UNIVERSIDADE BEIRA INTERIOR

The impacts of the tourism sector on the eco-efficiency of the Latin America and Caribbean countries: A two-stage DEA approach

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Dissertação para obtenção do Grau de Mestre em
Economia
(2º ciclo de estudos)

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junho de 2020

Acknowledgements

I would like to dedicate this page to all the people who have accompanied and helped me in this important and demanding period of my life. Firstly, I want to express my gratitude to my supervisor, Professor José Alberto Fuinhas, for his support, friendship and guidance during the last months. Without his availability, advice, and transmitted knowledge, the accomplishment of this dissertation would not be possible. I also want to thank Professor António Cardoso Marques for his assistance and contributions.

I would also like to express my huge gratitude to my family, especially to my parents and younger sister, for giving me this opportunity, for the patience, and for always supporting and motivating me during all this process.

Last but not least, I also want to thank my closest friends, who have always been by my side, giving me strength and motivation to complete this dissertation, even in the most challenging moments.

Resumo

Este estudo pretende analisar os impactos do sector do turismo na eco-eficiência total de 22 países da América Latina e Caraíbas, para um período de 1995 a 2016. A metodologia *two-stage Data Envelopment Analysis* foi utilizada para calcular primeiramente a eco-eficiência dos países da amostra (considerando as emissões de CO_2 como input e o crescimento económico como output), apontado os resultados para um decréscimo da eco-eficiência na maioria dos países. Posteriormente, foi aplicado o modelo *Panel Autoregressive Distributed Lag* para analisar os impactos das chegadas de turistas, do investimento de capital em turismo e da contribuição direta do turismo para o emprego na eco-eficiência anteriormente calculada. Considerando a presença de dependência seccional, heterocedasticidade e autocorrelação de primeira ordem no modelo, o estimador *Driscoll-Kraay* foi utilizado e os resultados indicam que as chegadas de turistas, a utilização de não renováveis para gerar (uma parte substancial da) energia elétrica para consumo e a abertura do comércio contribuem para reduzir a eco-eficiência destes países, tanto no curto como no longo prazo. Contrariamente, o investimento de capital em turismo, a contribuição direta do turismo para o emprego e o Índice de Desenvolvimento Humano promovem a eco-eficiência, no longo prazo. Estes factos sugerem que os decisores políticos devem prestar mais atenção à capacidade de carga dos destinos dado que, caso ignorem, esta pode resultar em choques ambientais e climáticos nestes países assim como constrangimentos ao seu desenvolvimento (tanto no curto como no longo prazo). Simultaneamente, para garantir o seu desenvolvimento sustentável, devem continuar a incentivar projetos de investimentos turísticos sustentáveis assim como a criação de emprego. Por fim, confirma-se que o mecanismo de correção de erros tem um valor negativo e estatisticamente significante na estimação, o que aponta para a existência de uma relação de cointegração/longa memória entre as variáveis.

Palavras-chave

Eco-eficiência; Chegadas de turistas; Investimento de capital em turismo; Contribuição direta do turismo para o emprego; *Two-stage* DEA; Países da América Latina e Caraíbas.

Resumo Alargado

A região da América Latina e Caraíbas tem vindo a registar uma aceleração no seu crescimento económico, um fator crucial para o seu desenvolvimento. No entanto, esse crescimento está normalmente associado a um aumento significativo no consumo de energia que, por sua vez, pode levar a um aumento nas emissões de CO_2 – um dos maiores contribuidores para o aquecimento global e, consequentemente, para as alterações climáticas.

Considerando os factos anteriormente referidos e a crescente preocupação ambiental, surgiu a noção de "eco-eficiência". Este conceito tornou-se alvo de interesse na investigação académica porque é um instrumento capaz de avaliar o desenvolvimento sustentável dos países/regiões. Recentemente, ao invés de apenas mensurar a eco-eficiência, alguns investigadores selecionaram fatores exógenos (de acordo com a sua área de estudo) que pudessem influenciar a eco-eficiência previamente calculada. Entre muitos outros, devido à sua relevância económica mas também à sua ligação ao consumo intensivo de energia e a fenómenos com implicações negativas no ambiente, o turismo pode ser considerado um importante fator de influência.

Este estudo pretende analisar empiricamente a relação entre o sector do turismo e a eco-eficiência total em 22 países da América Latina e Caraíbas entre 1995 e 2016 – utilizando um *Two-stage Data Envelopment Analysis* (DEA). Na primeira fase, foi calculada a eco-eficiência total dos países através de um *input oriented* DEA. Foram considerados rendimentos constantes à escala e utilizadas as seguintes variáveis: as emissões de CO_2 em toneladas como *input* para representar a degradação ambiental e o produto interno bruto em unidades monetárias nacionais constantes como *output* para representar o crescimento económico. Posteriormente, foi aplicado o modelo *Panel Autoregressive Distributed Lag* (PARDL) porque permite avaliar os impactos do turismo na eco-eficiência no curto e no longo prazo, suporta variáveis com diferentes níveis de integração na mesma estimação e produz resultados robustos perante amostras pequenas. Com o objetivo de captar diferentes vertentes do sector do turismo, foram selecionados: as chegadas de turistas em números de pessoas para representar a escala de mercado do turismo, o investimento de capital em turismo *per capita* em unidades monetárias nacionais para representar formação bruta de capital fixo do sector e a contribuição direta do turismo para o emprego em percentagem de participação no emprego total para representar a componente económica do turismo. Considerando a literatura já existente, foram utilizadas como variáveis de controlo: o consumo de energia elétrica *per capita* em GWh para medir o grau de sofisticação das

economias, a abertura de comércio em percentagem do produto interno bruto para medir o volume de comércio e o Índice de Desenvolvimento Humano para medir o bem-estar social e económico.

Antes de proceder à estimação do modelo PARDL, um grupo de testes preliminares e de especificação foram efetuados. Primeiramente, procedeu-se à realização dos testes de dependência seccional, da matriz das correlações, dos fatores de inflação da variância e dos testes de raízes unitárias de 1ª e 2ª geração. Foi também efetuado o teste de *Hausman*, que confronta efeitos fixos com efeitos aleatórios e o resultado confirmou a primeira hipótese. Posteriormente, foram executados três testes de especificação: o teste modificado de *Wald*, o teste de *Pesaran* e o teste de *Wooldridge*, cujos resultados confirmaram a presença heterocedasticidade e autocorrelação de primeira ordem. Portanto, considerando a presença de dependência seccional nas variáveis e de heterocedasticidade e autocorrelação de primeira ordem no modelo, concluímos que o estimador mais adequado era *o Driscoll-Kraay*. Por fim, foi confirmada a presença de homogeneidade no modelo e refeitos os três testes de especificação para o modelo parcimonioso – que apontaram para a presença de heterocedasticidade e autocorrelação de primeira ordem.

Os resultados do DEA demonstram que o Paraguai e a Costa Rica são os países mais eficientes e que Cuba é o menos eficiente durante o horizonte temporal. É ainda possível observar um (ligeiro) decréscimo na eco-eficiência total da maior parte dos países da amostra entre 1995-2005 e 2006-2016 – apenas Cuba, El Salvador, Guiana, Jamaica e República Dominicana aumentaram o *score* de eficiência entre as duas décadas. Considerando os resultados do PARDL, estes demonstram que as chegadas de turistas, a utilização de não renováveis para gerar (uma parte substancial da) energia elétrica para consumo *per capita* e a abertura de comércio têm um impacto negativo (decrescem) na eco-eficiência total desta região, tanto no curto como no longo prazo. Por outro lado, o investimento de capital em turismo *per capita*, a contribuição direta do turismo para o emprego e o Índice de Desenvolvimento Humano têm um efeito positivo (aumentam) na eco-eficiência total no longo prazo.

Através dos resultados do DEA, conclui-se que é essencial o aumento da percentagem de utilização de energias renováveis no *mix* de energia para reduzir a dependência de combustíveis fósseis e atenuar a degradação ambiental dos países da América Latina e Caraíbas. Nesse sentido, os governos devem remover os subsídios aos combustíveis fósseis (para aumentar a competitividade das renováveis) e considerar a exploração da sinergia entre o sector de transporte (um dos principais causadores das emissões de CO_2 da região) e o sector de energia. Após a breve exposição dos resultados do PARDL, torna-se ainda evidente a necessidade dos formuladores de políticas focarem o respeito pela capacidade de carga e a gestão do congestionamento destes destinos, promoverem a inclusão dos residentes nos benefícios (económicos) do turismo e estimularem a criação e estruturação de investimentos turísticos sustentáveis.

Abstract

This paper examines the impacts of the tourism sector on the overall eco-efficiency of 22 Latin America and Caribbean countries from 1995 to 2016. A two-stage Data Envelopment Analysis methodology was used in order to first calculate the overall eco-efficiency of the countries from the sample (considering the CO_2 emissions as the input and the economic growth as the output), with the outcomes pointing to an eco-efficiency decrease in the majority of countries. Posteriorly, a Panel Autoregressive Distributed Lag model was applied to analyse the impacts of tourism arrivals, tourism capital investment, and direct tourism contribution to employment on the previously calculated overall eco-efficiency. Moreover, given the presence of cross-sectional dependence, heteroscedasticity, and first order autocorrelation in the model, the Driscoll-Kraay estimator was used, and the results indicate that tourism arrivals, use of nonrenewables to generate (a substantial part of) electric power to consumption, and trade openness contributed to the decrease in these countries' eco-efficiency, both in the short- and long-run. Contrariwise, tourism capital investment, direct tourism contribution to employment, and Human Development Index seem to promote eco-efficiency in the long-run. These findings suggest that policymakers should pay attention to these destinations carrying capacity given that, if they ignore this feature, it can produce environmental and climatic shocks to these countries, as well as bringing constraints to their development (both in the short- and long-run). Simultaneously, in order to grant their sustainable development, they must continue to encourage investments in sustainable tourism projects and productive employment to all. Lastly, we see that the error correction mechanism has a negative and statistically significant value in the estimation, which points to the existence of a cointegration/long memory relationship between our variables.

