Aldo Pavan
Adriana Di Liberto

IL MONDO CHE CAMBIA

FrancoAngeli
OPEN ACCESS

 ISBN 9788891798701

Copyright © 2019 by FrancoAngeli s.r.l., Milano, Italy. ISBN 9788891798701

Aldo Pavan
Adriana Di Liberto

IL MONDO CHE CAMBIA

FrancoAngeli
OPEN ACCESS

 ISBN 9788891798701

Pubblicazione del Dipartimento di scienze economiche e aziendali dell'Università degli Studi di Cagliari.

INDICE

ECONOMIA DEL SETTORE PUBBLICO

ECONOMIA DEL TURISMO

GESTIONE E MISURE D'IMPRESA

STATISTICA E ANALISI QUANTITATIVA

STORIA ECONOMICA

13. A KAYA DECOMPOSITION ANALYSIS OF TOURISM-RELATED CO_2 EMISSIONS IN ITALY

by *Giovanni Bella*[*] and *Carla Massidda*[**]

Abstract

The purpose of this chapter is to provide a *Kaya* decomposition analysis of CO_2 emissions in Italy considering tourism among its determinants. *Kaya*'s identity is a variant of the IPAT identity that has been applied in studies of energy-related carbon emissions. The general IPAT specification corresponds to an identity with Impacts (*I*) on the left side and Population (*P*), Affluence (*A*) and Technology (*T*) on the right side. The terms on the right-hand side are connected by a multiplicative relationship. Until now, the literature has delivered various specifications of the *Kaya*'s identity. The simplest considers CO_2 emissions as a measure of the impacts and three ratios to decompose the amount of total emissions in its determinants. In detail, the first ratio is normally used to measure the carbon intensity of energy use, the second ratio denotes the energy intensity of economic activity. These two ratios correspond to the Technology (*T*) factor. The third ratio is income per capita that corresponds to the Affluence (*A*). Finally, to close the identity, the last term is not a ratio and it is given by Population (*P*). The present analysis proposes an extended version of the *Kaya* identity in order to take into account fossil fuel consumption and tourism. The results show that in Italy, among the driving forces behind CO_2 emissions, a significant role can be given to tourism.

Keywords: Kaya-identity, tourism, CO_2

Un'applicazione dell'identità di Kaya per l'analisi della relazione tra turismo e CO_2 in Italia

Lo scopo di questo capitolo è quello di fornire un'analisi delle determinanti delle emissioni di CO_2 in Italia attraverso l'applicazione della Kaya-*Identity* in cui il turismo

[*] Department of Economics and Business, University of Cagliari. Viale Sant'Ignazio da Laconi, 17, 09123 –Cagliari. Tel. 070-6753340. E-mail: bella@unica.it.
[**] Department of Economics and Business, University of Cagliari. Viale Sant'Ignazio da Laconi, 17, 09123 – Cagliari. Tel. 070-6753346. E-mail: massidda@unica.it.

compaia tra le determinanti. La *Kaya-Identity* è una variante della IPAT-*Identity* specificamente applicata negli studi sulle emissioni di carbonio legate al consumo energetico. La generale rappresentazione della IPAT corrisponde, appunto, a un'identità dove compaiono gli Impatti (*I*) sul lato sinistro e Popolazione (*P*), Affluenza (*A*) e Tecnologia (*T*) sul lato destro. I termini sul lato destro sono collegati da una relazione moltiplicativa. Sinora, la letteratura ha proposto diverse versioni dell'identità di *Kaya*. La più semplice considera le emissioni di CO_2 come misura degli impatti e, sul lato destro dell'identità, tre rapporti che decompongono le emissioni totali nelle sue determinanti. In dettaglio, il primo rapporto viene normalmente utilizzato per misurare l'intensità di carbonio nell'energia consumata mentre il secondo serve a indicare l'intensità energetica dell'attività economica. Questi due rapporti corrispondono al fattore Tecnologia (*T*). Il terzo rapporto è il reddito pro-capite che corrisponde al termine *Affluence* (*A*). Infine, per chiudere l'identità, l'ultimo termine non è un rapporto, ma è il livello della Popolazione (*P*). La presente analisi propone una versione estesa della *Kaya-Identity* per tenere conto del consumo di combustibili fossili e del ruolo del turismo. I risultati mostrano che in Italia, tra le forze che trainano le emissioni di CO_2, un ruolo significativo può essere dato al turismo.

