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Environmental degradation, renewable and non-renewable electricity consumption, and economic growth: Assessing the evidence from Algeria

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ABSTRACT

The imperative to reduce *CO2* emissions is stronger than ever and investment in renewable energy is one of the most viable options to reduce the carbon footprint. This article explores the dynamic causal relationship between CO2 emissions, renewable electricity consumption, non-renewable electricity consumption and economic growth in Algeria by using Autoregressive Distributed Lag Cointegration approach over the period 1980–2012. The empirical results confirm the existence of cointegration long-run relationship among the variables. We find that, in the long-run, economic growth and non-renewable electricity consumption have a detrimental effect on the environment quality, whereas renewable energy use has a beneficial environmental effect. Furthermore, in the short-run, results reveal unidirectional causality relationship running from GDP to NREC, supporting the conservation hypothesis, i.e. electricity consumption is dictated by economic growth. The results suggest broadly that renewable electricity consumption can help to enhance environmental quality in Algeria. But so far, renewable electricity generation has not reached a level that allows a significant contribution to energy-based carbon dioxide emissions reduction target.

1. Introduction

Nowadays, energy consumption accounts for 80% of CO_2 emissions which are the major source of global warming and represent the most dangerous effects of climate change. Then, it is indisputable that any effort to effectively reduce CO_2 emissions and mitigate climate change must include the energy sector (IEA, 2015).

Moreover, increasing global warming impact the way governments around the world approach energy related environmental issues. As a result, promoting sustainable development and tackling climate change have become fundamental aspects of both short-run and long-run energy planning and policy making (IEA, 2015).

With the rising concerns over the environmental consequences of CO_2 emissions from fossil fuels, renewable energy has emerged as an alternative source of energy (Apergis and Payne, 2012). According to the IEO (2015), renewable energy is intended to be the fastest enlarging world energy source. Specifically, renewable electricity generation will increase by 72% from 2013 to 2040, representing more than one-third of new generation capacity.

The prevalence of such problems is higher in countries such as Algeria, where environmental sustainability, energy security and economic growth are simultaneously important. In fact, the strong dependence of the Algerian economy on oil revenues and prices of fossil fuels raises several questions for future economic, environmental and energy policies (Bélaïd and Abderrahmani, 2013).

Since 1970, Algeria has experienced a fast economic growth due to its fossil fuel resources. The Algerian economy remains an oil-based economy and comprises energy intensives sectors such as building and transportation. Therefore, total electricity consumption is increasing rapidly. Electricity consumption reached 40.9 TWh in 2013, is expected to average about 75–80 TWh in 2020 and 130–150 TWh in 2030. Electricity demand is projected to increase at an average annual growth rate of 6%. This underlines the importance of electricity consumption as a crucial component of the economic growth for Algeria.

Algerian economy has benefited from rising energy prices over the period 2007–2013. However, Algeria has struggled to develop non-hydrocarbon industries, diversifying the economy and creating private sector jobs because of heavy regulation and an emphasis on state-driven growth. Additionally, much of oil revenue has been oriented to public sector expenditure in order to maintain stability through a combination of minimal political reforms and generous social spending. The government maintains large subsidies (subsidies represent 30% of GDP) such as electricity, cooking gas, food, education, housing,

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etc. Furthermore, the dramatic drop in oil prices since mid-2014 has an obvious effect on the Algerian economy, according to statistics published by the Algerian Ministry of Finance, Algeria's oil and gas export revenues, which account for around 95% of the total, have fallen by a whopping 41% in 2015 to $35.72 billion from $60.3 billion in 2014. In line with the slump in global oil prices, growth slowed to 2.9% in 2015 from 3.8% in 2014.

In contrast, Algeria's reserves for both oil and gas has been on a downward path since 2005 due to a lack of investment in upgrading existing fields and exploiting new discoveries, while the rise in domestic energy consumption has come at the expense of declining oil exports. Steadily increasing in energy domestic demand in recent years was driven by both demographics as well as by largely sustained economic activity. A challenge for Algeria is then to reduce dependence on fossil fuels by developing renewable energy before the fateful date of exhaustion of the fossil energies. CO_2 emissions in Algeria have gradually reached a high level due to over-use of energy resources. According to the WBG (2015), total Carbon dioxide emissions in Algeria reached 78,925 thousand metric tons in 1990 and increases to reach 121,755 thousand metric tons in 2011.

Given these environmental constraints, in order to reduce CO_2 emissions related to energy consumption, renewable energy production and environmentally friendly energy conversion technologies become a priority in Algeria. A process of shifting to green power and an ambitious program to develop renewable energy (RE) was launched in 2001.

According to the renewable energy policy network report (REPN, 2015), Algeria is the third largest investor in renewable energy in Africa. Since 2004, Algeria was the only country on the continent with a feed-in policy in place. Whereas, as of early 2015, only eight African countries had enacted such policies. In addition, the country revised its energy plan to take a series of actions in the long run and adopt new renewable energy goals to be achieved by 2030 (REPN, 2015).