Keywords

Eco-efficiency; Tourism arrivals; Tourism capital investment; Direct tourism contribution to employment; Two-stage DEA; Latin America and Caribbean countries.

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Acronyms list

BTI	Bertelsmann Stiftung's Transformation Index
CD	Cross-section Dependence
CIPS	Cross-sectionally Augmented Im, Pesaran and Shin test
CO_2	Carbon Dioxide
CRS	Constant Returns to Scale
DEA	Data Envelopment Analysis
DFE	Dynamic Fixed Effects
DMU	Decision-Making Units
ECM	Error Correction Mechanism
FE	Fixed Effects
FE-DK	Fixed-Effects Driscoll-Kraay
FER	Fixed Effects Robust
GDP	Gross Domestic Product
IDB	Inter-American Development Bank
IEA	International Energy Agency
ILO	International Labour Organization
IMF	International Monetary Fund
IRENA	International Renewable Energy Agency
LAC	Latin America and Caribbean
MG	Mean Group
OECD	Organization for Economic Co-operation and Development
PARDL	Panel Autoregressive Distributed Lag Model
PMG	Pooled Mean Group
RE	Random Effects
SE	Scale Efficiency
UECM	Unrestricted Error Correction Mechanism
UNWTO	World Tourism Organization
VIF	Variance Inflation Factor
VRS	Variable Returns to Scale

1. Introduction

Latin America and the Caribbean (LAC) region have experienced an improvement on economic growth during the last decades (Koengkan et al. 2019), which is usually considered as a relevant factor for the countries' development. However, the economic growth is also associated with increases in the production scale which, in turns, require increases in energy consumption. In the case of the LAC countries, this increase is mainly on nonrenewable energy, since the majority of these countries are still very fossil fuel dependent (Fuinhas et al. 2017). This heightens in fossil fuels consumption (motivated essentially by the energy and transport sectors) in tandem with the region energy inefficiency (as the dependence of foreign energy or energy security supply) leads to an inevitable increase in the LAC countries CO_2 emissions. As it is known, this phenomenon is considered one of the major contributors to global warming and, especially in emerging economies as the ones from the LAC, it represents a serious concern given their production structure and extreme vulnerability to natural disasters (Alvarado and Toledo, 2017; Saidi and Hammaming, 2015).

Based on previous information, in order to evaluate the state of the countries in terms of environmental degradation, one important concept has emerged on the environmental and sustainable development fields: the "eco-efficiency". This concept can be defined as: *"The delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life-cycle to a level at least in line with the Earth's estimated carrying capacity"* (WBCSD, 2006)[1], being used as an instrument for measure sustainable development.

Recently, the measurement of the eco-efficiency and the subsequent analysis of the impacts of exogenous factors on that notion became a target of interest in academic research (Zhou et al., 2018). Given the LAC natural and cultural assets and according to the IMF (2019), the countries of the region who are mainly tourism-dependent presented the best prospects for enhancing their economic growth compared to the countries which are heavily dependent on commodities export, which means that this sector can be a future solution to their economic improvement – but must be conducted in order to increase ecological awareness and ensure sustainable destination development (otherwise it will become destructive). Given that, the tourism sector can be considered as an important influencing factor to the LAC region eco-efficiency and lead us to the following main (central) question:

[1] Correspond to the original definition given by the WBCSD in 1992.

"What are the impacts of the tourism sector on the Latin America and Caribbean countries eco-efficiency?"

In order to answer to the previous question, the impacts of the tourism sector on the LAC countries eco-efficiency were investigated using the two-stage DEA methodology for a panel of 22 LAC countries, with annual data ranging from 1995 to 2016. During the first stage, a DEA was applied to assess the countries' overall eco-efficiency, using the CO_2 emissions (as undesirable output) to represent the environmental degradation and the GDP to measure the economic growth (as desirable output). This method allows us to analyse the eco-efficiency over time and estimate the dependent variable (the overall eco-efficiency), which will be used in the second stage. In the second stage, the Panel Autoregressive Distributed Lag (PARDL) model was chosen to regress the selected influential factors on the overall eco-efficiency, mainly because it is capable of producing robust results with small/moderate samples and supports both orders of integration (i.e. I(0) and I(1)) in the same estimation. This method also enables to evaluate the impacts of the tourism sector on the computed eco-efficiency, both in the short- and long-run. To reach this specific goal, three variables which reflect different strands of the sector were chosen, namely: tourism capital investment, tourism arrivals, and direct tourism contribution to employment.

Given the facts already stressed, analyse the impacts of tourism on LAC eco-efficiency is extremely necessary since most of the researchers focus on measure tourism eco-efficiency. Thus, perceive the effects of tourism on LAC countries environmental and economic performance can contribute to the enlargement of this thematic and also help the governments on developing efficient policies to achieve sustainable tourism, promoting resources management and environmental protection without compromise the economic output.

The results from the DEA estimation point to a (slight) decrease on the overall eco-efficiency of almost all decision-making units (DMU's) of our sample, between the first (1995-2005) and second (2006-2016) decades, with the exception of Cuba, Dominican Republic, El Salvador, Guyana, and Jamaica. Regarding the influencing factors regression, the outcomes have indicated that tourism arrivals, use of nonrenewables to generate (a substantial part of) electric power to consumption, and trade openness contribute to decreasing the overall eco-efficiency of LAC countries both in the short- and long-run. On the other hand, tourism capital investment, direct tourism contribution to employment and, Human Development Index positively affect (i.e. heightens) these countries' eco-efficiency in the long-run.

After this introductory section, the study will be organised as follows: Section 2 presents a brief literature review on tourism and eco-efficiency relationship, Section 3 presents the data, Section 4 describes the methodologies which were used, Section 5 displays the results, Section 6 provides their discussion and policy implications, and Section 7 concludes.

2. Literature Review

In the last few decades, the concerns regarding sustainability have been increasing, with the implementation and development of sustainable ways of production becoming a worldwide goal (Peng et al., 2017). Thus, to evaluate the state of the countries in terms of sustainable development, one important concept has emerged in the academic debate: the "eco-efficiency" (Schaltegger and Sturm, 1990).

The eco-efficiency is considered as an instrument for assessing sustainable development (Charmondusit et al., 2013) which allow exploring the trade-off between the economic and environmental performances (Carvalho et al., 2017) and with applications on both the micro (e.g. companies) and macro-level (e.g. regions) (Zhou et al., 2018). In order to conduct better to comprehend the idea of sustainable development and to conduct eco-efficiency analysis in a more precise way, some eco-indicators have been developed in the literature (Van Caneghem et al., 2010). These indicators are considered a unique method to evaluate sustainable development progresses (Singh et al., 2009), mainly because they allow to measure, compare and improve the eco-efficiency of different countries, areas, and industries (Caiado et al., 2017).

Eco-efficiency techniques have been extended through model calculations and innovative indicators (Kytzia et al., 2011). Nevertheless, in general, the Data Envelopment Analysis remains as the most used methodology on eco-efficiency focused studies (see Chaabouni, 2019), given that it produces an understandable index which does not present restrictions on the data distribution and allow multiple inputs and outputs simultaneously (Yi and Liang, 2014). This non-parametric method, based on linear programming, was developed by Charnes et al. (1978) and allows to measure the productivity and the scale efficiency of individual decision-making units (DMU) through an eco-efficiency ratio shaped as an input-output model – with the environmental and economic effects corresponding to the inputs and outputs, respectively (Lee and Ji, 2010; Kuosmanen and Kortelainen, 2005).

To assess the eco-efficiency and to analyse the impacts of certain variables on this indicator, the two-stage Data Envelopment Analysis is often applied (e.g. Gitto and Mancuso, 2011) and this technique is based, as the name indicates, on a two-stage approach. Similarly to the DEA, in the first step, it measures and evaluates the efficiency of each DMU. However, additionally to this evaluation, in the second step of the estimation, a regression model is constructed with a set of influencing factors in order to observe their impacts on the DEA efficiency scores that were achieved in the first stage estimation (Badunenko and Tauchmann, 2018). Moreover, we should state that the choice of the regression model does not represent an econometric problem (Ramalho et al., 2010). As an example, we can stress the use of two-limit Tobit models (e.g. Hedeman, 2014), Ordinary Least Square (see Fatimah and Mahmudah, 2017) and Fractional Regression Models (Ramalho et al., 2010) as an illustration of previously applied regressions. The two-limit Tobit (see Simar and Wilson, 2007) still be the most widely used model. However, the use of this methodology can be doubtful since DEA scores are different from the two-limit Tobit model domain – for the reason that, in this model, are not observed efficiency scores with zero values (Raheli et al., 2017).

The number of works that used DEA to evaluate the eco-efficiency in the LAC region is relatively scarce, and the ones that exist are more often applied to individual countries (Moutinho et al. 2018). For example, Piña and Martínez (2016) measured and evaluated the social, economic, and environmental efficiency of 11 cities of Colombia, while Camioto et al. (2014) dedicated their investigation to the efficiency analysis of the Brazilian industrial sectors.

Nonetheless, there is a large part of the literature which indirectly evaluates the eco-performance of the LAC region, analysing the nexus between economic growth and other environmental indicators/variables (see Moutinho et al. 2018). For instance, Al-Mulali et al. (2013) examined the relationship between economic growth, CO_2 emissions, and energy consumption for 18 LAC countries, finding a bidirectional and positive causality between energy consumption, CO_2 emissions, and economic growth in 60% of the countries which were analysed. Rosado and Sánchez (2017) investigated the causal relationships between electric power consumption, CO_2 emissions and economic growth in a group of South American countries. Their causality results confirmed that, in the short-run, there is bidirectional and positive causality between CO_2 emissions and electric power consumption. Additionally, it was also found a unidirectional and positive relationship between economic growth and CO_2 emissions and between economic growth and electric power consumption. In the long-run, the results displayed a bidirectional and negative causality between CO_2 emissions and economic growth and two unidirectional causalities running from electric consumption to CO_2 emissions and from electric power consumption to economic growth. Koengkan et al. (2018), studying similar causal relationships in the Andean community nations, found a bidirectional and positive causal relationship between CO_2 emissions and energy consumption and between economic growth and energy consumption. In this same study, the variables CO_2 emissions and economic growth have also presented a bidirectional causality, positive when it runs from economic growth to CO_2 emissions and negative when it runs from CO_2 emissions to growth. Furthermore, the empirical results from Acheampong

(2018), who focused its study on similar relationships, uncovered that economic growth does not seem to cause energy consumption, that CO_2 emissions do not cause energy consumption, that economic growth negatively causes CO_2 emissions, that energy consumption negatively causes CO_2 emissions, and that CO_2 emissions seem to positively cause economic growth.