Parole-chiave: identità di Kaya, turismo, CO_2

1. Introduction

International tourism has seen rapid growth in recent years bearing high potentials contribution on growth and poverty reduction. The most common approach to describe the link between tourism and growth is the so-called Tourism-Led Growth Hypothesis (TLGH), firstly introduced by Balaguer and Cantavella-Jorda (2002).

However, unprecedented tourism growth, besides positive economic outcomes, also brings with it a number of severe negative consequences. Actually, rapid tourism development means environmental and social pressure, stressed infrastructures, overcrowded major attractions and capacity constraints in major cities. Among these impacts, the relationship between tourism activities and CO_2 emissions, that was relatively underexplored until the last decade, is now gathering increasing attention among researchers. According to recent data (Lenzen et al., 2018), CO_2 emissions generated by the tourism sector are at around 8% across the globe and increased from 3,9 to 4,5 billion between 2009 and 2013. The great majority of these emissions (75%) depends on transportation (40% air transport, 30% car transport, and 5% other transport), while 21% and 4% depend on accommodation and other tourist activities (UNWTO, 2008). However, this is not all. Calculations of the impact of tourism on CO_2

emissions should also take into account its role on economic growth that is considered the main driver of environmental pollution.

For these main reasons, today the evaluation of CO_2 emissions led by tourism has become one of the fundamental steps to judge tourism sustainability. Inevitably, this theme becomes a part of the wider debate concerning the study of the determinants of CO_2 emissions at global level.

From this point of view, an interesting approach proposed by a recent strand of literature provides attempts to decompose the CO_2 emissions in its main determinants by applying the so-called IPAT decomposition technique. The IPAT model was firstly proposed by biologists and ecologists to describe the relationship between environmental impacts, population, economic factors and technology. Later, it has been often used as a basis for the Kaya identity suitable for investigations on the role of the various factors that drive carbon emissions (Dietz and Rosa, 1994). In these studies, the role of tourism is poorly considered.

The aim of this chapter is to provide a Kaya decomposition analysis of CO_2 in Italy, with tourism as a key determinant, over the period 1995-2014. Data are drawn from the World Development Indicators (2016).

The chapter is organized as follows. Section 2 sketches the general theoretical and empirical context to discuss the relationship between pollution and tourism development. Section 3 presents the IPAT-Kaya technique. Section 4 discusses the results, and Section 5 summarizes the main policy implications of the analysis.

2. General framework

The impact of tourism on CO_2 emissions is a topic that only recently has captured the interest of researchers. The discussion concerns both the direct effects generated by the tourism industry on CO_2, and the indirect effects that tourism can generate through its impact on economic growth.

At industry-level, tourism development increases energy use and related CO_2 emissions due to the expansion of all tourism-related economic activities, such as transportation, catering, accommodation, water supply, and the management of tourist attractions. Gössling (2000) was the first to propose a methodical approach to examine the consumption of energy and the related emissions of carbon due to the implementation of a tourism industry. Along these footsteps, many scholars developed an extensive bulk of research at both country and regional level. Numerous representative figures appeared (Becken, 2013; Cainelli and Mazzanti, 2013). In particular, Becken (2013) proposed

several studies including various tourist activities and accommodation types, tourist resorts, air travel and other transportation methods. Becken and Simmons (2002), for instance, reported that tourism is an important driver of global climate change, and found that tourist activities (e.g., scenic flights, jet boating or air travel) used more energy than tourist attractions (e.g., museums).

