



# Nuclear energy consumption, oil consumption and economic growth in G-6 countries: Bootstrap panel causality test

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## HIGHLIGHTS

- ▶ Bootstrap panel Granger causality test whether energy consumption promotes economic growth.
- ▶ Data from G-6 countries for both nuclear and oil consumption data are used.
- ▶ Results have important policy implications within the context of economic development.

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## ABSTRACT

This study applies bootstrap panel Granger causality to test whether energy consumption promotes economic growth using data from G-6 countries over the period of 1971–2010. Both nuclear and oil consumption data are used in this study. Regarding the nuclear consumption–economic growth nexus, nuclear consumption causes economic growth in Japan, the UK, and the US; economic growth causes nuclear consumption in the US; nuclear consumption and economic growth show no causal relation in Canada, France and Germany. Regarding oil consumption–economic growth nexus, we find that there is one-way causality from economic growth to oil consumption only in the US, and that oil consumption does not Granger cause economic growth in G-6 countries except Germany and Japan. Our results have important policy implications for the G-6 countries within the context of economic development.

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## 1. Introduction

Over the past several decades, a plethora of empirical studies have devoted increasing interest to investigating the relationship between energy consumption and economic growth in both developing and developed countries. The importance of energy consumption in economic development process has triggered interest in empirically identifying the nature of causal linkages between energy consumption and economic growth since either existence or lack of causality has important implications to develop sound energy policies. For instance, (i) a feedback relation between energy consumption and economic growth implies that excessive energy protection and reduce energy consumption may lead to pressure on economic activity, (ii) causality from economic growth to energy consumption provides that energy conservation policies have little adverse or no effect on economic growth, (iii) causality from energy consumption to economic growth shows that energy consumption stimulates economic

growth and thereby economic growth is dependent on energy consumption, implying that negative energy shocks and energy conservation policies may depress economic growth, and (iv) the neutrality between energy consumption and economic growth allows policy makers to develop energy policies that are not dependent on economic activity. Therefore, determining the direction of causality between energy usage and economic activity is crucial for selecting an appropriate energy strategy.

One strand of the empirical literature has concentrated on identifying causal linkages between oil consumption and economic growth. Oil is not only the main energy resource in the industrialized countries but also it is the major reason for global warming because of the carbon dioxide emission. Besides, oil plays a crucial role in sustaining growth of an economy. Furthermore, oil prices are characterized by very volatile process and tend to increase rapidly. Therefore, countries – especially industrialized countries – have put a lot of efforts to find another alternative energy to solve the problem. In that respect, both developing countries in the process of economic development and high industrialized countries for sustainable development manage oil supply and demand side measures in harmony with economy.

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The concerns on supply security in energy and environmental issues arising from the usage of fossil-based energy have led countries to focus on alternative energy sources. Nuclear energy is an important source for controlling energy security, the warming climate and unstable oil prices even though the radiation pollution of nuclear energy is worried by most of the countries around the world. However, before they can find better alternative for energy, oil and nuclear consumption keep their importance in economic activity for most of developed countries. The importance of nuclear energy leads researches to question to what extent economic growth is sensitive to nuclear energy consumption. Identifying the direction of causation between nuclear energy consumption and economic growth provides important information for better understanding the logical reason of investing in nuclear energy for economical concern or for environmental and social concerns. There are several reasons to concentrate on examining causal linkages between nuclear energy consumption and economic growth. First of all, an important component in the discussion on nuclear energy as an alternative to fossil-based energy is its impact on economic growth for sustainable development (Apergis and Payne, 2010, p: 545). In addition to this, higher fossil fuel prices allow nuclear power to become economically competitive with the generation from coal, natural gas, and liquids despite the relatively high capital and maintenance costs associated with nuclear power plants. Moreover, higher capacity utilization rates have been reported for many existing nuclear facilities (EIA, 2009). Vaillancourt et al. (2008) emphasize that long-term energy and environmental strategies to meet growing global energy demands have embraced the transition from fossil fuels to renewable or other non-greenhouse gas emitting energy sources. Apergis and Payne (2010, p: 545) extend this view by stating nuclear energy is an important energy source in the development of such long-term energy and environmental strategies. Lee and Chiu (2011) look the discussion on the nuclear energy consumption and economic growth nexus from a different perspective: To cope with soaring oil and fossil-based fuels, increasing green house gas emissions which results in concern on global warming, one of the important priorities of energy and environmental policy is to diversify the sources of energy and to find a secure, cheap, and non-GHG-emitting energy supply. All these discussion require pay attention to distinguish the direction of causality between the nuclear energy consumption and economic growth.

