7851	0.5294
C17	0.9676	0.9504	0.9739	0.8937	0.5790	0.6206	0.7781	1	0.9500
C18	0.9850	1	0.9956	0.9700	0.7370	0.9188	0.7757	0.7383	1
C19	0.9651	0.9672	0.9874	0.9860	0.6460	0.7154	0.8387	0.9396	1
C20	0.8213	0.7329	0.7864	0.9247	0.6119	0.6143	0.7067	0.7506	1
C21	1	1	1	1	0.6516	0.7320	1	1	1

Note: Maximal value of efficiency score is 1 (best). Most and least efficient counties were bolded.
Source: Author's calculation.

Sources of inefficiencies of C3, C5 and C7 are shown in Table 6, where needed changes of inputs and outputs for each DMU are shown. It can be seen that tourist arrivals in each county is satisfying. However, majority of changes are necessary regarding expenditures on environment protection in order to get on the efficient frontier. Local authorities should look into reasons why current expenditures are apparently needlessly high compared to waste generated. Reasoning could be found in higher restoration costs due to carelessness of part of the local population in county C3, or political affairs regarding waste management in county C5 several years ago.

Table 6
Sources of inefficiencies of least efficient DMUs, undesirable outputs model

DMU	Change			
	NO_R	CURR_EXP	W	ARR
C3 2011	-32.68%	-86.72%	-51.85%	0.00%
C3 2012	-45.00%	-87.01%	-57.31%	0.00%
C3 2013	-35.12%	-86.03%	-45.93%	0.00%
C3 2014	-34.40%	-89.25%	-34.89%	0.00%
C3 2015	-40.63%	-90.67%	-39.32%	0.00%
C5 2011	-57.65%	-76.84%	-17.98%	0.00%
C5 2012	-57.86%	-81.17%	-8.60%	0.00%
C5 2013	-62.54%	-79.34%	-9.08%	0.00%
C5 2014	-58.01%	-88.70%	-0.96%	0.00%
C5 2015	-55.39%	-64.81%	0.00%	0.00%
C7 2011	-50.46%	-69.25%	-51.87%	0.00%
C7 2012	-46.73%	-38.98%	-44.59%	0.00%
C7 2013	-50.56%	-62.82%	-36.86%	0.00%
C7 2014	-37.64%	-28.17%	-15.36%	0.00%
C7 2015	-32.43%	-61.16%	-39.14%	0.00%

Source: Author's calculation.

Finally, two models have been observed where different weights have been given to good and undesirable outputs. If policy makers are not much interested in the environmental aspect of tourism, greater weight is given good outputs (model where ratio bad to good is 1:4). On the other hand, if they are especially environmentally conscious, a different version of model is observed (where ratio bad to good is 4:1). It can be seen that again, counties C3, C5 and C7 are the most inefficient. Results regarding most efficient are similar. Left panel shows that C4, C8 and C12 are most efficient, whilst right panel shows C4, C8 and C9. By observing the dynamic changes of (in)efficiency over time, policy makers should concentrate more on resolving problems in certain counties. If, e.g., county C3 is found to be inefficient over the last couple of years, the purpose of public resources should be reassigned into solving specific issues. This saves time and money to conduct relevant analysis. Finally, robustness of results has been made by comparing the ranks of each county for all three undesirable outputs models in table 8. It can be seen that the ranking is similar, with few minor changes. So the results are reliable and can form basis for further more detailed analysis of specific counties.

Table 7
Efficiency scores for models with undesirable outputs

DMU	Bad : good = 1:4					Bad : good = 4:1				
	2011	**2012**	**2013**	**2014**	**2015**	**2011**	**2012**	**2013**	**2014**	**2015**
C1	0.5009	0.4903	0.5281	0.6232	0.6280	0.4255	0.4322	0.4830	0.5860	0.6013
C2	0.4672	0.7261	1	0.6627	1	0.4207	0.6445	1	0.6627	1
C3	**0.3652**	**0.3050**	**0.3611**	**0.3568**	**0.3178**	**0.2849**	**0.2331**	**0.2883**	**0.2972**	**0.2609**
C4	**0.9077**	**0.8966**	**1**	**0.8415**	**1**	**0.7516**	**0.8064**	**1**	**0.8415**	**1**
C5	**0.3162**	**0.2997**	**0.2829**	**0.2660**	**0.3990**	**0.2863**	**0.2828**	**0.2709**	**0.2492**	**0.3990**
C6	0.6051	1	1	0.6058	1	0.6051	1	1	0.6027	1
C7	**0.3173**	**0.4210**	**0.3595**	**0.6200**	**0.4788**	**0.2837**	**0.4212**	**0.3345**	**0.5975**	**0.4052**
C8	**0.9214**	**1**	**0.9590**	**0.9955**	**1**	**0.9214**	**1**	**0.9590**	**0.9955**	**1**
C9	**1**	**1**	**1**	**0.5529**	**1**	**1**	**1**	**1**	**0.5395**	**1**
C10	0.6751	0.6139	0.6681	0.7327	0.4176	0.6234	0.6071	0.6383	0.7048	0.3781
C11	0.6096	1	1	1	0.8156	0.6097	1	1	1	0.8076
C12	**1**	**1**	**1**	**1**	**0.7890**	**1**	**1**	**1**	**1**	**0.7890**
C13	0.4640	0.6858	1	0.9249	0.6007	0.3796	0.5694	1	0.8893	0.4985
C14	0.5380	0.5139	0.5645	0.5173	0.5724	0.5243	0.5015	0.5645	0.4985	0.5485
C15	0.5469	0.5569	0.5833	0.7282	0.5896	0.4613	0.4653	0.5118	0.6479	0.5214
C16	0.6633	0.6790	0.8296	0.8226	0.5404	0.6287	0.6424	0.8296	0.7509	0.4938
C17	0.6123	0.6500	0.7783	1	0.9500	0.5491	0.5937	0.7779	1	0.9500
C18	0.7463	0.9188	0.7757	0.7512	1	0.7280	0.9188	0.7757	0.7257	1
C19	0.6841	0.7618	0.8631	0.9437	1	0.6120	0.6742	0.8156	0.9355	1
C20	0.6177	0.6143	0.7067	0.7506	1	0.6014	0.6069	0.7037	0.7352	1
C21	0.6832	0.7676	1	1	1	0.6229	0.6994	1	1	1

