Ecological Indicators 73 (2017) 589–596

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Environmental sustainability measurement in the Travel & Tourism Competitiveness Index: An empirical analysis of its reliability

José G. Dias *, [1]

Instituto Universitário de Lisboa (ISCTE-IUL), Business Research Unit (UNIDE-IUL), Lisboa, Portugal

ARTICLE INFO

Article history:
Received 2 February 2016
Received in revised form 5 October 2016
Accepted 9 October 2016

Keywords:
Environmental sustainability
Reliability
Indices
Travel & tourism industry
Exploratory and confirmatory factor analyses

ABSTRACT

Indices provide a straightforward summary of the status of an object or concept. Examples of concepts are diverse and go from city quality of life, country level of freedom, human development to environment sustainability. This paper introduces a methodology to assess the reliability of the environmental sustainability index implemented by the Travel & Tourism Competitiveness Index that is published by the World Economic Forum using exploratory and confirmatory factor analyses.

Results show that the original index is not reliable as most of the variables are weakly correlated. A simplified version of the original index is obtained by exploratory factor analysis and tested by confirmatory factor analysis. Measures of reliability show that the new index called TTESI – Travel & Tourism Environmental Sustainability Index – is reliable. Results also show that combining data from different sources (e.g., survey data and physical measurements) proves problematic. A *z*-score value for each country was computed and countries were ranked based on the TTESI. Additionally, the new index is more in line with the HDI – Human Development Index – and can therefore be integrated more easily in an overall index of sustainable development.

1. Introduction

Environmental sustainability (ES) is unquestionably an important concept in the policy-making debate nowadays and one that is under public scrutiny. Its importance is due to the fact that it tends to define trade-offs with the social and economic components of sustainable development (Goodland, 1995). For instance, stakeholders are taking increasing interest in the environmental performance of firms before making investment decisions. Recently, Volkswagen's market value plunged 50% following the announcement of the automaker's violations of the Clean Air Act (CNN, 2015). In the aftermath of the scandal, Volkswagen was removed from the Dow Jones Sustainability World Index (S&P Dow Jones Indices and ROBECOSAM, 2015).

While the concept of sustainability has been broadly used, little research deals with its assessment and measurement. Klemeš (2015) notes only 0.1% of the 96,290 publications on Scopus that include the word "sustainability" also contain "measurement". Many one-dimensional indicators of sustainable development covering the three dimensions of economic, environmental, and social conditions are available in the literature. In this line of thought, it has been argued that the Human Development Index (HDI) is an incomplete measure of development as its use of income, life expectancy, and educational data takes only two development components into account, namely social and economic dimensions. There have been a number of suggestions in the literature on how to make HDI a greener indicator (e.g., Dahme et al., 1998; Morse, 2003; Togtokh, 2011; Išljamović et al., 2015). Togtokh (2011) introduced the Human Sustainable Development Index (HSDI) that adds a fourth variable into its computation: per capita carbon emissions. Other more specific examples on environmental sustainability indices are: the *Living Planet Index* (LPI) that measures biodiversity (WWF, 1998), the *Ecological Footprint* (EF) index developed by Wackernagel and Rees (1996), and the *Environmental Sustainability Index* (ESI) of Samuel-Johnson and Esty (2000) and Esty et al. (2005). For instance, the Ecological Footprint tracks past and current human pressure on the biosphere's capacity to provide a life-supporting ecosystem and can be used to track the spatial impact of the production and consumption of products and services. Recently, Asici and Acarb (2016) show that as countries grow richer they tend to export the ecological cost of their consumption to poorer economies. However, its conceptual and operational definitions are still topics of active research (e.g. Mancini et al., 2016). Böhringer and Jochem (2007) provide a

* Correspondence to: Department of Quantitative Methods for Management and Economics, Av. Forças Armadas, Edifício ISCTE, 1649-026 Lisboa, Portugal.
E-mail address: jose.dias@iscte.pt

[1] I would like to thank both reviewers for their insightful comments, which allowed me to make significant improvements to the paper.

http://dx.doi.org/10.1016/j.ecolind.2016.10.008
1470-160X/

detailed survey of these and other less well-known environmental sustainability indices, covering the steps of conceptualization, normalization, weighting, and aggregation.

In a recent paper, Babcicky (2013) shows that the ESI's unidimensional structure[2] is problematic and the weight of components is far from perfect. Similarly, Siche et al. (2008) analyze the ESI, the EF, and two emergy performance indices; they conclude that they are weakly correlated and present distinct perspectives on environmental sustainability. Böhringer and Jochem (2007) also conclude that the use of 11 indices to measure environmental sustainability tends to be misleading and inconsistent as a result of the aggregation and normalization used in their computation, and it is therefore useless in terms of policy advice. Bravo (2014) compares the HSDI and alternative indicators of environmental sustainability (e.g., Ecological Footprint) and concludes that HSDI makes only a small advance in the definition and measurement of sustainable development as the correlations between HSDI and these indicators tend to be weak. Given the proliferation of distinct measures of environmental sustainability and the weak correlation between them, Hizsnyik and Toth (2010) recognize that it might be difficult to define a single measurement of sustainable development.