The previous studies indicate that the outcomes are not consensual, given that distinct samples, variables, and empirical methodologies were used. However, there are few doubts about the existence of a relationship between environmental degradation, energy consumption, and economic growth in this region. This indicates that further investigations should be conducted, in order to evaluate the sustainable development of the LAC region, perhaps with the application of new inference methods (for instance, with the use of the DEA methodology).

Eco-efficiency is becoming the focus of many researchers, including in the tourism research field (Qiu et al., 2017), with the increasing tourism economic impacts all over the world and the intensive energy consumption associated with destinations (e.g. Peng et al., 2017; Becken and Simmons, 2002) being the central reasons to the enlargement of the literature on this thematic.

The inclusion of the eco-efficiency concept on sustainable tourism was first proposed by Gössling et al. (2005), who explored the impact of some economic variables associated with the tourism activity on indicators as carbon dioxide emissions and energy consumption (indicators which were representing eco-efficiency). After this study, many researchers have followed the same guideline while others focus their analysis on singular aspects of tourism eco-efficiency. For instance, Huang et al. (2016) measured the coastal tourism development eco-efficiency in Taiwan, and Brida et al. (2014) evaluate tourism transports eco-efficiency in South Tyrol, both using the Data Envelopment Analysis.

Regarding the two-stage DEA, the number of studies that apply this method is still reduced (see Liu et al. 2017). For instance, Liu et al. (2017) investigated the Chinese coastal cities tourism eco-efficiency and, in the second step of the analysis, were selected a group of indicators (comprehensive utilisation of the tourism-related “three wastes”, tourism arrivals, economic growth, tourism industry structure, and green coverage rate of built-up area) that influence the previously calculated eco-efficiency. These authors applied three models – considering Constant Returns to Scale (CRS), Variable Returns to Scale (VRS), and Scale Efficiency (SE) – and all empirical results indicated that the tourism arrivals and the comprehensive utilisation of the tourism-related "three wastes" have negatively affected tourism eco-efficiency. In contrast, the economic growth, the tourism industry structure and the green coverage rate of the built-up area contribute to increasing it. Applying the same method, Peng et al. (2017) assessed the eco-efficiency of Huangshan National Park as a tourism destination. In this investigation were also estimated three but, in this case, the outcomes were not consensual. In the first model, using CRS, the tourism development and the industry structure positively affected tourism eco-efficiency while the technical level, the investment level, and the environmental regulation have had a negative impact (i.e. reduce) on it. The second model, considering SE, points to similar results, and only the environmental regulation signal becomes positive. Lastly, in the model which considers the VRS, all variables seem to be detrimental to tourism eco-efficiency. As it is possible to observe, both Liu et al. (2017) and Peng et al. (2017) select their influencing factors according to the tourism aspect which is focused on their studies, being a possible explanation to the disparity of results in this research field.

Specifically, for the LAC region, it can be noted that it exists a lack of studies centred on the analysis of the influencing factors impacts on the first step computed eco-efficiency. As well as happen on the eco-efficiency measurement, most of the published research evaluates the relationship between tourism and eco-efficiency indirectly – through causality and impact analysis, with the combination of tourism, economic, and environmental indicators (e.g. Akadiri et al., 2018; Paramati et al., 2016). Regarding Akadiri et al. (2018), they studied the causal relationships between tourism, CO_2 emissions, economic growth, and globalisation in island nations. Their findings indicate that CO_2 emissions positively cause both tourism and growth in the Bahamas. Tourism and economic growth also positively cause CO_2 emissions in Trinidad and Tobago, as well as in Saint Vincent. Lastly, tourism seems to cause CO_2 emissions in Belize and Dominica. On the other hand, Paramati et al. (2016) have concentrated their investigation on the impacts that tourism could produce on the economic growth and CO_2 emissions of the developed and developing countries. According to their results, in the developing economies (in which were included Argentina, Brazil, Dominican Republic, and Mexico), there seems to exist a positive impact from tourism on growth. Nevertheless, the results also state that sector development can probably lead to an increase in CO_2 emissions.

After this brief but consistent review of the literature, the existent gap in this investigation field became obvious. Thus, the primary purpose of this study is to contribute to decreasing that gap, focusing on the evaluation of the impacts that the tourism sector has on overall eco-efficiency, especially in the case of the LAC countries, where the tourism sector is rising, and it is considered as one of the main drivers of these economies. In addition, the results from this study will also contribute to expanding the knowledge concerning the economic and environmental impacts of the tourism activity in this region, which can be a precious help on the development of measures that will contribute to the sustainable development of this sector in the Latin America and Caribbean countries.

According to the previous statements, in the first step of this analysis, we will measure the overall eco-efficiency of the LAC countries – following a perspective that contains both economic and environmental elements – and, posteriorly, analyse the impacts that a group of tourism indicators probably have on the previously calculated overall eco-efficiency score.

3. Data

In order to achieve the goals of this analysis, we collected annual data, ranging from 1995 to 2016, for 22 LAC countries, namely: Argentina, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru and, Uruguay. The availability of the data was the central criteria to choose both the period and countries to be included in the analysis. Moreover, it should be referred that the statistical software package STATA 15 was used to perform econometric analysis. The name, definition, and source of the variables are presented in Table 1.

TABLE 1. Variables description

Variable	Definition	Source
E	Overall eco-efficiency	Authors own calculation
Y	Gross Domestic Product in the constant local currency unit	World Development Indicators
C	Annual carbon dioxide emissions in tonnes	Our World in Data
IPC	Capital investment in the constant local currency unit	World Travel & Tourism Council
A	Tourism arrivals in the number of persons	World Development Indicators
EMP	Direct contribution to employment in % share of total employment	World Travel & Tourism Council
EPC	Electric power consumption in GWh	CEPALSTAT
T	Trade, in % of Gross Domestic Product	World Development Indicators
H	Human Development Index	Human Development Report
P	The total population in the total number of persons	World Development Indicators

The Gross Domestic Product in constant local currency unit (Y) and the annual carbon dioxide emissions in tonnes (C) were both used to calculate the dependent variable: Overall eco-efficiency (E). The dependent variable was obtained through a Data Envelopment Analysis – using the annual carbon dioxide emissions (C) as the input and the Gross Domestic Product (Y) as the output. Following Kuosmanen and Kortelainen (2005), the present investigation uses the pollutants (or undesired outputs) as the inputs and the economic value-added (or the desired output) as the outputs. The Gross Domestic Product (Y) was retrieved from the "World Development Indicators" database while the annual carbon dioxide emissions (C) were obtained from the "Our World in Data" database.

Regarding the interest variables, the tourism capital investment in constant local currency unit (IPC) was used to represent the sector gross fixed capital formation (Barišić and Cvetkoska, 2019), the tourism arrivals in the number of persons (A) was used to measure the tourism market scale (Liu et al., 2017) and, the direct tourism contribution to employment in % share of total employment (EMP) was used in order to represent the direct economic impacts of this sector (Barišić and Cvetkoska, 2019). Both the tourism capital investment and tourism direct contribution to employment were obtained from the "World Travel and Tourism Council" database. The tourism arrivals were collected from the "World Development Indicators".

Given the characteristics of our dependent variable, the control variables were chosen considering the past empirical investigations on economic growth and CO_2 emissions, choosing the ones which are proven to influence both of these variables. Thus, our control variables will be the electric power consumption in GWh (EPC) – which include electricity generated by both primary and secondary sources – was collected from "CEPALSTAT" and will be used to represent the sophistication level of the economies (Santiago et al., 2018), the Trade in % of Gross Domestic Product (T), retrieved from the "World Development Indicators", to proxy for trade volume (Alfaro et al., 2004), and the Human Development Index (H), obtained from the "Human Development Report", to represent the countries social and economic well-being (see Ouedraogo, 2013).

The population in the number of persons (P) was retrieved from the "World Development indicators" to transform both the tourism capital investment in constant local currency unit (IPC) and the electric power consumption in GWh (EPC) in their respective *per capita* values, eliminating the distortions caused by population variations.

4. Methodology

A two-stage DEA approach was applied to conduct this investigation. Therefore, the present section was divided into two sub-sections: 1) describes the DEA method, which is commonly used to measure and evaluate the relative efficiency of each DMU; 2) describes the second phase which consists in the estimation of a regression model in order to measure the impacts of exogenous factors on the overall eco-efficiency scores produced by the DEA.

4.1. Data Envelopment Analysis

The Data Envelopment Analysis methodology was first proposed by Charnes et al. (1978) – inspired by Farrell (1957) fundamental principles – and is a non-parametric, mathematical programming technique used to evaluate the relative efficiency of each DMU. The DEA measures the efficiency as a ratio between weighted outputs and weighted inputs, and the model can be converted into a Linear Programming Problem (Charnes and Cooper, 1962) to determine the weights which maximize that ratio. In other words, this model estimates the optimal combination of inputs and outputs which maximize the DMU's efficiency.

The results are expressed through an efficiency score with the values ranging from 0 (lower value) to 1 (maximum value). This evaluation consists of comparing a unit performance with the best score unit in a given sample. The best score DMU represents the DEA frontier, and the units that are not included in the frontier are considered inefficient. In order to ensure the validity of this analysis, the sum of inputs and outputs should be at least three times smaller than the total number of DMU's (Peng et al., 2017).

