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Electricity consumption and economic growth in Algeria: A multivariate causality analysis in the presence of structural change

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HIGHLIGHTS

- We examine the causal relationships between EC, GDP and BOP of Algeria.
- We used a multivariate approach based on ZA, Gregory–Hansen and Granger tests.
- There is a short-run bi-directional relationship between EC and GDP of Algeria.
- Results also substantiate a strong long-run bi-directional causality between EC and GDP.
- Findings disprove the assumption referred to as the *neutrality hypothesis*.

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ABSTRACT

This article addresses the issue of electricity consumption, petroleum price and economic growth in Algeria. The primary objective is to investigate and analyze the causal relationship between electricity consumption (EC), Brent oil price (BOP) and economic growth (GDP) for Algeria over the period of 1971–2010. To examine short-run, long-run and joint causality relationships we used a multivariate cointegration approach based on the recent advances in time series econometrics (e.g., Zivot–Andrews test; Gregory–Hansen cointegration test; Vector Error Correction Models (VECM)). The empirical results show that there is evidence of short-run and a strong long-run bi-directional causal relationship between EC and real GDP in Algeria. Findings indicate also the absence of causal relationship between BOP and EC. Our empirical findings support the idea that there a link between electricity consumption and economic growth and disproves the neo-classical assumption referred to as the "neutrality hypothesis".

1. Introduction

The economic progress in recent decades in developed countries, which was extended to the whole world, led to an enormous improvement in living conditions and population growth. This was accompanied by an explosion of energy demand in all sectors. World primary energy consumption grew by 5.6% in 2010, the strongest growth since 1973 (British Petroleum, 2011). All forms of energy grew strongly suggesting that global CO_2 emissions from energy use grew at the fastest rate since 1969. In addition, conventional energy resources (fossil) are becoming increasingly rare. The gradual opening of economies after World War II related to economic development has upset the balance between supply and energy demand. Infrastructure development and technological advances in transport and equipment have increased the demand for energy in all forms. Increasingly high demand on the one hand goes against the objectives of sustainable development. On the other hand, it is upgrading production systems and consumption patterns. This has the effect of challenging issues related to energy and creates new challenges: impact of consumption on the environment, sustainability practices, supply capacity to meet demand, exploration of alternative energy, causality between growth and energy consumption, etc. Thus, increasing interest is given to issues of causality between economic growth and energy consumption. Moreover, these problems are several years old. Many researchers have addressed this issue for several countries using different variables. The most frequently used variables: GDP vs. Electricity consumption; GDP vs. Energy consumption; GNP vs. Energy; GDP vs. Energy production, etc. The results of these studies are different from one country to another. Some have demonstrated

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the presence of a bidirectional causality (Glasure and Lee, 1997; Belloumi, 2009), others have found the presence of a unidirectional causality (Morimoto and Hope, 2004; Mazbahul and Nazrul, 2011), and other non-presence of causality (Glasure and Lee, 1997). We discuss some of these studies in Section 2. However, despite the expanding literature on the field of the causality between energy/electricity consumption there have been no empirical studies on Algeria. At present none have focused on the causal relationship between electricity consumption and GDP for Algeria. The central question now is whether energy consumption stimulates, delays or is neutral to the economic growth.

Two views have emerged in the literature analyzing the relationship between energy consumption and economic growth (Belloumi, 2009). The first strand considers that the impact of energy on growth is minimal or neutral. This is based on the fact that the consumption of energy cannot affect economic growth because the cost of energy is very small as a proportion of GDP. This assumption is known in the literature as the "neutrality hypothesis" (Yu and Choi, 1985; Squalli, 2006). The second strand believes that energy is not neutral to growth as long as energy is the main source of value and the other factors of production such as capital and labor cannot function without energy. Thus, energy is assumed to play a fundamental role in achieving social, technological, and economic progress (Ebohon, 1996; Templet, 1999). For the proponents of this hypothesis, a deficiency in energy supply may limit economic growth and technological progress. The hypothesis stems from the fact that energy was a major source of improved living standards in advanced countries and played a crucial role in advancing science and technology in these countries (Rosenberg, 1998).