As for the indirect channel, as said above, the impact of tourism on polluting emissions is explained because of its role in leading economic growth that, in turn, is considered the main driver of CO_2. Theoretical literature discusses the role of tourism for growth in terms of the so-called *Tourism Led Growth Hypothesis*, firstly introduced by Balaguer and Cantavella-Jorda (2002). From an empirical viewpoint, most of this research is framed within the Environmental Kuznets Curve (EKC), revisited to include the hypothesis of tourism development (De Vita et al 2015, Katircioglu, 2014a, 2014b; Katircioglu et al., 2014; Lee and Brahmasrene, 2013). This allows also to investigate the way tourism development, by fostering economic growth, might help the economy to eventually achieve the desired level of output growth after which polluting emissions are expected to decline. In this regard, however, the EKC original specification suffers the limit to omit important variables that could be among the determinants of CO_2 emissions.

In an attempt to develop the EKC model beyond growth, some authors have extended the conventional EKC framework by including additional variables, such as energy use (Apergis and Payne, 2009), trade (Ang, 2008; Halicioglu, 2009) and population density (Akbostanci et al., 2009). In spite of that, recent empirical and theoretical works argue that, even if extended to include energy use, the EKC approach still remains overly simplistic because CO_2 emissions depend both on the level of energy consumption and on the characteristics of the energy mix (cf., inter al., Henriques-Borowiecki, 2017). This literature provides attempts to consider all these factors in order to decompose the resulting CO_2 emissions in the vein of the so-called IPAT decomposition technique (Ma and Stern, 2008). Until now, however, this new approach has devoted very little attention to the tourism sector.

3. The IPAT-Kaya Identity

The Kaya identity is a variant of the IPAT identity (Kaya, 1990), appropriately defined in order to account for energy consumption in studies on carbon emission determinants (Ma and Stern, 2008). The IPAT model was first proposed by biologists and ecologists to formalize the impact of population, human welfare and technology on the environment (cf., among others,

Commoner, 1972, 1992; Elulich and Ehrlich, 1990). Its general formulation corresponds to the following identity:

$$Impact = Population \cdot Affluence \cdot Technology$$

As mentioned, a variant of the IPAT identity is referred in the literature as the Kaya identity (Kaya, 1990), which responds to the next standard specification:

$$C = \frac{C}{E}\frac{E}{Y}\frac{Y}{P}P \tag{1}$$

where C is carbon emissions, E is energy use, Y is economic output and P is population.

In detail, the first term on the right-hand side (C/E) represents the carbon intensity of energy use and the second term (E/Y) denotes the energy intensity of economic activity. These two terms correspond to the Technology factor. The last two terms (Y/P and P) correspond to the Affluence and Population factors, respectively, which jointly provide the effect of economic scale.

Starting from this basic specification, several variants have been proposed in the attempt to explore the driving forces behind the complex phenomenon of CO_2 emissions (cf. inter al., Ma and Stern, 2008). However, up to our knowledge, the Kaya identity specifications with tourism among the CO_2 driving forces are almost nil.

4. An application of the Kaya identity to Italian data

This section exploits the analysis of the CO_2 determinants in Italy by using an extended version of the Kaya technique in Eq. (1), which decomposes the changes in polluting emissions in all the factors that contribute to the emergence of such emissions. As deeply specified by Stern (2004), different specifications of this decomposition can be assumed. Here, we consider a variant of the standard model version, and introduce the role of tourism, joint with other energy factor, among the determinants of CO_2 (Ma and Stern, 2008). Therefore, we adopt the following identity:

(2) $$C = \frac{C}{F}\frac{F}{E}\frac{E}{Y}\frac{Y}{P}\frac{P}{T}T$$

where, in addition to the aforementioned Eq. (1), F stands for fossil fuel consumption, and T is the number of tourist arrivals. The shares expressed on the right-hand side of Eq. (2) represent a useful specification of different economic phenomena. In particular, the ratio C/F represents the *substitution* effect between fossil fuels and carbon emissions; instead, F/E measures a *penetration* effect of fossil fuels energy on total energy use; and, finally, E/Y provides an *intensity* scale of energy use on the output of the economy. Additionally, the term Y/P is a standard measure of national productivity, whereas P/T indicates the incidence of tourism over population.

The identity in Eq. (2) can also be written as follows

(3) $$C = S_C S_F S_I S_G S_{TP} T$$

where the S_i stand for the shares specified above.

