

A bootstrap panel Granger causality analysis of energy consumption and economic growth in the G7 countries



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ABSTRACT

The paper investigates the causality between energy consumption and economic growth in the countries which are members of the Group of Seven (G7), during the period 1970–2012, by following the bootstrap panel Granger causality approach. The main aim of the paper is to identify the right policies to deal with the interaction between energy consumption and economic growth.

The findings show a bi-directional causality between energy consumption and GDP in Canada, Japan and United States. GDP causes energy consumption in France and Germany, while no causality is found for the rest of the sample (i.e. Italy and United Kingdom). These outcomes are very sensitive to the cross-sectional dependences between countries. Therefore, their environmental and growth policies should be widely reconsidered when the level of interdependence dramatically decreases.

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1. Introduction

The connection and causality between energy consumption and economic growth have been extensively explored over the last decades, becoming one of the most important topics in the energy economics literature. Starting with February 2005, when the Kyoto Protocol has been implemented, the interaction between energy

consumption and economic growth registered new valences, especially in developed countries.

This international treaty is an extension of the United Nations Framework Convention on Climate Change (UNFCCC) from 1992 and has as main objective the reduction of greenhouse gas emissions in developed countries to the level in 1990. There are two main premises of this target: the global warming exists and it has been caused by the man-made carbon-dioxide (CO₂) emissions. During the years, many researchers started to revisit the connection and causality between energy consumption and economic growth, for various countries and periods, by following different methodological tools. The results are very heterogeneous and emphasize different research perspectives, from causality to no causality statements.

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On this ground, the aim of the paper is to analyse the energy consumption–economic growth nexus, in case of the Group of Seven (G7 countries), by using a bootstrap panel Granger causality approach, for the period 1970–2012. The G7 area includes the world's seven most industrialized economies, more precisely: Canada, France, Germany, Italy, Japan, United Kingdom (UK) and United States (US). Under Kyoto Protocol, this group of developed countries arises a special interest, as any influence of energy consumption policy on growth requires climate change response strategies. US is included in the sample, even if this country does not ratify the Kyoto Protocol. US has intensive trade and financial relationships with the rest of G-7 countries, being one of the first energy consumer in the world. Therefore, these characteristics give consistence of cross-sectional dependence property of G7 panel, which is one of the main assumption of the methodological tool followed (i.e. complex and intensive economic relationships run between G7 countries). Moreover, in 2012, during the 18th Conference of the Parties (COP18), all delegates agreed to extend the Kyoto Protocol until 2020, while US assumed the reduction of the carbon-dioxide emissions and greenhouse gases.

Between 1970 and 2012 (Fig. 1), all G7 countries registered an increasing tendency for both energy consumption (average of energy use in kt of oil equivalent) and gross domestic product (GDP) (average GDP expressed in constant 2005 billions of US dollars).

For the overall period, the average GDP illustrates an emphasized growth tendency, whereas the average energy consumption seems to follow a smooth increase. Significant negative shocks are registered over the 2007–2010 period, for both variables, as effects of world economic crises.

The paper extends the literature in the field by offering the first study to investigate the relationship and causality between energy consumption and economic growth in the case of G7 countries, by following the bootstrap panel Granger causality developed by Kónya [1]. This technique is more powerful compared to existing ones, as it takes into account cross-sectional dependence and cross-country heterogeneity. Besides the contribution of Šmiech and Papież [3], to the best of our knowledge, this is one of the first papers which uses the Kónya's [1] tool in energy economics area. In comparison, Šmiech and Papież [3] explore European Union (EU) member states and analyse the period 1993–2011. The second contribution to the literature is given by the panel dimension, which covers an extended period of time, from 1970 to 2012, on annual basis. Finally, the outputs offer an important support for the economic energy policy makers in the G7 countries, helping them to manage, over the long-run, the interaction between energy consumption and economic growth.

The rest of the paper is as follows: Section 2 reviews the literature, Section 3 presents the data and methodology, while Section 4 shows the empirical results. Section 5 concludes.

2. Literature review

The literature about the linkage and causality between energy consumption and economic growth is prolific and offers a diversity of findings, deriving from the targeted countries, periods of analysis and econometric tools used. Relying on these different outcomes, the literature also offers contradictory policy solutions for policymakers regarding the adjustments of the relationship between energy consumption and economic growth.

There are four main hypotheses outlining the literature review in respect to the energy consumption–growth nexus: (i) growth–energy consumption hypothesis, (ii) energy consumption–growth hypothesis, (iii) feed-back hypothesis, and (iv) neutrality hypothesis.

The *growth–energy consumption hypothesis* is also called the conservation hypothesis and suggests that any increase in GDP causes a rise in energy consumption. This statement supports the idea that the policy conservation of energy consumption has no significant or no adverse influence on economic output. The seminal work regarding the causality between economic growth and energy consumption is offered by Kraft and Kraft [4]. Investigating the case of US, between 1947 and 1974, they find strong proof for unidirectional causality, which runs from income to energy consumption. This finding is reinforced by Abosedra and Baghestani [5], who claim the same unidirectional causality from gross national product (GNP) to energy, in the US case. Their analysis covers the period 1947–1987 and follows a mixed co-integration and Granger causality tool.

The *energy consumption–growth hypothesis* is the growth hypothesis and reveals there is one-way causality, from energy consumption to economic growth. This statement highlights the importance of energy use in the growth area, as a complementary factor to labor and capital. Any limitation in energy consumption negatively influences growth. One of the first contributions to support the energy consumption–growth hypothesis belongs to Yu and Choi [6]. They explore a set of 5 countries (i.e. Philippines, Poland, Korea, UK and US), over the 1950–1976 period, by applying Granger causalities. One of the main outputs supports the energy consumption–growth hypothesis, but only in the case of Philippines. Several years later, Stern [7] achieves the first country-specific study which supports the growth hypothesis. The author explores the case of US, over 1947–1990, by performing a multivariate Vector Autoregressive (VAR) model. The results show that there is no Granger causality from growth to energy consumption, while a one-way causality is registered from energy consumption to growth.

The *feed-back hypothesis* or the bi-directional causality hypothesis assumes that there is a biunivoque connection between energy consumption and economic outputs. In this case, the energy consumption

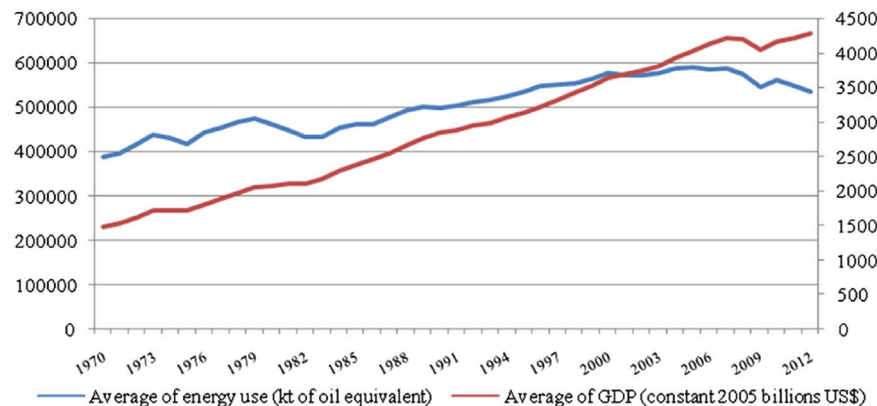


Fig. 1. Average of energy consumption and GDP in G7 countries, for the period 1970–2012. Source of data: [2] World Bank online database (2015, January).

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