The purpose of this paper is to investigate the relationship between energy consumption (using both nuclear energy and oil consumption) and economic growth in G-6 countries. The bootstrap panel Granger causality method which is the novel approach to panel causality framework is conducted to test whether nuclear energy and oil consumption promote economic growth using data from G-6 countries over the period of 1971–2010. The findings show that the nature of causality between nuclear energy consumption, oil consumption and economic growth is in favor of the neutrality hypothesis in most the countries.

The fossil fuels are the main source of energy for G-6 countries. Canada, the United Kingdom (UK) and the United States (US) are all rich in nature resource. However, some countries which do not have nature resource rely on nuclear energy. According to World Nuclear Association Report (2011), the proportion of nuclear energy used in France is 79%, Japan is 34% and Germany is 23% in 2011. Since energy policy is the very important issue in industrialized countries, the goal of a complete energy policy needs to fulfill stable energy supply, impetus economic growth and emphasize environment protection. It still cannot find any energy to fit the three energy policy goal. Some researchers propose conservation policy to face the nature resource exhaust,

environment pollution and warming climate, however conservation policy is not the best energy policy for every country. From these points of the views, examining the nature of causality between nuclear energy consumption and economic growth and between oil consumption and economic growth is timely and important for designing sound energy policies in G-6 countries.

The nature of causality between energy consumption and economic growth is identified by conducting a systematic modeling approach. Our study benefit from panel causality approach instead of time series methods since panel analysis produces more reliable and statistically powerful results than time series analysis by combining information from both cross-section and time dimensions. Moreover, we test for cross-sectional dependency and heterogeneity across countries due to the fact that ignoring cross-sectional dependency and country specific heterogeneity in a panel causality analysis are potential sources of misleading inferences regarding the direction of causality. No doubt that G-6 countries have a highly degree of integration and thereby a shock in one country is likely to be transmitted to other countries through international economic interrelationships. This is not done in the previous studies.

The plan of this paper is organized as follows. Section 2 represent the literature review, Section 3 describes the data, Section 4 outlines the econometric methods, Section 5 first presents our empirical results and then discusses some economic and policy implications, and finally Section 6 concludes the paper.

## 2. Literature review

There are four hypotheses regarding the nature of causality between energy consumption and economic growth. The growth hypothesis argues that energy consumption causes economic growth if there is unidirectional causality from energy consumption to economic growth. The conservation hypothesis postulates unidirectional causality from economic growth to energy consumption, implying that energy conservation policies do not adversely impact economic growth. The feedback hypothesis indicates bidirectional causal relationship between energy consumption and economic growth. In this case, energy consumption and economic growth are associated with each other in a complementary way. Finally, the neutrality hypothesis implies non-sensitivity of economic growth (energy consumption) to energy consumption (economic growth) that non-causation between energy consumption and economic growth supports evidence on it.

The vast and still growing literature on energy consumption and economic growth is document to test the above hypothesis. Payne (2010) and Ozturk (2010) provide the comprehensive reviews on the causal linkages between the energy consumption and economic growth. Despite the expanding literature on the study of causal relationships between energy consumption and economic growth, to the best of our knowledge, there have been only a few studies specifically addressing the causal relationship between oil consumption and economic growth. Many of these studies have been focused on developing and/or emerging country context. Yang (2000) finds that there is unidirectional causality running from economic growth to oil consumption in Taiwan. Zou and Chau (2006) for China indicate that oil consumption could be a useful factor that forecasts change in the economy in the short run as well as in the long run and thereby has great effects on the Chinese economy. Inconsistent with this finding, Zhao et al. (2008) support two-way causality between oil consumption and economic growth in China. For Turkey, Aktaş and Yilmaz (2008) show that there is a feedback relation between oil consumption and economic growth in both the short- and

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