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Economic growth and transport energy consumption in the Latin American and Caribbean countries

F. Rehermann[a], M. Pablo-Romero[a,b,*]

[a] Department of Economic Analysis and Political Economy, Faculty of Economics and Business Sciences, Universidad de Sevilla, 41018 Sevilla, Spain
[b] Universidad Autónoma de Chile, Chile

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ABSTRACT

Transport is a strategic sector for economic development whilst being one of the most polluting sectors of the economy. The Latin American and Caribbean countries have been consolidated as the region with significantly faster energy consumption growth. This paper analyzes how the GDP per capita affects the transport energy consumption, testing possible non-linear relationships between variables. A transport energy consumption function depending on GDP and its squared and cubed value is estimated for 22 LAC countries, over the period 1990–2014. The results support an N-shaped curve, while the elasticity values of transport energy consumption, with respect to GDP per capita, do not show a tendency to decrease in the long term. Fourteen LAC countries show absolute coupling levels at the end of the period, while the rest exhibit partial couplings. Likewise, trade openness, population density, degree of urbanization and structural changes in the economy have positive effects on the transport energy consumption. This paper proposes some energy efficiency measures to control the growing energy use, and the promotion of biofuels and electric vehicles is also considered necessary to reduce the negative effects of transport energy use.

1. Introduction

Economic growth plays an essential role in the structure of the transport sector. According to Achour and Belloumi (2016), economic growth provokes changes in the transport volume and in its organization, generating increases in energy consumption, which ultimately have negative impacts on the environment through the increase of emissions. In fact, the transport sector is one of the most polluting economic sectors in terms of carbon dioxide (CO_2) emissions. Last available data referring to 2015 indicated that the sector represents 28.8% of world energy consumption and 65.2% of total final oil consumption (IEA, 2018).

Latin America has been growing significantly since the end of the last century, mainly due to the large investment flows received. This growth was accompanied by sustained increases in energy demand, being the region of the world with the fastest energy consumption growth (Chang and Carballo, 2011) and by a greater proportion than GDP, since 1990 (Omri et al., 2014; Pablo-Romero and De Jesús, 2016).

The transport sector in the region has not been exempt from this process. The Latin American region presents the fastest growing motorization rate in the world since 2000 (Viscidi and O'Connor, 2017). Since 2007, there has been a notable increase in the vehicle fleet. On the one hand, according to Tissot (2012), the number of cars per inhabitants has determined a 50% increase, from 2007 to 2012, from 113 to 169 cars per 1000 inhabitants. According to Vergara et al. (2015), this important vehicle fleet growth may be mainly related to the inhabitants' purchasing power increase and the growth of the middle class. Between 2006 and 2016, the middle class of the region went from 99 to 186 million people (Duryea and Robles, 2016). Therefore, as the middle class has grown, the number of vehicles, mainly in big cities, has also been growing, causing the demand of fossil fuels growth. This process also seems not to have come to an end, because according to UN Environment (2016), in the next 25 years, the vehicle fleet is projected to triple.

On the other hand, the large increase in demand for commodities over the last decade, particularly in China, has brought strong pressure to bear on the transit of raw materials (Keeling, 2013). Likewise, the development of the domestic market has also had a notable influence on freight transport growth (Barbero and Guerrero, 2017). Thus, the energy consumption growth in the transport sector may also be associated with freight transport growth in the region, which is mainly carried out by road (Viscidi and O'Connor, 2017). For example, in

* Corresponding author at: Department of Economic Analysis and Political Economy, Faculty of Economics and Business Sciences, Universidad de Sevilla, 41018 Sevilla, Spain.
E-mail address: mpablorom@us.es (M. Pablo-Romero).

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Argentina, road transport accounts for 95% of freight transport measured in tons per kilometer, while in Chile and Mexico this accounts for 93% and 73%, respectively (Barbero and Guerrero, 2017). Thus, according to IEA (2017), the total vehicle-kilometers for road freight transport in Latin America nearly doubled, between 2000 and 2015. This road freight transport growth has provoked an energy consumption growth, as trucks are an energy intensive mode of transport (Barbero and Guerrero, 2017).

Therefore, the economic growth in the Latin American and Caribbean (LAC) countries may have a noticeable impact on the energy consumption in the transport sector. In this sense, in 2015, the transport sector accounted for 36.8% of total energy consumption (higher than the world percentage shown before), followed by the industrial and residential sectors, with 31.6% and 15.7%, respectively (IEA, 2018). It should also be noted that this transport sector energy consumption continues to be based mainly on oil, accounting for 88.4% of total energy consumed, followed by biofuels, natural gas and electricity, with 7.8%, 3.5%, and 0.3%, respectively (IEA, 2018). Therefore, the transport sector may have negative and growing impacts on the environment, if the economic growth is still inducing the sector growth. As stated in (Barbero and Guerrero, 2017), while the modernization of the fleets, and the implementation of mandatory technical reviews in some countries (for example in Chile) have had favorable effects on environmental sustainability, these measures seems to be insufficient to counteract the activity increase effect generated by the region's economic growth.