The Data Envelopment Analysis can follow an input-orientation or an output-orientation. The input-orientation DEA minimize the inputs for a fixed level of outputs, while the output-orientation DEA maximize the outputs for a fixed level of inputs. This work followed an input-orientation to evaluate the eco-efficiency of LAC countries, minimizing the CO_2 emissions (input) for a given level of economic growth (output).

DEA methodology can also be different in terms of returns to scale: The Constant Returns to Scale (CRS) model (or the CCR model) considers that an increase in the inputs produces a proportional increase in the outputs (Charnes et al. 1978), while the Variable Returns to Scale (VRS) model (or the BBC model) assumes that an increase in the inputs leads to a disproportionate increase in the outputs (Banker et al., 1984). The CRS and VRS efficiency scores are known as Technical Efficiency and Pure Technical Efficiency, respectively. Following the previous literature, the CRS was applied in this investigation, given that it is the most used in this type of studies, to enable us to measure the overall technical efficiency – which includes technical efficiency and scale efficiency (Figueroa et al., 2017).

Assuming that there are "n" DMU's to be evaluated, the relative efficiency (θ) of DMU_j (with j = 1, ..., n) is the ratio of the weighted combination of outputs y_{rj} (with r = 1, ..., s) and inputs x_{ij} (with i = 1, ..., m). Then, the relative efficiency of a DMU_j can be evaluated by solving a fractional programming problem, as follows:

$$\theta_j = max_{u_r,v_i} \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}}$$

subject to: (1)

$$\frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1, j = 1, ..., n; v_i \geq \delta, i = 1, ..., m; u_r \geq \delta, r = 1, ..., s.$$

In Eq. (1), u_r and v_i are the outputs and inputs weights, respectively, which are constrained to be greater than or equal than some small positive quantity, represented by δ. This last feature avoids that some input or output be entirely ignored when determining the relative efficiency (θ_j). With this in mind, the Eq. (1) can be transformed into a linear programming model (Eq. (2)) and formulated as a multiplier model:

$$\theta_j = max_{u_r,v_i} \sum_{r=1}^{s} u_r y_{rj}$$

subject to: (2)

$$\sum_{i=1}^{m} v_i x_{ij} = 1; \sum_{r=1}^{s} u_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0; j = 1, ..., n; v_i \geq \delta, i = 1, ..., m; u_r \geq \delta, r = 1, ..., s.$$

It can also be formulated as an envelopment model (Eq. (3)). In this case, provides supplementary information about peers, targets, and slacks of individual inputs and outputs:

$$\theta_j = min_{\lambda_j,s_i,s_j} \theta_j - \varepsilon \left(\sum_{i=1}^{m} s_i - \sum_{r=1}^{s} s_r \right)$$

subject to:

$$\theta_j x_{ij} - \sum_{j=1}^{n} \lambda_j x_{ij} - s_i = 0; j = 1, ..., n; i = 1, ..., m; y_{rj} = \sum_{j=1}^{n} \lambda_j x_{rj} - s_r = 0; r = 1, ..., s.; \lambda_j, s_i, s_r \geq \forall_{j,i,r}.$$ (3)

If θ_j = 1, this means that DMU$_j$ is efficient relative to other units. If $\theta_j \leq 1$, then the DMU can be considered as inefficient.

The previous equations (Eq. (1) and Eq. (2)) denote the CRS model with an input-orientation, which is the one used in this study. For more information regarding the DEA methodology see, e.g. Moutinho et al. (2018), Lee and Ji (2010), and Charnes et al. (1978).

4.2. Panel Autoregressive Distributed Lag Model

In the second stage, the PARDL model in the form of an Unrestricted Error Correction Mechanism (UECM) was used to evaluate the impacts of tourism capital investment, tourism arrivals, and direct tourism contribution to employment, on the overall eco-efficiency of the selected LAC countries.

This study recurs to the PARDL method mainly due to the presence of fixed effects on our model and its flexible characteristics (e.g. it is robust in the presence of endogeneity, is capable of dealing with cointegration, and supports both I(0) and I(1) orders of integration in the same estimation). Moreover, this methodology gives us the dynamic effects of the variables, allowing the division between the short- and long-run impacts. This decomposition can be understood as being similar to testing the Granger causality if a given coefficient present statistically significant effect (see Fuinhas et al., 2017; Jouini, 2015).

The PARDL model follows the specification of Eq. (4), with the prefix "L" denoting the transformation of the variables into natural logarithms.

$$E_{it} = \alpha_{4i} + \beta_{4i1}E_{it-1} + \beta_{4i2}LIPC_{it} + \beta_{4i3}LIPC_{it-1} + \beta_{4i4}LN_{it} + \beta_{4i5}LN_{it-1} + \beta_{4i6}LEMP_{it} + \beta_{4i7}LEMP_{it-1} + \beta_{4i8}LEPC_{it} + \beta_{4i9}LEPC_{it-1} + \beta_{4i10}LT_{it} + \beta_{4i11}LT_{it-1} + \beta_{4i12}H_{it} + \beta_{4i13}H_{it-1} + \varepsilon_{4it} \quad (4)$$

The dynamic general UECM form of the PARDL model (i.e. Eq. (4)) can be reparametrized into the Eq. (5), in order to obtain the dynamic relations between the variables.

$$DE_{it} = \alpha_{5i} + \beta_{5i1}DLIPC_{it} + \beta_{5i2}DLN_{it} + \beta_{5i3}DLEMP_{it} + \beta_{5i4}DLEPC_{it} + \beta_{5i5}DLT_{it} + \beta_{5i6}DH_{it} + \gamma_{5i1}E_{it-1} + \gamma_{5i2}LIPC_{it-1} + \gamma_{5i3}LN_{it-1} + \gamma_{5i4}LEMP_{it-1} + \gamma_{5i5}LEPC_{it-1} + \gamma_{5i6}LT_{it-1} + \gamma_{5i7}H_{it-1} + \varepsilon_{5it} \quad (5)$$

In the Eq. (5), the α_i represents the intercept, while β_{ik} and γ_{ik} represent the estimated parameters, with k = 1, ..., 7 while the ε_{it} denotes the error term.

5. Results

This section is also divided into two sub-sections: 1) displays the DEA results; 2) presents the preliminary and specification tests of the PARDL model, as well as its outcomes.

5.1. Data Envelopment Analysis results

The results of Data Envelopment Analysis are reported in Table 1. in the "Appendix" Section and reflect the changes in terms of overall eco-efficiency of each DMU, with CRS, during the period of analysis.

Looking at the individual outcomes, we conclude that Paraguay is the most efficient country (i.e. DMU) in our sample given that it presents the highest eco-efficiency scores between 1995 and 2016, reaching a maximum value (E=1) in 2005. This value represents the DEA frontier, meaning that all other scores are considered inefficient against the 2005 score of Paraguay. This country is followed by Costa Rica, which is the second most efficient DMU in the entire period. On the contrary, Cuba seems to be the least efficient DMU during all period. Moreover, it is possible to perceive that most of DMU's are decreasing their efficiency score (although on a small scale) comparing 1995 to 2016.

TABLE 2. Overall Eco-efficiency (E) scores averages with Constant Returns to Scale (%)

	1995-2005	2006-2016	1995-2016
Argentina	0.6700	0.6680	0.6690
Barbados	0.6952	0.6879	0.6916
Bolivia	0.6892	0.6834	0.6863
Brazil	0.6846	0.6820	0.6833
Chile	0.8400	0.8370	0.8385
Colombia	0.8823	0.8804	0.8813
Costa Rica	0.9105	0.9064	0.9084
Cuba	0.6599	0.6647	0.6623
Dominican R.	0.7720	0.7818	0.7769
Ecuador	0.6723	0.6665	0.6694
El Salvador	0.7087	0.7090	0.7089
Guatemala	0.7484	0.7421	0.7452
Guyana	0.8627	0.8657	0.8642
Haiti	0.7665	0.7433	0.7549
Honduras	0.7680	0.7567	0.7623
Jamaica	0.7945	0.8064	0.8004
Mexico	0.7117	0.7104	0.7110
Nicaragua	0.7826	0.7823	0.7824
Panama	0.7039	0.7033	0.7036
Paraguay	0.9945	0.9914	0.9930
Peru	0.7130	0.7037	0.7083
Uruguay	0.8072	0.8026	0.8049
Total average	0.7653	0.7625	0.7639

Table 2. shows the computed average for the Overall Efficiency scores of the countries between 1995 and 2016 (presented in Table 1. of "Appendix" section). According to the

results, the regional average during the entire period was 76.39%, meaning that these countries could decrease the application of inputs (i.e. CO_2 emissions) by at least 23.61%, this in order to be more efficient. Following that guideline and considering the first and second decades averages, the CO_2 emissions from these LAC countries could be reduced by, at least, 23.47% and 23.75%, respectively. From the results displayed in Table 2., we can also note that almost all of the DMU's suffered a slight decrease in their efficiency scores between the first and second decades, except for Cuba, Dominican Republic, El Salvador, Guyana, and Jamaica, which were able to improve their scores between the 1995-2005 and 2006-2016 decades.

5.2. Panel Autoregressive Distributed Lag results

Before proceeding with the PARDL estimation, it is crucial to understand the features of both the series and cross-sections. In this sense, a set of preliminary and specification tests were performed, before the model estimation, to uncover the features of the variables and of countries' analysis. First, in Table 3., we exhibit the descriptive statistics and the results from the Pesaran CD test (Pesaran, 2004). By the results of the CD test, it is possible to observe that the presence of cross-sectional dependence is confirmed for all variables, both in natural logarithms and in first differences, with an exception for the overall eco-efficiency (E) in first differences. This outcome reveals that exists correlation among the cross-sections, pointing for the fact that these countries share common shocks (see Fuinhas et al., 2015).

