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The role of renewable energy consumption in economic growth: Evidence from asymmetric causality

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ABSTRACT

This paper investigates the causality among economic growth, renewable energy consumption, capital and labor for new EU member countries for the period of 1990–2009, by using asymmetric causality test approach and autoregressive distributed lag (ARDL) approach. The empirical results support that renewable energy consumption has positive impacts on economic growth for all investigated countries. But only for Bulgaria, Estonia, Poland, and Slovenia there is statistically significant impact on economic growth has found. And also supports neutrality hypothesis for Cyprus, Estonia, Hungary, Poland and Slovenia while the conservation hypothesis is present for Czech Republic. The fact that there is a causal relationship from economic growth to renewable energy consumption and the growth hypothesis is supported for Bulgaria, referring to causality from energy consumption to economic growth.

Contents

1. Introduction

Currently, in most countries, fossil fuels like coal, oil, and natural gas are mostly used for energy. These are not renewable resources and may exhaust someday. Also, the production of these fuels will also be more harmful for the environment, and it must be considered vital because of the greenhouse effect and global warming. In contrast, renewable energy resources constantly renew themselves and have less negative effect on the environment than fossil energy technologies.

The most important features of renewable energy sources are reducing carbon dioxide emissions, assisting to protect the environment, reducing dependence on foreign sources because of being domestic sources of energy, and contributing to an increase in employment. While theoretically renewable on a very long timescale, fossil fuels are exploited at rates that may exhaust these resources in the near future, and are therefore not regarded as renewable.

By increasing concerns of high and volatile energy prices of fossil fuels and global warming and environmental consequences of greenhouse gas, renewable energy sources have emerged as an important component of world energy consumption. According to the [20,21], "renewable are the fastest growing source of world energy with consumption increasing by 3.0% per year" and "renewable energy is the world's fastest growing form of energy, and the renewable share of total energy use increases from 10% in 2008 to 14% in 2035 in the reference case".

The causality between renewable energy consumption and economic growth relationship has been investigated in a number of studies. Considering renewable energy as one of the cornerstones of a sustainable energy future, it is important to understand the relationship between renewable energy consumption and

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Table 1
Share of renewable energy (in % of gross final energy consumption).
Source: Eurostat

Countries	2006	2007	2008	2009	2010
Bulgaria	9.6	9.3	9.8	11.9	13.8
Cyprus	2.5	3.1	4.1	4.6	4.8
Czech Republic	6.5	7.4	7.6	8.5	9.2
Estonia	16.1	17.1	18.9	23.0	24.3
Hungary	5.1	5.9	6.6	8.1	n.a
Poland	7.0	7.0	7.9	8.9	9.4
Romania	17.1	18.3	20.3	22.4	23.4
Slovenia	15.5	15.6	15.1	18.9	19.8

economic growth. It is also vital for the EU to set up the right structure for the development and distribution of sustainable technologies, and thus limit CO_2 emissions from the use of fossil fuels. The most cost-effective way to reduce emissions, improve energy security and competitiveness, and keep energy cost down is energy efficiency. It can be accomplished by increasing the production and consumption of renewable energy.

Between 2006 and 2010, all Member States in EU increased their share of renewable energy in total consumption. The largest increases were recorded in Estonia (from 16.1% in 2006 to 24.3% in 2010) and Romania (from 17.1% to 23.4%) as seen in Table 1. The European Commission claimed that the 2020 renewable energy policy goals are likely to be met and exceeded if Member States fully implement their national renewable energy action plans and if financing instruments are improved.

The estimations show that such measures could lead to 10 billion Euros savings each year in EU countries and the European Council of March 2006 called for EU leadership on renewable energies and asked the Commission to produce an analysis on how further to support renewable energies over the long term. In addition, a 25% target for renewable energies in the EU's overall energy consumption by 2020 is declared by the [11].