The strong dependence of the Algerian economy on oil revenues and prices of fossil fuels raises several questions for future economic and energy policies. This requires the adoption of an economic recovery plan that covers the short, medium and long term. The plan should focus on energy issues. The priority is the choice of an effective energy policy that will determine the optimal model of rational consumption and exploitation of fossil resources. This model must consider, first, how to reduce dependence on fossil fuels and develop renewable energy before the fateful date of exhaustion of the fossil energies. Second, the environmental constraints in order to reduce greenhouse gas emissions (GHGE) related to energy consumption.

We propose in this article to present an empirical study of causal relationships between electricity demand and economic activity in Algeria. We will focus on a relationship between electricity consumption, oil price and GDP growth in Algeria. Economic activity is represented by the real gross domestic product per capita, energy by electricity power consumption (kWh per capita) and oil price by Brent crude oil price.

The aim is to shed light on the possible sources and directions of the relationship between electricity consumption, oil price and economic growth. The study can provide ideas on the design and the implementation of future economic and energy policies in Algeria.

In addition to the introductory section (Section 1), the rest of the paper is organized as follows: Section 2 presents the state of the art dealing with literature on the subject of causality between energy consumption and economic growth. Section 3 gives an overview of the economic situation in Algeria. It is followed by a brief presentation of the specifics of the electricity market in Algeria (Section 4). Section 5 describes the data and the model specification. We report our empirical findings in Section 6. Based on the results of the model, we draw conclusion and provide some policy implications based on the empirical results (Section 7).

2. Review of literature

The theme of growth and electricity are often linked and the causality relationship between electricity consumption and economic growth is a well-studied topic in the literature. Several authors have discussed the interrelationship between electricity consumption and economic growth over the last thirty years. This theme was particularly stimulated both by increasing the awareness of global warming and climate change and rising oil prices in recent years. Several studies have been conducted to examine the causality between electricity consumption and economic growth. Unfortunately there is no consensus yet on the results of these studies and the direction of causality between electricity consumption and economic growth remains controversial. The conclusion is that the direction of causality is different from one country to another. This diversity of results due to the specificity of the country's economic policy, energy resources, the variables used at different times and the methodological approach used to test causality.

These studies could date back to the seminal work of Kraft and Kraft (1978), in their analysis of the U.S. economy between 1947 and 1974. Since then, the Granger causality test approach has become a popular tool for analyzing this type of problem in different countries, e.g. Yang (2000), Ghosh (2002), Yuan et al. (2007), Lean and Smyth (2010).

For example, Narayan and Smyth (2005) performed an empirical study to examine the causal relationship between electricity consumption and GDP for Australia for China during the 1966–1999 period using ARDL bounds test (Autoregressive Distributed Lag Procedure) and vector error-correction model approach. Their results showed that there was unidirectional causality running from per capita GDP to per capita electricity consumption.

Recently, Mazbahul and Nazrul (2011) have explored the causality between electricity consumption and GDP per capita in Bangladesh. They used a vector error correction model based on the Granger causality tests for the period of 1971–2008. The results show that there is a short-run unidirectional causality running from per capita electricity consumption to per capita GDP without feedback. By contrast, results reveal a long-run bi-directional causal flow running from electricity consumption to economic growth with feedback.

Table 1 summarizes some earlier relevant studies conducted to explore the causal relationship between electricity consumption and economic growth including their main findings, methodology employed and main features.

From the table, we can see that the findings of the literature review on the causal relationship between electricity consumption and economic growth vary across countries and remain ambiguous. So, we should be cautions with the analysis and the explanation of the empirical results.

In this article we focus on electricity consumption and its relationship with economic activity in Algeria, given the importance of this energy in Algeria. This makes it possible to measure the weight of this energy in economic growth in Algeria, and meet the needs of economic and energy policy. Recall that Algeria has huge renewable energy potential, especially solar energy. An overview of the electricity market in Algeria is presented in Section 4.

3. Specificity of the Algerian economy

Algeria's economy remains dominated by the state, a legacy of the country's socialist post-independence development model. Gradual liberalization since the late 1980s has opened up more of the economy. Sustained high oil prices in the last decade have