TABLE 3. Descriptive statistics and cross-sectional dependence

Variables	Descriptive statistics					Cross-sectional dependence (CD)		
	Obs	Mean	Std. Dev.	Min.	Max.	CD-test	Corr	Abs(corr)
E	484	0.7639226	0.0869688	0.653919	1	6.44***	0.090	0.390
LIPC	484	-13.58398	2.508002	-18.34472	-8.323441	23.11***	0.324	0.498
LA	484	13.99844	1.161789	11.09741	17.37311	57.46***	0.806	0.806
LEMP	484	1.233882	0.5829695	-0.1395276	2.81116	13.45***	0.189	0.369
LEPC	484	-6.939026	0.9524391	-10.67969	-5.598604	45.61***	0.640	0.769
LT	484	4.129005	0.4972411	2.74955	5.362827	15.85***	0.222	0.468
H	484	0.6796364	0.0845778	0.418	0.842	69.48***	0.975	0.975
DE	462	-0.0004092	0.0036985	-0.019732	0.014057	0.03	0.000	0.194
DLIPC	462	0.0425435	0.211792	-0.860465	1.168026	16.01***	0.230	0.328
DLA	462	0.055384	0.1313973	-0.7962065	1.273706	9.31***	0.134	0.217
DLEMP	462	0.0145773	0.1229764	-0.6297776	1.22041	4.11***	0.059	0.200
DLEPC	462	0.0293593	0.0816952	-0.5647078	0.6469841	5.05***	0.073	0.203
DLT	462	0.0006979	0.0974585	-0.4373145	0.6474607	23.23***	0.334	0.346
DH	462	0.0048052	0.0038672	-0.011	0.027	5.41***	0.078	0.203

Notes: To achieve the results of descriptive statistics and to test the presence of cross-sectional dependence, the Stata commands *sum* and *xtcd*, respectively, were used. The CD test has N(0,1) distribution under the H0: cross-sectional independence, *** denote statistical significance at 1% level.

In order to check the degree of correlation between the variables, and to test for the presence of multicollinearity, both the correlation matrix and Variance Inflation Factor (VIF) tests were computed, with the results being presented in Table 4. (for the variables in natural logarithms) and Table 5 (for the variables in first differences).

The results from the correlation matrices do not seem to cause concerns, except for the correlation between the Human Development Index (H) and electric power consumption (LEPC). The HDI is directly correlated with energy consumption, especially in developing economies like Latin America and Caribbean countries (IEA, 2004) and, following Ouedraogo (2013), that can be possibly explained by the reason that energy is directly linked with basic human needs (as health, life expectancy or education). As the VIF statistics test presents lower VIF and the mean VIF values, this means that multicollinearity does not represent an econometric problem to our estimation and that the high correlation between the Human Development Index (H) and electric power consumption (LEPC) does not impose any restriction to conducting the analysis.

TABLE 4. Correlation matrices and VIF statistics (for the variables in natural logarithms)

	E	LIPC	LA	LEMP	LEPC	LT	H
E	1.0000						
LIPC	0.8030	1.0000					
LA	-0.2586	0.0845	1.0000				
LEMP	-0.1553	0.1326	0.3945	1.0000			
LEPC	-0.0052	0.3401	0.5739	0.4604	1.0000		
LT	0.3114	0.1256	-0.4456	0.2396	-0.0781	1.0000	
H	-0.1023	0.2884	0.6190	0.3966	0.9101	-0.1709	1.0000
VIF	n.a.	1.17	2.45	1.69	6.56	1.73	6.47
Mean VIF		3.34					

TABLE 5. Correlation matrices and VIF statistics (for the variables in first differences)

	DE	DLIPC	DLA	DLEMP	DLEPC	DLT	DH
DE	1.0000						
DLIPC	-0.0994	1.0000					
DLA	-0.0540	0.2071	1.0000				
DLEMP	-0.0213	-0.0180	0.0635	1.0000			
DLEPC	-0.1281	0.1078	0.1380	0.0746	1.0000		
DLT	-0.1139	0.1455	0.1015	0.1140	-0.0670	1.0000	
DH	-0.0947	0.1598	0.0851	0.0189	0.1045	0.0926	1.0000
VIF	n.a.	1.09	1.07	1.02	1.05	1.06	1.04
Mean VIF		1.06					

To assess the order of integration of the variables, both the 1st generation and 2nd generation unit root tests were carried out (see Table 6).

The panel unit root test of Maddala and Wu (1999) – 1st generation – was used because it considers cross-sectional independence, and given that cross-sectional dependence seems not to be present on the overall eco-efficiency (E) in first differences it is the most suitable to test the stationarity of this same variable. The results of this test revealed that DE seems to be I(0).

In order to analyse the orders of integration of the remaining variables, the cross-sectionally augmented IPS (CIPS) test (Pesaran, 2007) was computed. This test accounts for the presence of cross-sectional dependence in the variables, with its results pointing to that the majority of the variables are on the borderline between I(0) and I(1) orders of integration. Derived from this conclusion, we can assume that the PARDL methodology is the most suitable for our estimation since it is capable of supporting in the same estimation I(0) and I(1) variables (or fractionally integrated variables).

TABLE 6. Panel Unit Roots tests

	1st generation unit root test		2nd generation unit root test	
	MW (Zt-bar)		**CIPS (Zt-bar)**	
	Without trend	**With trend**	**Without trend**	**With trend**
E	67.678**	59.944*	-0.846	0.649
LIPC	76.533***	94.045***	-5.940***	-2.374***
LA	39.811	77.400**	-0.812	0.606
LEMP	56.425*	40.809	-1.645*	-1.979**
LEPC	62.478**	60.919**	-0.364	0.205
LT	39.239	33.752	-0.618	1.298
H	20.024	49.275	-1.127	2.632
DE	293.902***	230.432***	-6.432***	-4.793***
DLIPC	217.249***	159.264***	-6.002***	-4.316***
DLA	154.714***	113.964***	-3.380***	-2.411***
DLEMP	177.993***	132.244***	-7.308***	-5.058***
DLEPC	175.872***	147.872***	-4.565***	-3.273***
DLT	193.608***	152.763***	-4.880***	-2.913***
DH	233.909***	187.768***	-4.703***	-3.185***

Notes: *, **, *** denote statistical significance at 10%, 5%, and 1% level, respectively; Maddala and Wu (1999) Panel Unit Root Test (MW) assumes that cross-sectional independence and H0: series is I(1); Pesaran (2007) Panel Unit Root Test (CIPS) assumes that cross-sectional dependence is in the form of a single unobserved common factor and H0: series is I(1); the Stata command *multipurt* was used to compute this tests.

To reach the purpose of confronting the presence of random and fixed effects in the panel, and to choose the most suitable estimator, the Hausman test was performed. This test has the null hypothesis that the difference in coefficients is not systematic, and the estimator selected contingent upon its results. In this case, the outcomes (in Table 7) seem to indicate that the individual effects of the countries are significant and should be taken into account, being the fixed effects model the most appropriate to analyse the impacts of the variables over time. Additionally, as a form of robustness, both the *sigmaless* and *sigmamore* options of the Hausman test were used in order to correct the error that the covariance matrix is not positively defined (see Fuinhas et al., 2019; Santiago et al., 2018).

TABLE 7. Hausman test

	FE vs RE
Hausman test	Chi2(13) = 104.37***
Sigmaless	Chi2(13) = 105.10***
Sigmamore	Chi2(13) = 87.18***

Notes: *** denotes significance at 1% level; In both models, the Hausman test were performed with both the *sigmaless* and *sigmamore* options. H0: random effects are the most appropriate or difference in coefficients is not systematic.

As was previously stated, before the model estimation, a group of specification tests were also computed. These tests were: 1) the Modified Wald Test to check the presence of heteroskedasticity of fixed effects with the null hypothesis of homoscedasticity; 2) the cross-sectional independence Pesaran test, to test the presence of contemporaneous correlation, with the null hypothesis of residuals are not correlated and follow a normal distribution; 3) The Breusch-Pagan Lagrangian multiplier test, to verify if the variances across individuals are not correlated; and 4) the Wooldridge test, to check the existence of serial correlation, with the null hypothesis of no first-order autocorrelation. By the results of these tests, it is possible to confirm the presence of heteroskedasticity and first-order autocorrelation in the model. Although, the result from the cross-sectional independence Pesaran test indicated that contemporaneous correlation is not present in the model. We should also refer that the Breusch-Pagan Langragian could not be carried out probably since, in our sample, the number of countries is higher than the number of years, giving origin to the problem: "the correlation matrix of residuals was singular". Although, as the cross-sectional independence Pesaran test tests a similar hypothesis, this is far from being a concern. All the results are displayed in Table 8.

TABLE 8. Specification tests

	Statistics
Modified Wald test	1789.78***
Pesaran's test	-0.142
Wooldridge test	57.938***

Notes: H0 of Modified Wald test: sigma(i)^2= sigma^2 for all I; H0 of Pesaran's test: residual are not correlated and follow a normal distribution; H0 of Wooldridge test: no first-order autocorrelation; *** denotes statistical significance at 1% level; Both the Frees and Friedman tests (H0: cross-sectional independence) were also performed, and the results corroborate with the Pesaran test results.

Considering the presence of cross-sectional dependence in the variables, and heteroskedasticity and first-order autocorrelation in the model, the Driscoll and Kraay (1998) estimator seems to be the most suitable estimator because it is capable of producing standard errors robust to the previously mentioned disturbances.

In the first estimation of the model, the tourism capital investment (DLIPC), the direct tourism contribution to employment (DLEMP) and, the Human Development Index (DH), were all not statistically significant in the short-run. Given this outcome, and following the principle of parsimony, these variables were retrieved from the estimation. To represent the most parsimonious model, the Eq. (5) was replaced by the Eq. (6):

$$DE_{it} = \alpha_{5i} + \beta_{6i1}DLN_{it} + \beta_{6i2}DLEPC_{it} + \beta_{6i3}DLT_{it} + \gamma_{6i1}E_{it-1} + \gamma_{6i2}LIPC_{it-1} + \gamma_{6i3}LN_{it-1} + \gamma_{6i4}LEMP_{it-1} + \gamma_{6i5}LEPC_{it-1} + \gamma_{6i6}LT_{it-1} + \gamma_{6i7}H_{it-1} + \varepsilon_{6it} \quad (6)$$

When working upon macro panels, it is generally recommended to test the panel heterogeneity/homogeneity. It is possible to test parameter slopes heterogeneity of two types: first, the presence of heterogeneity of parameters both in the short- and long-run and second the presence of heterogeneity of parameters delimited to the short-run.