As suggested by Ang and Zhang (2000) and Ang (2004), the identity specified in Eq. (3) can be further put into natural logarithms, and consequently transformed into the following standard integrated form:

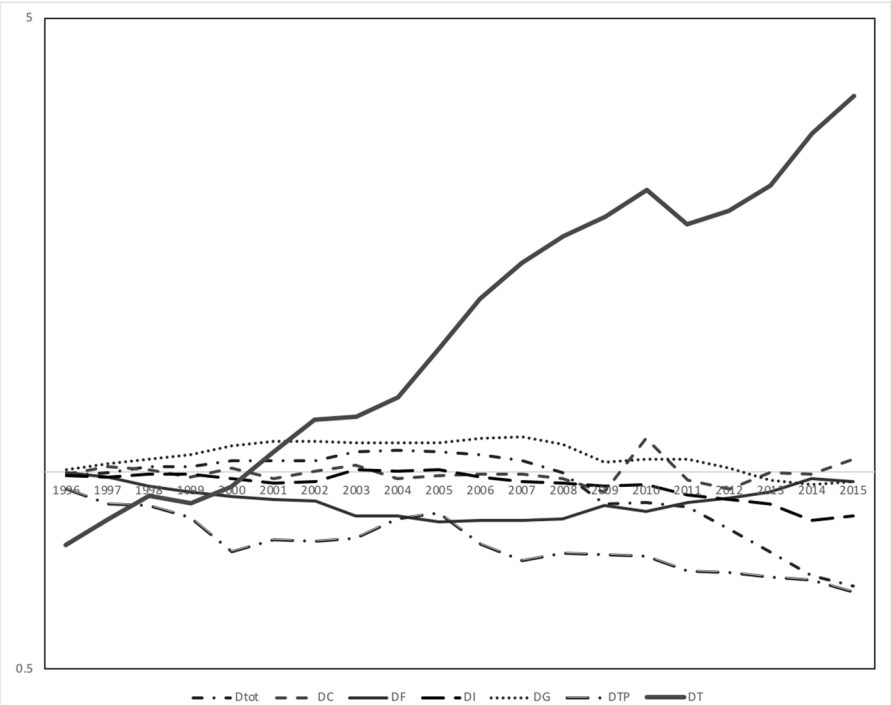
(4) $$\frac{C_t}{C_{t-1}} = \frac{S_{Ct}}{S_{Ct-1}}\frac{S_{Ft}}{S_{Ft-1}}\frac{S_{It}}{S_{It-1}}\frac{S_{Gt}}{S_{Gt-1}}\frac{S_{TPt}}{S_{TPt-1}}\frac{T_t}{T_{t-1}}$$

where all factors are thus expressed in growth rate terms.

We proceed now to analyze our data according to the specification in equation (4). The period considered is 1995-2014. Data are drawn from the World Development Indicators (2016).

The accumulated effects derived from Eq. (4) are reported in Figure 1, where it clearly appears that the dominant scale effect is due to tourism growth (DT), whereas the tourism-population growth (DTP) and the penetration effect of carbon-free energy (DF) produce negative effects.

Figure 1 – The Kaya decomposition



5. Conclusions

In line with the recent strand of literature exploring the study of the determinants CO_2 emissions led by tourism and economic growth, we applied the so-called Kaya decomposition technique to Italian data and investigate the role of both energy and tourism factors that drive carbon emissions. The latter appears as the dominant factor. While very interesting, regarding this result caution is in order.

As a matter of fact, the main problem with the Kaya identity approach is that the relation is deterministic and thus some effects could be overestimated (Ehrlich and Holdren, 1972). In other words, it is an accounting model that is not suitable as a basis for hypotheses testing. From this point of view, for future studies on the importance of tourism as CO_2 driving force, the stochastic version of the IPAT identity, referred to in the literature as the STIRPAT model, can be much more fruitful of interesting results.

References

Akbostanci E., Türüt-Asik S., Tunç G.I. (2009). The relationship between income and environment in Turkey: is there an environmental Kuznets curve? *Energy Policy*, 37: 861-867.