In this context, it is interesting to analyze the relationship between economic growth and the transport sector energy consumption increase, in order to be able to develop adequate energy and economic policy measures to achieve economic growth, while avoiding the energy growth that could increase environmental damage. Thus, the purpose of this study is to analyze the relationship between economic growth and the transport sector energy consumption in the LAC countries. With this aim, an energy consumption function (in per capita terms), depending on GDP (in per capita terms), its squared and cubed values and other control variables are estimated for the transport sector. Panel data, referring to 22 LAC countries, over the period 1990–2014, are considered. In addition, transport energy elasticity values with respect to GDP are calculated for each LAC country, which allows differences to be shown between them.

Therefore, the study focuses on a key economic sector, which represents a high percentage of energy use, and on a region with a noticeable energy use growth, which is also among the highest contributors to emissions due to fuel combustion.

The paper is structured into seven sections. After this introduction, the second section reviews the previous literature related to this topic. The third section presents the data employed, some summary indicators, and the sources used. The methodology is given in the fourth section, with the subsequent specification of the analysis model. The results are presented in the fifth section, followed by a discussion in the sixth. Finally, section seven concludes and presents the policy implications.

2. Literature review

The literature related to energy consumption and economic growth is very broad. In this section, some questions are analyzed regarding this literature, which are relevant to justifying this study and our proposal.

2.1. Economic growth and energy use: non-linear relationships

Since the study by Kraft and Kraft (1978), who studied the energy-growth nexus for the United States, the relationships between both variables have been widely analyzed in the energy economics literature. Some studies that review the previous literature are, Ozturk (2010), Omri (2014), Payne (2010), and Tiba and Omri (2017). A large part of the studies reviewed show that there is at least a causal relationship between the variables that indicate that economic growth causes energy consumption.

Delving further into this line, several studies have focused on the non-linear relationships between economic growth and energy consumption, borrowing the idea of the EKC (Dong and Hao, 2018). The study by Suri and Chapman (1998) is one of the earliest to analyze the non-linearity between the variables by testing what has come to be called an energy-EKC. The authors found an inverted-U curve between commercial energy consumption and GDP for 33 countries worldwide, in the period from 1971 to 1991, although the turning point was outside the data sample.

After this study, some others have also found evidence of the existence of an inverted-U curve. Among these could be cited the studies by Richmond and Kaufmann (2006a, 2006b), which found decreasing rates of energy consumption increases with respect to income for the OECD and non-OECD countries. Likewise, Nguyen-Van (2010) shows evidence for the existence of an inverted-U curve for an international panel dataset. In addition, other studies confirm this hypothesis, such as that by Yoo and Lee (2010) referring to the electricity consumption on a set of 88 countries, and more recently the study by Sbia et al. (2017) referring to the electricity consumption in the United Arab Emirates.

Nevertheless, other studies fail to support the inverted-U curve hypothesis. Among them could be cited the study by Luzzati and Orsini (2009) for 113 countries over the period 1971–2004. Likewise, the hypothesis is not supported in the studies by Zilio and Recalde (2011) and Pablo-Romero and De Jesus (2016) referring to the LAC region. In addition, the study by Aruga (2017) revealed that the hypothesis is not satisfied for the low- and middle-income groups in the Asia-Pacific region.

Two main considerations may be extracted from the previous review. Firstly, there is no consensus regarding the energy-EKC hypothesis, the results depending upon the region or period considered. Therefore, regional studies referring to specific circumstances may be adequate. Secondly, regardless of the previous results, in favor or against the energy-EKC hypothesis, the results of the previous works show that the relationships between economic growth and energy consumption are not linear, at least not for all countries and periods. Therefore, considering this non-linearity in energy-economic growth studies is relevant.

2.2. Studies referring to specific sectors: studies related to the transport sector

In addition to differences in the relationships between energy and economic growth, due to regions and time periods, Burke and Csereklyei (2016) found a substantial heterogeneity in income elasticity of energy use across sectors. Nevertheless, in spite of the sectoral heterogeneity in the energy use, studies that analyze the non-linear effects of economic growth on sectoral energy use are scarce. Among them, it is worth highlighting those by Liu et al. (2016), Pablo-Romero and Sánchez-Braza (2017b) and Yin et al. (2015), for the residential sector, and, those by Katircioğlu (2014) and Pablo-Romero et al. (2017b, 2017c) relating to tourism.

Regarding the transport sector, the studies analyzing the relationships between energy use and economic growth in the sector are also scarce. Most studies related to this sector analyze the causality between variables for different countries and periods and compare the results with respect to other sectors. Among them may be cited those by Abdallah et al. (2013), Achour and Belloumi (2016), Azlina et al. (2014), Costantini and Martini (2010) and Saboori et al. (2014). These studies find at least one causal relationship running from economic growth to energy use in the transport sector, with bidirectional relationships also being found in some of them. In addition, when comparing, with respect to other sectors, the authors tend to find