In order to cope with the previous recommendation, both the Mean Group (MG) and Pooled Mean Group (PMG) estimators were computed. The MG is the most flexible technique because it runs a regression for each cross, computing an average coefficient for all individuals posteriorly, although it is inefficient in the presence of homogeneity (Pesaran et al., 1999). Contrariwise, the PMG estimator performs restrictions among cross-sections, i.e., the long-run parameters must be homogeneous (the ones that are usually the target of interest) while in the short-run parameters can be heterogeneous. Thus, it is possible to conclude that in the presence of homogeneity in the long-run, the PMG is more efficient than the MG (see, e.g. Koengkan et al., 2019).

To evaluate if MG and PMG are adequate estimators, we tested them against the Dynamic Fixed Effects (DFE) estimator. The Hausman tests to the three specifications are presented in Table 9. The outcomes of these tests revealed that the DFE is the preferable estimator (i.e. the efficient estimator under the null hypothesis), over the MG and PMG, indicating that the panel seems to be homogeneous. This result supports, once again, the idea that countries from our sample share identical behaviours and common shocks.

TABLE 9. Estimation Results of Heterogeneous estimators and Hausman test for selection

Dependent Variable: **DE**	**MG**	**PMG**	**DFE**
Constant	0.4509***	0.2913***	0.2470***
DLA	0.0016	-0.0009	-0.0017
DLEPC	-0.0004	-0.0072*	-0.0061***
DLT	-0.0042	-0.0007	-0.0040**
E (-1) (ECM)	-0.8581***	-0.4699***	-0.3161***
LIPC (-1)	-0.0015	0.0014***	0.0028**
LA (-1)	0.0047	0.0011	-0.0060**
LEMP (-1)	0.0029	0.0020**	0.0039
LEPC (-1)	-0.0264***	-0.0164***	-0.0119***
LT (-1)	-0.0014	-0.0020**	-0.0090***
H (-1)	0.0510	0.0544***	0.0809**
Diagnostic statistics			
N	462	462	462
Hausman test for selection			
	MG vs PMG	**MG vs DFE**	**PMG vs DFE**
	Chi2(11) =1.13	Chi2(11) =0.00	Chi2(11) =0.00

Notes: ***, **,* denote statistical significance at 1%, 5% and, 10% level, respectively; the Stata command *xtpmg* was used to estimate the models; The Hausman test was performed with the *sigmamore* and *constant* options. H0: difference in coefficients not systematic.

Table 10 shows the estimation results from the parsimonious model with the fixed-effects Driscoll-Kraay (FE-DK) estimator. We should stress that the previously mentioned specification tests were remade to the parsimonious model in order to grant that the results also hold for this model, this is, to grant that the model specification remained valid. In Table 10, the results from the fixed effects (FE) and the fixed effects robust (FER) estimators were also presented, but only to see the differences when we correct/not correct the phenomena which were found. Thus, our analysis is based on the fixed-effects Driscoll-Kraay (FE-DK) results.

TABLE 10. Estimation Results of Fixed Effects and Driscoll-Kraay estimators

Dependent Variable: **DE**	**FE**	**FER**	**FE-DK**
Constant	0.2470***	0.2470***	0.2470***
DLA	-0.0017	-0.0017	-0.0017*
DLEPC	-0.0061***	-0.0061***	-0.0061***
DLT	-0.0040**	-0.0040*	-0.0040**
E (-1) (ECM)	-0.3161***	-0.3161***	-0.3161***
LIPC (-1)	0.0009**	0.0009**	0.0009***
LA (-1)	-0.0019**	-0.0019*	-0.0019***
LEMP (-1)	0.0012	0.0012	0.0012**
LEPC (-1)	-0.0037***	-0.0037*	-0.0037***
LT (-1)	-0.0029***	-0.0029	-0.0029***
H (-1)	0.0256**	0.0256	0.0256**
Diagnostic statistics			
N	462	462	462
R^2	0.2236	0.2236	0.2236
F	F(10,430)=12.39***	F(10,21)=18.97***	F(10,20)=50.45***

Notes: ***, **, * denote statistical significance at 1%, 5%, and 10% level, respectively; the Stata command *xtreg* and *xtscc* were used to estimate the models.

The results of our estimation demonstrate that, in the short-run, the tourism arrivals (DLA), the electric power consumption (DLEPC), and the trade openness (DLT), are all statistically significant at 10%, 1%, and 5% level, respectively, and all have a negative effect on the eco-efficiency (i.e. contribute to its decrease). Furthermore, Table 10 also shows that all variables included in the model are statistically significant in the long-run, with the tourism capital investment (LIPC), the tourism direct contribution to employment (LEMP), and the Human Development Index (H), all having a positive impact on eco-efficiency (i.e. contribute to its increase). Conversely, tourism arrivals (LA), electric power consumption (LEPC), and trade openness (LT), all seem to have a negative effect on these countries eco-efficiency in the long-run.

The long-run elasticities are not displayed in Table 10, to access them it is necessary to calculate the ratio between the variables coefficient and the E (-1) coefficient, both lagged once, and, posteriorly multiply this ratio by - 1. The short-run impacts, the long-run elasticities, and the adjustment speed of the model (ECM) are presented in Table 11.

TABLE 11. Short-run impacts, elasticities and speed of adjustment

Dependent Variable: **DE**	**FE**	**FER**	**FE-DK**
Short-run impacts			
DLA	-0.0017	-0.0017	-0.0017*
DLEPC	-0.0061***	-0.0061***	-0.0061***
DLT	-0.0040**	-0.0040*	-0.0040**
Long-run (computed) elasticities			
LIPC	0.0028269**	0.0028269***	0.0028269***
LA	-0.0060279**	-0.0060279**	-0.0060279**
LEMP	0.0038883	0.0038883	0.0038883**
LEPC	-0.0118508***	-0.0118508**	-0.0118508***
LT	-0.0090347***	-0.0090347	-0.0090347***
H	0.0809307**	0.0809307**	0.0809307***
Speed of adjustment			
ECM	-0.3161***	-0.3161***	-0.3161***

Notes: ***, **, * denote statistical significance at 1%, 5%, and 10% level, respectively, the ECM denotes the coefficient of the variable E lagged once.

In the results presented above, it is possible to observe that the tourism arrivals (DLA and LA), the electric power consumption (DLEPC and LEPC), and the trade openness (DLT and LT), all contribute to the LAC countries eco-efficiency decrease (both in short- and long-run). Regarding the tourism capital investment (LIPC), the direct tourism contribution to the employment (LEMP), and the Human Development Index (H), all proved to be statistically significant, but only in the long-run, with all seeming to contribute to increasing these countries eco-efficiency.

Regarding the ECM, we see that it has a negative and statistically significant coefficient in our estimation, pointing to the presence of long-memory between the variables. This value represents the speed of adjustment of the models, i.e., the speed at which the dependent variable returns to equilibrium after changes in the explanatory variables. In our case, the speed of adjustment is relatively moderated, indicating that after a change in the explanatory variables, our dependent variable will return to equilibrium after a relatively short/moderate period.

6. Discussion and policy implications

The tourism sector has a significant role in LAC countries' economic development (as was previously stated). Although, with the growing environmental awareness around the world, the trade-off between this sector's economic benefit and its adverse implications on the environment gained relevance as a subject for investigation. This study evaluates the impacts of tourism on eco-efficiency (measuring both the economic and environmental components simultaneously) of LAC countries, both in short- and the long-run, through a two-stage approach.

By the outcomes of the DEA estimation, it is possible to perceive that almost all LAC countries suffered a slight decrease in the overall eco-efficiency values between the first and second decade. The reason that can probably explain these results in this region is due to the CO_2 emissions are mostly caused by the use of fossil fuels (Vergara et al., 2015).

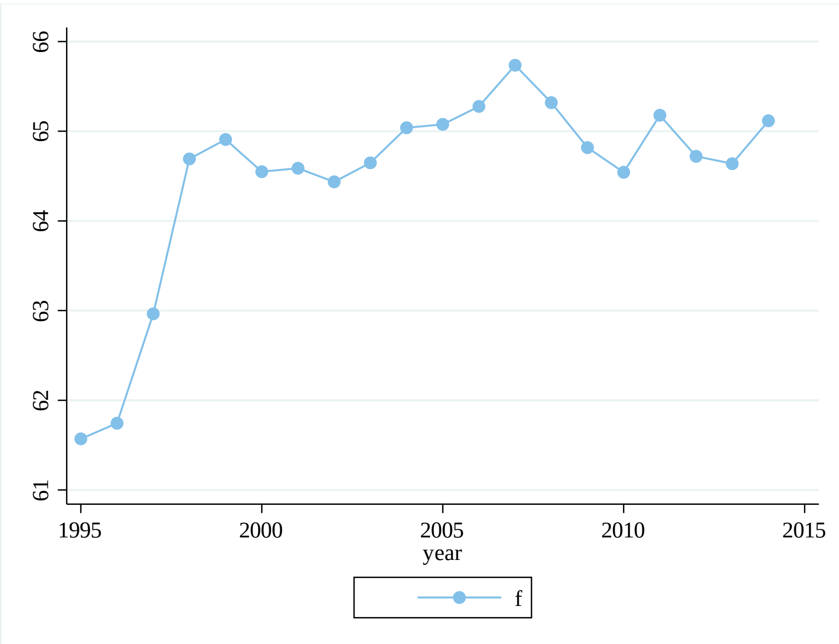

Fig. 1. Fossil fuel consumption (% of total) of Latin America and Caribbean countries.
Notes: The Stata command *twoway scatter* was used to obtain this graph; The blue dots represent the mean of the fossil fuels consumption for the region.