The main goal behind these strategies is to reach the optimal model of rational consumption and exploitation of fossil resources. For example, forecasts intend the volume of natural gas will be saved by the 22 GW of renewable energy which is equivalent to eight times the national consumption in 2014. The Algerian government intend that renewable energy will supply 40% of its electricity needs by 2030 (Nacer et al., 2016).

To the best of our knowledge, this paper presents the first known application of ARDL modeling approach for the examination of the dynamic link between renewable and non-renewable electricity consumption-carbon emissions-GDP in Algeria. The choice of Algeria for this research is also motivated by the fact that Algeria is facing several energy and environmental challenges, including high demand of energy while the supply is decreasing, large dependence on fossil fuel, high volatility of oils prices and severe negative effects of energy-based carbon emissions on the environmental quality.

In fact, Algeria's energy demand is experiencing steep consumption rates, with growth of 8–10% annually. Steadily increasing in energy domestic demand in recent years driven by both demographics as well as by largely sustained economic activity. Furthermore, CO_2 emissions from energy use have increased by 5%/year since 2000, reaching 125 Mt in 2014. In this context understanding the casual links between such variables can help to better guide the needed energy sector and economic transformation for the country and more generally for countries behaving similarly.

This study is in line with earlier work by Bélaïd and Abderrahmani (2013) who analyzed the causal relationship between electricity consumption, crude oil price and economic growth in Algeria. In embarking in this path, this research develops an ARDL Bounds testing procedure which allows the long-run estimation without requiring pre-testing the time-series for the presence of unit roots in the data generating process incorporated in the cointegration model.

In addition to the introductory section (Section 1), the remainder of this paper is build up as follows: Section 2 presents the theoretical background and the state of the art dealing with literature on the subject of energy consumption, economic growth and pollutant emissions. Section 3 provides an overview of renewable energy in Algeria. Section 4 describes the data and the econometric methodology. We report our empirical findings and discuss their implications in Section 5. Section 6 concludes the paper with a summary of the main findings and provides some policy implications based on the empirical results.

2. Literature review

An impressive body of literature have dealt with the dynamic causality between electricity consumption, CO_2 emissions and economic growth (Salim et al., 2014). Three main views have emerged in the literature. The first strand is related to the relationship between economic growth and electricity consumption. Economic growth and electricity consumption nexus is a very well studied topic in the literature. Pioneered by the seminal work of Kraft and Kraft (1978), many other studies emerged, employing the Granger causality and cointegration model, as a new empirical tool to study this kind of purpose for different countries (for example, Chandran et al. (2010), Bélaïd and Abderrahmani (2013), Khalid (2015)). However, emanating results show that there is no consensus and causality direction between the series differ from one country to another. According to Bélaïd and Abderrahmani (2013) the heterogeneous feature in the results are mainly due to the specific nature of the country's economic policy, energy resources, different periods that data cover and the methodological approach employed to test causality. In this first strand of research, there is a very limited number of studies on the economic growth and electricity consumption nexus in Algeria. Bélaïd and Abderrahmani (2013) examine the causal relationship between economic growth and electricity use in Algeria over the period of 1971–2010. Using a multivariate cointegration approach, they find both short-run and long-run bidirectional causality between the series. Their findings lay emphasis on electricity consumption as a prerequisite of achieving higher economic growth for Algeria. A high level of economic activity leads to a high level of electricity demand.

The second strand focuses on the causality between economic growth and pollutant emissions. It is linked to testing the validity of the environmental kuznets curve (EKC) hypothesis of an inverted U-shaped relationship between CO_2 emissions and economic growth. According to the EKC hypothesis, CO_2 emissions increase with an increase of the economic growth until reaching a threshold, and after that decline with the economic growth beyond this threshold. Since the seminal work of Grossman and Krueger (1991), who were the first to test the EKC hypothesis to analyze the relationship between the income per capita and environmental degradation, many other studies emerged. A long-run and inverted U-shaped linkages between CO_2 emissions and economic growth were examined in the following studies realized for different countries like Algeria (Lacheheb et al., 2015), Tunisia (Fodha and Zaghdoud, 2010), Malysia (Saboori et al., 2012), Turkey (Halicioglu, 2009), Iran (Asghari, 2012) and Saudi Arabia (Alshehry, 2012; Alkhathlan et al., 2012).

Some of these studies have also explored Granger causality between economic growth and CO_2 emissions. However, the empirical results look to be controversial. In fact, Saboori et al. (2012) find a long-run unidirectional causality running from carbon emissions to economic growth. Fodha and Zaghdoud (2010) report a unidirectional causality running from economic growth to CO_2 emissions. Lacheheb et al. (2015) study the dynamic causality between economic growth and CO_2 emissions and the existence of the (EKC) hypothesis in Algeria, over the period 1971–2009. They find that in the long-run, economic growth affect significantly CO_2 emissions and confirm the non existence of the (EKC) hypothesis in the case of Algeria.

Finally, the third strand combines the two previous lines of research into the study of causal link between economic growth, energy