Ang J.B. (2004). Decomposition analysis for policymaking in energy: which is the preferred method? *Energy Policy*, 32: 1131-1139.

Ang B.W., Zhang F.Q. (2000). A survey of index decomposition analysis in energy and environmental studies. *Energy*, 25: 1149-1176.

Ang J.B. (2008). Economic development, pollutant emissions and energy consumption in Malaysia. *Journal of Policy Modeling*, 30: 271-278.

Apergis N., Payne J. (2009). Energy consumption and economic growth: evidence from the Commonwealth of Independent States. *Energy Economics*, 31: 641-647.

Balaguer J., Cantavella-Jorda M. (2002). Tourism as a long-run economic growth factor: the Spanish case. *Applied Economics*, 34: 877-884.

Becken S. (2013). A review of tourism and climate change as an evolving knowledge domain. *Tourism Management Perspectives*, 6: 53-62.

Becken S., Simmons D.G. (2002). Understanding energy consumption patterns of tourist attractions and activities in New Zealand. *Tourism Management*, 23: 343-354.

Cainelli G., Mazzanti M. (2013). Environmental innovations in services: Manufacturing–services integration and policy transmissions. *Research Policy*, 2: 1595-1604.

Commoner B. (1972). The Environmental Cost of Economic Growth, in Population. *Resources and the Environment*. Washington, D.C.: Government Printing Office, pp. 339-63.

Commoner B. (1992). *Making Peace with the Planet*. New York: The New Press.

De Vita G., Katircioglu S., Altinay L., Fethi S., Mercan M. (2015). Revisiting the environmental Kuznets curve hypothesis in a tourism development context. *Environmental Science and Pollution Research*, 22: 16652-16663.

Dietz T., Rosa E.A. (1994). Rethinking the environmental impacts of population, affluence and technology. *Human Ecology Review*, 1: 277-300.

Ehrlich P.R., Ehrlich A.H. (1990). *The Population Exclusion*. New York: Simon and Schuster.

Gössling S. (2000). Sustainable tourism development in developing countries: Some aspects of energy use. *Journal of Sustainable Tourism*, 8: 410-425.

Halicioglu F. (2009). An econometric study of CO_2 emissions, energy consumption, income and foreign trade in Turkey. *Energy Policy*, 37: 1156-1164.

Henriques T., Borowiecki K.J. (2017). The drivers of long-run CO_2 emissions in Europe, North America and Japan since 1800. *Energy Policy*, 101: 537-549.

Katircioglu S.T. (2014). Testing the tourism-induced EKC hypothesis: the case of Singapore. *Economic Modelling*, 41: 383-391.

Katircioglu S.T. (2014b). International tourism, energy consumption, and environmental pollution: the case of Turkey. *Renewable and Sustainable Energy Reviews*, 36: 180-187.
Katircioglu S.T., Feridun M., Kilinc C. (2014). Estimating tourism-induced energy consumption and CO2 emissions: the case of Cyprus. *Renewable and Sustainable Energy Reviews*, 29: 634-640.
Kaya Y. (1990). Impact of carbon dioxide emission control on GNP growth: interpretation of proposed scenarios. *Paper presented at the IPCC Energy and Industry Subgroup, Response Strategies Working Group*. Paris.
Lee J., Brahmasrene T. (2013). Investigating the influence of tourism on economic growth and carbon emissions: evidence from panel analysis of the European Union. *Tourism Management*, 38: 69-76.
Lenzen M., Sun Y., Faturay F., Ting Y., Geschke A., Malik A. (2018). The carbon footprint of global tourism. *Nature Climate Change*, 8: 522-528.
Ma C., Stern D.I. (2008). Biomass and China's carbon emissions: A missing piece of carbon decomposition. *Energy Policy*, 36: 2517-2526.
Stern D.I. (2004). The Rise and Fall of the Environmental Kuznets Curve. *World Development*, 32: 1419-1439.
UNWTO (2008). *Climate Change and Tourism*. World Tourism Organization, Madrid.
World Development Indicators (2016). *World Bank*. Washington, D.C.