According to Fig. 1., we can see that the consumption of fossil fuels grew over time, with the most accentuated peaks being reached during the second period of our analysis, fact which could probably explain the observed reduction on the eco-efficiency scores in the period ranging from 2005 to 2016. This heightens it is possibly linked with the pressure from transport demand, one of the major challenges faced by this region (Viscidi and O'Connor, 2017). In LAC countries, both the passenger and freight transport are rapidly increasing and, although public transport continues to be the most used by the population of this region, the inefficiency and unsafe conditions of urban mobility simultaneously with the middle-class, income and urbanization growth are encouraging the purchase of private cars and motorcycles (Yañez-Pagans et al., 2019). This vehicle fleet development becomes clear since the number of vehicles in circulation doubled between 2005 and 2015, resulting in severe concerns of urban congestion, accidents in traffic, and air pollution in the LAC region (Viscidi and O'Connor, 2017).

Following the previous idea and the report from IRENA (2016), countries as Paraguay and Costa Rica account for a small percentage of total LAC CO_2 emissions, mainly because, by contrast to the other countries in the region, their energy supply comes almost entirely from renewable sources. This fact can explain why these two countries were noticed as being the most efficient countries of our analysis. However, in order to enhance their eco-efficiency even more, Paraguay and Costa Rica ought to keep working on the decarbonisation of their transport sectors since that it is the main factor motivating the oil and derivatives consumption and the increase of the national CO_2 emissions in both countries (IRENA, 2019; Timilsina and Shrestha, 2009).

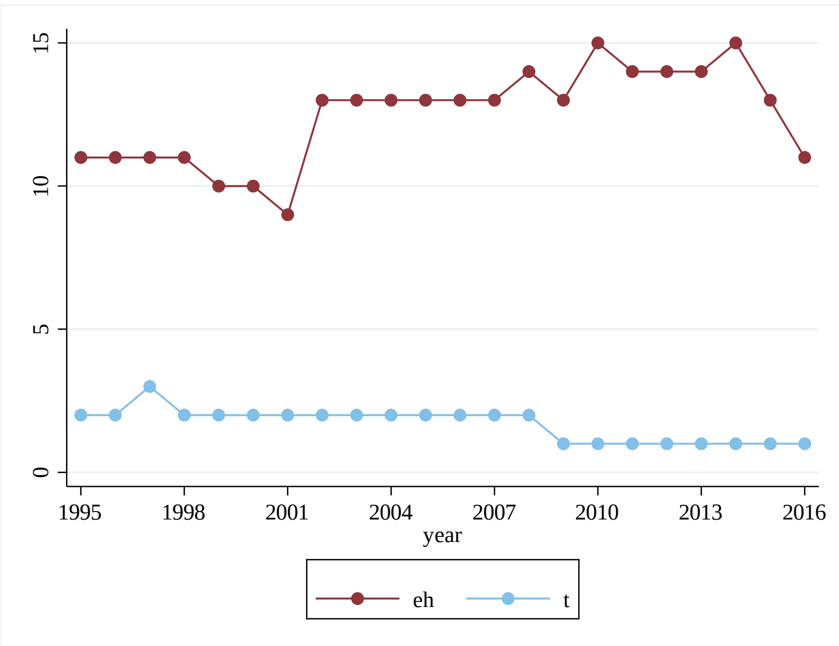

Fig. 2. CO_2 emissions by electricity and heat generation and transport sectors in Cuba.
Notes: The Stata command *twoway scatter* was to obtain this graph used; The maroon dots represent CO_2 emissions from the electricity and heat generation sector (eh) while the blue dots represent CO_2 emissions from the transport sector (t), both from Cuba.

Furthermore, it is possible to observe that Cuba was one of the few countries that presented an improvement in the eco-efficiency score between the first and second decades. This can be linked with the CO_2 emissions decrease from the electricity and heat generation (eh) and the transport (t) sectors – see Fig. 2. Although, due to the high fossil fuel consumption in its energy mix (which reached about 80% of total energy production in 2014) and to the deceleration on its economic growth (apparently caused by the Venezuela political and economic crisis in 2015 to 2016, given that it is the major Cuban trade partner), Cuba remained as the least efficient DMU during all the 1995-2016 period (Pedraza, 2018; BTI, 2018).

Given the previously stated facts, renewable energy deployment becomes necessary to decrease the region's fossil fuel dependence and to attenuate its environmental issues. In this sense, a battery of new and variated policies must be adopted to support the penetration of renewable sources in the energy mix of a range of sectors. As an example, being the transport sector one of the major contributors to the escalation of the LAC countries environmental concerns, mainly due to its energy intensity, the increases on its energy efficiency and the renewable share can be a precious help to decarbonise the region's energy sector. Bearing this in mind, the policymakers should explore the synergies between both the power and transport sectors (e.g. offering favourable conditions to electric vehicles acquisition), remove fossil fuel subsidies, and promote the investment on R&D and renewable fuels (more efficient biofuels).

Analysing tourism influencing factors and answering to the central question, we see that tourism arrivals have a negative impact (contribute to a decrease) on the LAC eco-efficiency, probably due to the reason that countries adopt tourism as an economic development strategy but seem to forget that the tourism arrivals relentless growth can involve to unsustainable practices, and possibly resulting in the over-tourism emergence. The over-tourism – which embraces both tourism carrying capacity and tourism congestion management (UNWTO et al., 2018) – is commonly associated to irreversible environmental implications, for example, the loss of destination authentic heritage, deterioration of natural ecosystems or air pollution, and to overcrowding and congestion in transports infrastructure, public spaces and local roads (Capocchi et al., 2019). Given that tourists are becoming largely sensitive to the environment quality and its features, this phenomenon can also be responsible for a demand decline in the own sector, with negative economic repercussions, especially in economies that are strongly dependent on tourism (Peeters et al., 2018). An example of these shortcomings is the lack of carrying capacity, uncivilised comportments and congestion, which were felt by tourists at Machu Picchu (Peru) (Peeters et al., 2018).

Contrariwise, tourism direct contribution to employment positively affects the eco-efficiency (but only in the long-run), and the explanation for that seems to be connected to the local population benefits generated by the tourism job creation (Barišić and Cvetkoska, 2019). Particularly in developing countries, the access of the local community to employment is crucial to tourism sustainable development since that it is a form to involve these communities in the economic benefits of this sector (Dogra and Gupta, 2012) and to incentive education and training of the employees, which, in turn, can lead to a decrease on environmental degradation and improvement of the natural heritage conservation (Anup, 2016). These positive effects can also be associated with the integration of vulnerable groups – as women, young people, and indigenous – which can lead to poverty reduction and social/economic development (ILO, 2011).

Regarding the positive impact of tourism capital investment on these countries' eco-efficiency in the long-run, it can be related to the important tourism role in spurring investments on human capital development and new infrastructures in the LAC countries (Fayissa et al., 2011). Thus, it can bring considerable benefits to the local community (OECD, 2018) – through employment, higher income or social cohesion – and be a mechanism to the own sector development and, consequently, to economic growth (Du et al., 2016). Moreover, some authors have identified tourism investment as a relevant factor to the CO_2 emissions mitigation (e.g. Paramati et al., 2018; Paramati et al., 2016), something that is probably linked to the capacity of tourism investments to heighten the environmental quality – investing in renewables energy, clean technologies, and eco-friendly activities by tourism companies (Lu et al., 2019). Considering the previously mentioned facts, the projects developed and financed by the Inter-American Development Bank (IDB) to help LAC countries on the achievement of sustainable tourism can be stressed as some of the reasons for the obtained results – e.g. in 2010, the IDB approved the financing to the construction of 8 Marriott hotels in the region, imposing them its Leadership in Energy and Environmental Design (LEED) certification (IDB, 2010).

Overall, the results from the interest variables reveal a necessity of the policymakers rethink and rebalance their strategies on how to achieve tourism sustainable growth, i.e., instead of developing measures which are only focused on the increase of tourism arrivals, they should pay more attention to the distribution of tourists pressure and respect the destination carrying capacity, e.g. creating limitations in the high seasons and/or in specific areas. Furthermore, it is important that the LAC governments continue to promote the residents' inclusion, with the development of policies that help on the improvement of their benefits (applying taxes for the visitors or generating tourism employment) and should continue to increase the levels of efficient investments in tourism – taking advantage of these countries potential to the renewables energy penetration which, simultaneously, can help to enhance the profitability and the economic output of this region.

The electric power consumption proved to be a relevant factor in enhancing the economic growth of developing economies, since it contributes to the production, working as a complement to labour and capital (Santiago et al., 2018; Hanif, 2017). However, the LAC region exceptional dependence on fossil fuels – with some of these countries being dependent on the imports of this type of energy and others being substantial producers – (Fuinhas et al., 2017) and the recurrent drought periods, which also require the generation of electricity from nonrenewable sources (Koengkan et al., 2019) are probably the main justifications for the negative effects of the electric power consumption on eco-efficiency (both in short- and long-run). Considering that the adverse environmental effects are outranking their positive economic effects, the policymakers should develop measures to increase renewables investments and implement subsidies to motivate the use of more energy-efficient devices (in order to decrease the global energy consumption) which, consequently, will improve their economic development and environmental quality.

Concerning the negative impacts of trade openness on eco-efficiency both in the short- and long-run, we can conclude that it is probably related to these economies' dependence on the export of primary goods (mainly commodities) and import of high-value products since that can be responsible for countries' welfare reductions (Sheikh et al., 2020; Keho, 2017). Moreover, the low levels of trade openness presented by a lot of these countries become problematic to the adoption of energy-efficient technologies, possibly increasing the energy demand from fossil fuels and leading to an increase on CO_2 emissions (Koengkan et al., 2019a). Thus, the LAC governments should expand trade agreements to increase their economic output and, at the same time, develop regulation focused on the environmental preservation (for instance, reforming the subsidies for fossil fuels and providing technology transfers that facilitate renewable energy implementation).