Note: Maximal value of efficiency score is 1 (best). Most and least efficient counties were bolded.
Source: Author's calculation.

Table 8
Ranking DMUs in models (2), (3) and (4)

DMU	Rank		
	Model (2)	**Model (3)**	**Model (4)**
C1	18	17	18
C2	11	11	11
C3	21	20	21
C4	4	3	5
C5	20	21	20
C6	7	8	7
C7	19	19	19
C8	1	1	1
C9	3	4	3
C10	15	15	15
C11	5	6	4
C12	2	2	2
C13	13	13	14
C14	17	18	16
C15	16	16	17

Table 8 **Continued**

DMU	Rank		
	Model (2)	Model (3)	Model (4)
C16	14	14	13
C17	10	10	10
C18	8	9	8
C19	9	7	9
C20	12	12	12
C21	6	5	6

Source: Author's calculation.

Conclusion

In the last two decades, concepts of sustainable business and environmentally conscious tourism have gotten more and more attention. This is especially true in Croatia, where central and local authorities in the last ten years adjust the legislative and development strategies of the economy and tourism with respect to sustainability in the long run. Growing environmental pressures in tourism industry could have negative consequences on the economy if they are not managed well. The purpose of this paper was to empirically evaluate sources of (in)efficiencies in tourism industry of Croatian counties, with respect to economic and environmental factors. In that way, bad and good practices can be observed in more detail in those regions where tourism plays an important role, as well as growing environment pressure. In order to compare the counties, DEA methodology was applied. This is because this methodology was developed in order to compare how efficient are observed units in managing their resources to achieve some results. The study used three different specifications of undesirable outputs (waste) model in order to gain some insight into sources of (in)efficiencies of counties. It was shown how policy makers can obtain basic information on these sources, both on the input and output side of the "production" process. This can save time and money when searching for optimal policy measures in order to eliminate (or at least diminish) sources of inefficiencies. By observing good practices and finding sources of bad ones, policy makers could focus more on these extremes in order to act more quickly and efficiently.

Contributions of this study are as followed: combining economic and environmental variables in order to evaluate total efficiency of tourism industry as a sustainable business; including dynamic optimization; observing different specifications of the same model in order to check for robustness; etc. Some of the pitfalls include using only yearly data due to its availability; including those variables which were available when writing this research (only municipal waste); etc. Thus, more effort should be made in the field of monitoring and measuring certain variables in order to carry out more reliable and detailed analysis in the future.

However, results in this study indicate that it is possible to obtain satisfactory economic and environmental results simultaneously. The results can be used in construction of benchmarking indices and measures of sustainable tourism and business, an issue which has been in the spotlight in the last two decades. Finally, future research should include other variables which could measure other benefits or pressures on the society as a whole. It depends upon the issues relevant to policy makers and their goals. Nevertheless, we hope that findings in this paper will encourage development of similar research in the future, in order to contribute to the achievement of environmentally conscious tourism industry in the long run.

Notes:

[1] SBM type of models introduced invariant measures of units of inputs and outputs and monotonicity. For details see Tone (1997, 2001).

[2] Republic of Croatia is divided into 21 counties. In the rest of the paper the following labels will be given to the counties in order to compare the results: Zagreb county (C1), Krapina-Zagorje (C2), Sisak-Moslavina (C3), Karlovac (C4), Varaždin (C5), Koprivnica-Križevci (C6), Bjelovar-Bilogora (C7), Primorje-Gorski kotar (C8), Lika-Senj (C9), Virovitica-Podravina (C10), Požega-Slavonia (C11), Brod-Posavina (C12), Zadar (C13), Osijek-Baranja (C14), Šibenik-Knin (C15), Vukovar-Srijem (C16), Split-Dalmatia (C17), Istria (C18), Dubrovnik-Neretva (C19), Međimurje (C20), City of Zagreb (C21).

[3] Number of beds and number of rooms refers to the total capacities in each county.

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Submitted: 19/12/2017
Accepted: 26/04/2018