Although it is clear that renewable energy plays an important role in energy efficiency in EU countries, new EU countries consume more fossils than developed EU countries. However, these countries should urgently increase their production and consumption of renewable energy for their own benefit both because they need to abide by the common policies as they are EU members and due to reasons listed above. Therefore, the case of last eight EU member countries that use renewable energy less intensively, energy consumption and economic growth relations should not be ignored.

Section 2 provides an overview of the energy consumption-economic growth hypotheses along with a focus on the empirical literature of the causal relationship between renewable energy consumption and economic growth. Section 3 discusses the data, methodology, and empirical results. Section 4 provides conclusions.

2. Literature review

Energy economics literature has examined the short and long-run relationships between energy consumption and economic growth [12,13]).While the literature on energy consumption and economic growth has been extensively examined in the literature (see [32,34,35] usually focusing on energy consumption and/or electricity consumption variables, much fewer studies discussed the relationship between renewable energy consumption and economic growth. The aim of this study is to extend the research on the causal relationship between renewable energy consumption and economic growth to the case of new eight EU member countries (Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Poland, Romania, and Slovenia).

The literature on the relationship between economic growth and energy consumption suggests four hypotheses: growth, conservation, feedback and neutrality [6]. *The growth hypothesis* suggests that energy consumption is an important supplement in the process of economic growth and/or is based on the presence of unidirectional causality from energy consumption to economic growth. That means the reduction of energy consumption or energy conservation policies which reduce energy consumption have a destructive impact on economic growth. *The conservation hypothesis* is supported if there is a unidirectional causality running from economic growth to energy consumption. In this case, the energy consumption reduction will not affect economic growth adversely. *The feedback hypothesis* argues that there is bidirectional causality between energy consumption and economic growth. This relationship suggests that energy conservation have a negative impact on economic growth and vice versa. In this case, it is supported by the causation in both directions between energy consumption and economic growth. *The neutrality hypothesis* is supported if there is no causality between energy consumption and economic growth. Under the neutrality hypothesis, the energy consumption reduction will not adversely affect economic growth.

In the literature, there are a number of studies that examine the causality between economic growth and energy consumption relationship, but no consensus has been expressed. Kaygusuz et al. [25] suggest that for EU-15 Member States, wind energy has reliable and cost-effective technology as well as positive effects on the reduction of CO_2 emissions. Ewing et al. [15] examine the relationship between disaggregate energy consumption and industrial output with the generalized variance decomposition approach in the US over the period of 2001:1–2005:6., and find that for industrial production, total renewable energy consumption explains 2.3% of forecast error variance: waste 10.6%, wood 6%, wind 5.8%, solar 3.8% and hydroelectric power 1.9%. Ewing et al. [40] employ an ARDL model and report that industrial output has a positive impact on hydroelectric, waste, and wind energy consumption and has a negative impact on solar energy consumption. Employment has a negative impact on hydroelectric, waste and wind energy consumption and a positive impact on solar energy consumption. Industrial output and employment have no statistically significant impact on wood energy consumption.

Sadorsky [38] provides evidence of unidirectional causality running from economic growth to renewable energy consumption, within a bivariate panel error correction model for 18 emerging countries over the period 1994–2003. Tests results indicate that real income increases have positive and statistically significant impact on per capita renewable energy consumption. Sadorsky [39] presents that oil price increases have small and negative impact on renewable energy consumption for the G7 countries.

Payne [33] uses Toda-Yamamoto causality tests for the US, over the period 1949–2006 to examine the relationship between renewable and non-renewable energy consumption and economic growth and provides support for no causality between renewable energy consumption and economic growth. Apergis and Payne [3] support the bidirectional causality between renewable energy consumption and economic growth in the short-run and long-run for 13 countries within Eurasia over the period 1992–2007. Halicioglu [16] uses Granger causality tests for Turkey over the period 1968–2008 to examine the relationship between energy consumption and aggregate output and the results support growth hypothesis.

The Granger-causality test results which were used by Apergis and Payne [4] indicate bidirectional causality between renewable energy consumption and economic growth in the short and long-run for a panel of twenty OECD countries over the period 1985–2005. To examine the causal relationship between nuclear energy