Although the improvement of human development encourages the electric power consumption, its positive influence on LAC eco-efficiency in the long-run can be associated with the education dimension upsurge, which probably has also led to the positive progress in the LAC HDI (Prados de la Escosura, 2015; UNDP, 2015). The education is considered an essential tool for sustainable development, raising an individual's awareness about the environmental degradation consequences (Rasekhi and Mohammadi, 2015) and possibly enhancing the CO_2 emissions mitigation. However, these countries still have a long path to go through regarding their human development level and, in this context, the policymakers should adopt diversified measures to ensure a better life expectancy, decrease income inequality, and especially promote the education investments (mostly in rural areas), in order to help the promotion of the renewables sources penetration and natural resources preservation.

7. Conclusion

In this investigation, a two-stage DEA method was applied to a panel of 22 LAC countries between 1995 and 2016, in order to investigate the impacts from the tourism sector on the region eco-efficiency. Firstly, was applied a CRS DEA model – following the input-orientation and considering the CO_2 emissions as the input and the economic growth as the output – in order to measure the countries' overall eco-efficiency scores. Posteriorly, the impacts of tourism arrivals, tourism capital investment, and tourism direct contribution to employment on the eco-efficiency scores were investigated, both in the short- and long-run, using a PARDL model. The specification tests confirmed the presence of cross-sectional dependence on the variables, and of heteroscedasticity and first-order autocorrelation in the model. For these reasons, the Driscoll-Kraay estimator with fixed effects was used to conduct the analysis. Regarding the EMC, it presents a negative coefficient with a 1% statistical significance level, pointing to the existence of cointegration/long-memory relationships between the variables.

The DEA outcomes revealed a reduction on the eco-efficiency scores between the first and second decades of our analysis (1995-2005; 2006-2016) in most LAC countries, with Paraguay and Costa Rica being the most efficient DMU's, and with Cuba being the least efficient DMU during all period. Given the decrease in eco-efficiency, it is crucial that the LAC governments develop policies in order to promote renewable sources penetration. Thus, the decarbonisation of these economies should be encouraged, especially in the transport sector. This strategy can probably contribute to reducing this region's dependence on fossil fuels and can be used as a tool also to decarbonise its energy sector.

Focusing on the PARDL model results, it is possible to observe that the tourism arrivals, the use of nonrenewables to generate (a substantial part of) electric power to consumption, and the trade openness exert a negative influence on the LAC eco-efficiency, both in the short- and long-run. Additionally, in the long-run, the tourism capital investment, the direct tourism contribution to employment, and the Human Development Index, all contributed to increasing the region eco-efficiency, with both the tourism capital investment and Human Development Index being its main drivers. In this sense, the policymakers should apply measures with major awareness in destinations carrying capacity and congestion management and not only in the promotion of mass arrivals, to be possible to take advantage of the tourism economic benefits without neglecting these countries' environment. Furthermore, they should continue to plan and sustainably regulate investments and promote the tourism sector productive employment (mainly to ensure resident's inclusion and to enhance their well-being).

For further research, given that these countries are extremely dependent on natural resources, it could be suitable the inclusion of a variable that represents the depletion of the natural resources, in order to evaluate its effects on the LAC eco-efficiency. We should stress that, for now, this seems complicated, mainly due to the lack of data.

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Appendix

TABLE 12. Overall Eco-efficiency (E) scores with Constant Return to Scale (%)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Argentina	0.67068	0.670098	0.671278	0.671756	0.66911	0.670099	0.671162	0.670764	0.670045	0.666719	0.667845
Barbados	0.70555	0.70568	0.704489	0.693979	0.691084	0.693514	0.69132	0.691483	0.690681	0.69018	0.689342
Bolivia	0.687315	0.688662	0.685491	0.686749	0.689059	0.687274	0.698576	0.691168	0.68921	0.690361	0.687741
Brazil	0.688905	0.686048	0.684974	0.683697	0.682916	0.683076	0.682477	0.68378	0.685126	0.684727	0.684609
Chile	0.84728	0.841944	0.836643	0.836619	0.833258	0.836804	0.842372	0.841485	0.842197	0.840575	0.840546
Colombia	0.879724	0.879558	0.877008	0.876516	0.883287	0.882985	0.884278	0.885286	0.884626	0.887933	0.884208
Costa Rica	0.913739	0.915557	0.914355	0.912676	0.911598	0.913216	0.911364	0.906837	0.905341	0.904275	0.906351
Cuba	0.653919	0.654107	0.658401	0.658685	0.659044	0.659469	0.661252	0.660683	0.662626	0.664925	0.666325
Dominican R.	0.772145	0.769762	0.770412	0.77123	0.772502	0.770839	0.771515	0.769402	0.768627	0.776815	0.778543
Ecuador	0.670854	0.669082	0.681371	0.674062	0.674454	0.676289	0.67301	0.671105	0.668798	0.668088	0.667924
El Salvador	0.712075	0.716873	0.709377	0.707433	0.70897	0.708978	0.70771	0.707592	0.704377	0.705924	0.706037
Guatemala	0.755897	0.760358	0.755254	0.750003	0.750205	0.746418	0.74388	0.742989	0.744876	0.742578	0.739957
Guyana	0.862785	0.863063	0.862175	0.859176	0.859337	0.861435	0.862725	0.863653	0.864009	0.862158	0.869083
Haiti	0.789479	0.783063	0.768445	0.774889	0.771529	0.770331	0.763091	0.755115	0.758006	0.74969	0.748026
Honduras	0.778385	0.778102	0.777038	0.772249	0.771097	0.770452	0.764906	0.762787	0.75896	0.75672	0.757262
Jamaica	0.79898	0.796237	0.794003	0.795185	0.794161	0.792687	0.791842	0.794181	0.793037	0.793845	0.795154
Mexico	0.713277	0.713299	0.712552	0.711869	0.712314	0.712946	0.711544	0.711418	0.709593	0.710415	0.708977
Nicaragua	0.790238	0.790417	0.786908	0.783562	0.7826	0.782108	0.780297	0.779636	0.776174	0.777256	0.779818
Panama	0.726387	0.706655	0.6994	0.699208	0.702551	0.702506	0.694031	0.702633	0.701834	0.7068	0.701417
Paraguay	0.994029	0.998149	0.992102	0.987537	0.987121	0.999471	0.996924	0.995447	0.994006	0.994915	1
Peru	0.715975	0.715851	0.712581	0.711979	0.710082	0.709506	0.714262	0.71571	0.718133	0.711557	0.706987
Uruguay	0.812005	0.804726	0.806164	0.806313	0.79704	0.808697	0.809917	0.812677	0.813271	0.803953	0.804632

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Argentina	0.666988	0.66919	0.667488	0.667743	0.668611	0.669379	0.668979	0.670046	0.666872	0.6669	0.66627
Barbados	0.690547	0.691307	0.682892	0.681555	0.685962	0.684496	0.686361	0.687049	0.693485	0.691957	0.691726
Bolivia	0.680241	0.689993	0.68881	0.68754	0.685216	0.684204	0.679313	0.680961	0.679379	0.680754	0.680797
Brazil	0.685548	0.685456	0.684426	0.686297	0.683412	0.68278	0.680929	0.679227	0.677611	0.677257	0.679109
Chile	0.839875	0.836462	0.837287	0.840211	0.838015	0.835369	0.835758	0.835655	0.836499	0.836979	0.834682
Colombia	0.884351	0.886576	0.883086	0.880147	0.878969	0.880516	0.879249	0.874877	0.879169	0.878434	0.878767
Costa Rica	0.906081	0.901268	0.902471	0.903872	0.907201	0.907252	0.908465	0.910471	0.910298	0.907097	0.905643
Cuba	0.667412	0.670244	0.666337	0.667428	0.658472	0.661674	0.662308	0.664486	0.664718	0.664406	0.663844
Dominican R.	0.778435	0.777346	0.779322	0.780638	0.781116	0.78151	0.780353	0.783181	0.785148	0.785979	0.787081
Ecuador	0.671021	0.667759	0.667244	0.664966	0.665489	0.665361	0.667351	0.665901	0.664216	0.665419	0.667066
El Salvador	0.704749	0.70447	0.708064	0.708118	0.708837	0.70866	0.709451	0.713085	0.713028	0.711098	0.70983
Guatemala	0.741211	0.743128	0.748746	0.746804	0.748919	0.749451	0.749791	0.744769	0.732595	0.72938	0.727815
Guyana	0.877394	0.867879	0.868664	0.869522	0.865161	0.864667	0.859604	0.862953	0.861958	0.862666	0.862699
Haiti	0.747825	0.742517	0.742683	0.746498	0.748082	0.747627	0.746371	0.745688	0.737762	0.736096	0.735637
Honduras	0.763048	0.753934	0.755778	0.759796	0.760135	0.755648	0.756758	0.757113	0.755883	0.753196	0.751947
Jamaica	0.79115	0.800033	0.797179	0.809344	0.812286	0.809131	0.8115	0.807552	0.811871	0.810223	0.809878
Mexico	0.709037	0.709307	0.708632	0.708594	0.710688	0.710006	0.709966	0.710717	0.712095	0.713242	0.711906
Nicaragua	0.779366	0.779331	0.782482	0.780619	0.781577	0.779791	0.784462	0.786757	0.784805	0.783255	0.782346
Panama	0.700531	0.704988	0.707198	0.700509	0.699249	0.698216	0.70114	0.700515	0.710764	0.707235	0.706035
Paraguay	0.998915	0.998154	0.995558	0.993658	0.9897	0.988194	0.988697	0.989513	0.987836	0.98757	0.987841
Peru	0.711603	0.705319	0.709666	0.70069	0.698524	0.706138	0.703644	0.703666	0.70118	0.700643	0.699485
Uruguay	0.798577	0.805784	0.791552	0.794338	0.808395	0.799926	0.795145	0.803386	0.81037	0.810519	0.810146