Decoupling economic growth from GHG emissions for Australia: Decomposition analysis by sectoral factors

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Overview

The economies worldwide have become severely dependent on energy, mainly fossil fuels, since the industrial revolution. However, burning fossil fuels has been the main cause of greenhouse gases (GHG) emissions. On the literature, several approaches were pursued to analyse the relationship between economic growth, energy consumption, and environmental pollution. The decomposition and the decoupling model developed by Tapio (2005), which allow undertake an analyse by sectoral factors. The decomposition analysis is one of the most effective tools to study the mechanisms that influence the energy consumption and the environment. Decomposition index was used initially in the late of 1970s, to analyse the effect of the changes in product mix on industrial energy demand, (Ang and Zhang 2000). Since 1980s, it started to be employed for energy and environmental analysis (Ang and Zhang 2000). The decomposition model has two differents methods, namely: (i) the Index Decomposition Analysis (IDA); and (ii) the Structural Decomposition Analysis (SDA). These methods have originated two other methods, the Logarithmic Mean Divisia Index (LMDI), and the Arithmetic Mean Divisia Index (AMDI). The decoupling model was introduced for the first time in environmental studies, at the beginning of the 2000s by the author Zhang (2000). The decoupling index (DI) is used to study the relationship between economic growth and CO_2 emissions. Indeed, it provides a reasonable indicator to measure the effectiveness of policies (Jorgenson and Clark 2012). The empirical evidence of both decomposition and decoupling remains scarce for Australia.

Australia is one of the ten largest emitters of GHG. However, it displays an economic growth without economic recession for 26 consecutive years. Despite its extensive non-renewable and renewable resources, the main energy sources this country is using are coal (in which Australia is largely dependent), natural gas, and petroleum products. The GHG emissions in Australia reflect the high energy consumption to support the idiosyncratic economic activities. Therefore, this paper intends to explain the decoupling effects of the major Australian sectors (including agricultural, industrial, construction, transport, residential and service). The decoupling model combined with the LMDI model has been used to decompose GHG emissions into selected factors and to measure the contribution of each factor. This combination allows obtain results not only about the Australian sectors, but also the effect on overall Australian economy. This paper provides outcomes that could help to evaluate the impact of public policies on economic growth, GHG emissions, and to design more suitable mitigation policies.

Methods

This paper uses annual data from 1990 to 2015 for Australia. The variables of the analysis are: Gross Domestic Product (GDP), Industry Gross Value Added (IGVA), Energy Consumption (EC), and Greenhouse gas emissions (GHG). The database sources are Australian National Accounts for GDP and IGVA, Department of the Environment and Energy for EC, and Department of the Environment Australian Government for GHG emissions. The Australian sectors were divided according Australian and New Zealand Standard Industrial Classification (ANZSIC).

The approaches employed in this study are, the LMDI and the decoupling model. The LMDI is the method applied on the majority decomposition studies, (Ang 2005; Ang and Liu 2001). This method is employed to analyse the decomposition of emission change, once it has a upright adaptability and a robust theoretical foundation. Indeed, according to Ang (2004), the LMDI method provides concrete and complete results about the decomposition without residual effects. The extended Kaya identity equation used is based on the decomposition model, where a set of determinants is represented (Kaya 1990). The decomposition model is calculated from a base year, 0, to a final year, t. The factors used, are in accordance with the literature (Zhao et al. 2017), namely energy emissions (EE), energy intensity (EI), process GHG intensity (GI), economic share (ES), and economic activity level (EA). By its turn, the decoupling model analyzes the relationship between economic growth, environmental pressure, and this relationship can indicate the ability to produce more economic products with less energy. This model uses a flexible analysis for study the decoupling effect using dynamic data. Instead of measuring absolute values, the decoupling model measures the sensibility on incremental values. The results of the decoupling model can be classified into, negative decoupling, decoupling, or coupling. The first category is subdivided in expansive, strong and weak negative decoupling. The second, in weak, strong and recessive decoupling. And the last category is divided in expansive and recessive coupling.

Results

The results of this paper show that Australia undergo the strong decoupling of economic growth from GHG emissions during 1990-2015. Through the sectoral analysis it was possible to understand which sector is more influential and which is less influential, as well as the factors that have greater and lesser contribution to the national decoupling. According with Tapio (2005), given that Australia has a positive variation of GDP, the factors with a negative sign have a positive effect on the decoupling, and the factors with positive sign have a negative effect.

The results reveal that two (agriculture and commercial services) of the six under analysis performed a strong decoupling, while the other four performed a weak decoupling. Hereupon, the agriculture sector has a dominant role, while construction sector has the most marginal influence on the decoupling state of Australia. Within each sector, two factors stand out by the positive effect. The EE of agriculture sector followed by the ES of industrial sector are the specific factors that played the bigger positive role on decoupling. Therefore, the EE of agriculture sector has a key role on the national decoupling state, while the EI of the service sector is the factor which contributed positively the least for the decoupling. In contrast, the EA of the industrial sector is the factor with the bigger negative effect on the decoupling. Overall, the factors EA followed by EE are those that have affected more the Australian decoupling. The EA has a negative impact (is the only factor with a negative impact) and EE has a positive impact on the decoupling. In contrast the GI is the factor with lower contribution. The EI factor must be highlighted due to the negative sign (positive effect) in all sectors excluding the agriculture sector. This means that EI accelerate the sectoral decoupling.

Conclusions

This paper provides evidence for the decoupling phenomenon of economic growth from GHG emissions in Australia, by employing the LMDI decomposition approach. The calculation of decoupling sub-indicators turns possible to get useful insights about the driving forces. The findings reveal that Australia, during 1990-2015, experienced strong decoupling of economic growth from GHG emissions. The EE of the agriculture sector, and the ES of the industrial sector are the factors with a dominant role on the national decoupling. The EI of the service sector is the factor with the smallest positive contribution for the decoupling. Concerning the agriculture and the construction sectors, it is highlighted that the first one is the dominant sector, and the second has the less influence on the national decoupling. Overall, by factors, the EE and the EA factors reveal the higher positive effect and the larger negative effect on decoupling, respectively. Therefore, it is possible to conclude that Australia start to have it sectors efficient, and through this was capable to reduce the national GHG emissions. However, there is sectors where Australia should invest in energy efficiency technology, to become all sectors efficient and reduce the GHG emissions even more. Adoption of electric vehicles on the transport sector, replace carbon-intensive materials by new low-carbon materials and recycling the materials on the construction sector, are examples of measures to make the sectors more efficient. Beyond, the renewable energy can be used in all sectors.

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