The travel & tourism industry is an important source of environmental stress (e.g., airlines, hoteliers, car rental companies) and so it needs access to reliable indicators. This study empirically assesses the psychometric properties of the *Environmental Sustainability Index* under the pillar *T&T Policy and Enabling Conditions* reported by *The Travel & Tourism Competitiveness Reports 2015* (Crotti and Misrahi, 2015). This research introduces a methodology that is commonly applied in the development of measurement scales in social sciences to compute the reliability of unobserved constructs. In order to assess the reliability of the environmental sustainability indices, I assume that the indicators are a manifestation of the underlying level of environmental sustainability which is measured by these indicators (Churchill, 1979; Peter, 1979). Not only have few studies employed principal component analysis (e.g., Bolcárová and Kološta (2015) in the context of sustainable development), but most of these did not apply confirmatory factor analysis to test the reliability of the scales.[3]

The main hypothesis underlying this research is that the combination of distinct sustainability indicators – physical vs. attitudinal data – may create problems for the reliability of aggregate indicators. I take a confirmatory factorial approach (CFA) to assess the psychometric properties of a multi-item scale of measurement (Jöreskog, 1971; Jöreskog and Sörbom, 1982; Gerbing and Anderson, 1988; Nunnally and Bernstein, 1994; Kline, 2016). Additionally, I recommend further changes to the index as a consequence of these results. In summary, this research conducts an analysis of the reliability of the ESI derived from the data in *The Travel & Tourism Competitiveness Report 2015* and explores further improvements to the index.

The paper is structured as follows. Section 2 introduces the data used in this study, which comes from *The Travel & Tourism Competitiveness Report 2015*. Section 3 describes the methodology for assessing the reliability of Environmental Sustainability indices. Section 4 presents the results, addressing the reliability of the original Environmental Sustainability Index and proposing a modified index that I call the Travel & Tourism Environmental Sustainability Index (TTESI). Section 5 concludes the paper with further discussion of potential extensions and applications of this method.

2. Data

Data comes from *The Travel & Tourism Competitiveness Report 2015*, a more detailed description of which can be found elsewhere (Crotti and Misrahi, 2015). The 10 indicators used in the *Environmental Sustainability* pillar are: (1) *Stringency of environmental regulations* (2013–2014 weighted average of the responses from the Executive Opinion Survey of the World Economic Forum to the question *How would you assess the stringency of your country's environmental regulations?* using the scale of measurement: 1 = Very lax; 7 = Among the world's most stringent); (2) *Enforcement of environmental regulations* (2013–2014 weighted average of the responses from the Executive Opinion Survey of the World Economic Forum to the question *How would you assess the enforcement of environmental regulations in your country?*, using the scale of measurement: 1 = Very lax; 7 = Among the world's most rigorous); (3) *Sustainability of travel and tourism industry development* (2013–2014 weighted average of the responses from the Executive Opinion Survey of the World Economic Forum to the question *How would you assess the effectiveness of your government's efforts to ensure that the Travel & Tourism sector is being developed in a sustainable way?*, using the scale of measurement: 1 = Very ineffective – development of the sector does not take into account issues related to environmental protection and sustainable development; 7 = Very effective – issues related to environmental protection and sustainable development are at the core of the government's strategy); (4) *Particulate matter (2.5) concentration* (Population-weighted exposure to PM[2.5 (micro-grams per cubic meter)], 2012 Yale University and Columbia University, Environmental Performance Index (EPI) 2012 edition based on NASA MODIS and MISR data); (5) *Environmental treaty ratification* (Total number of ratified environmental treaties, 2014 The International Union for Conservation of Nature (IUCN), Environmental Law Center ELIS Treaty Database). This indicator measures the total number of international treaties from a set of 27 in which a state is a participant); (6) *Baseline water stress* (Normalized (0–5) ratio of total annual water withdrawals (municipal, industrial and agricultural) to total available annual renewable supply, 2010 World Resources Institute, Aqueduct Country and River Basin Rankings); (7) *Threatened species* (Threatened species as a percentage of total species (mammals, birds and amphibians); 2014 The International Union for Conservation of Nature (IUCN), Red List of Threatened Species); (8) *Forest cover change* (Forest cover change between 2000 and 2012, 2012 Yale Center for Environmental Law & Policy (YCELP) and the Center for International Earth Science Information Network (CIESIN) at Columbia University, Environmental Performance Index 2014); (9) *Wastewater treatment* (Percentage of wastewater that receives treatment weighted by connection to wastewater treatment rate; 2012 Yale Center for Environmental Law & Policy (YCELP) and the Center for International Earth Science Information Network (CIESIN) at Columbia University); (10) *Costal shelf fishing pressure* (Trawling catch per exclusive economic zone (EEZ) (tonnes per square kilometer) 2006 Yale Center for Environmental Law & Policy (YCELP) and the Center for International Earth Science Information Network (CIESIN) at Columbia University).

The TTCI data set covers 141 countries. There is data for all countries for indicators 1, 2, 3, 4, and 7. For the remaining indicators, missing data is generated by two mechanisms: (a) data is not available due to measurement difficulties; (b) the indicator lacks meaning given specific contexts. For instance, the four missing observations for the *Environmental treaty ratification* indicators

[2] Contrary to multidimensional structures, unidimensional structures assume that all observed variables converge and are clustered into a single composite figure. This is explained by the fact that the indicators are correlated and measure a unique concept or construct, e.g., environmental sustainability.

[3] For instance, Böhringer and Jochem (2007) provide a summary in Table 3 in which two of 11 sustainability indices apply principal component analysis (PCA) and none applies confirmatory factor analysis.