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Modeling the causal linkages between nuclear energy, renewable energy and economic growth in developed and developing countries

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ABSTRACT

This article investigates the causal relationship between two types of energy variables and economic growth using dynamic simultaneous-equation panel data models for 17 developed and developing countries. Our results indicate that there is a unidirectional causality running from nuclear consumption to economic growth in Belgium and Spain, while a unidirectional causality running from economic growth to nuclear consumption is supported in Bulgaria, Canada, Netherlands, and Sweden. A bidirectional relationship appears in Argentina, Brazil, France, Pakistan, and the USA, while no causality exists in Finland, Hungary, India, Japan, Switzerland, and the U.K. Second, the results for the second nexus among renewable energy and economic growth show that there is a unidirectional causality running from renewable consumption to economic growth in Hungary, India, Japan, Netherlands, and Sweden, while there exist a unidirectional running from economic growth to renewable consumption in Argentina, Spain, and Switzerland. A bidirectional relationship is supported in Belgium, Bulgaria, Canada, France, Pakistan, and the USA, while no causality exists in Brazil, Finland, and Switzerland. Third, we find the existence of a bidirectional causality between nuclear consumption and economic; and a unidirectional causality running from economic growth to renewable energy consumption for the global panel.

Contents

1. Introduction

The issue of causality between energy resources and economic growth has been an interesting topic concerning energy economists' for the last few years, and numerous studies have been conducted to examine the relationship between the two. Early models such as that of Solow [35] did not explain how improvements in technology come about, so this model assumes that technological change is exogenous and not introduce resources or energy. However, there some economists believe that energy plays a pivot role in economic growth as well as being a crucial factor in explaining the industrial revolution (e.g. [41,1]). As well, some others such as Hall et al. [13] support that either increase in energy consumption accounts for most apparent productivity growth, or that innovation in technological change mainly increases productivity by allowing more energy consumption. Therefore, energy

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Table 1
Summary of empirical studies on the causality between nuclear/renewable energy consumption and growth.

No.	Author(s)	Country(ies)	Period	Methodology	Confirmed hypothesis
First nexus: Nuclear consumption-Growth					
A-Time series studies					
1.	Yoo and Jung [43]	Korea	1972–2002	VECM	Growth hypothesis
2.	Yoo and Ku [44]	Six countries	1965–2005	Hsiao's version of Granger causality, Granger causality, ECM, cointegration	Growth hypothesis: Korea Conservation hypothesis: France, Pakistan Feedback hypothesis: Switzerland Neutrality hypothesis: Argentina, Germany
3.	Payne and Taylor [29]	USA	1957–2006	TY approach	Neutrality hypothesis
4.	Menyah and Wolde-Rufael [18]	USA	1960–2007	TY approach	Neutrality hypothesis
5.	Wolde-Rufael [39]	India	1969–2006	TY approach	Neutrality hypothesis
6.	Wolde-Rufael and Menyah [40]	Nine developed countries	1971–2005	TY approach	Growth hypothesis: Japan, Netherlands, Switzerland Conservation hypothesis: Canada, Sweden Feedback hypothesis: France, Spain, U.K., USA.
7.	Lee and Chiu [14]	6 highly industrialized countries	1965–2008	TY approach	Conservation hypothesis: Japan Feedback hypothesis: Canada, Germany, U.K. Neutrality hypothesis: France, USA
8.	Lee and Chiu [15]	6 developed countries	1971–2006	Cointegration, Granger causality	Conservation hypothesis (in the lon run) Neutrality hypothesis (in the short run)
9.	Chu and Chang [10]	G-6 countries	1971–201	Granger causality	Growth hypothesis: Japan, U.K., USA Neutrality hypothesis: Canada, France, Germany
B- Panel data studies					
10.	Apergis et al. [2]	19 developed and developing countries	1984–2007	Panel VECM	Feedback hypothesis (in the long run) Growth hypothesis (in the short run)
11.	Apergis and Payne [3]	16 developed and newly developing countries	1980–2005	Panel VECM	Feedback hypothesis (in the short run) Growth hypothesis (in the long run)
12.	Nazlioglu et al. [19]	14 OECD countries	1980–2007	Panel Granger causality, TY approach	Neutrality hypothesis
Second nexus: Renewable consumption-Growth					
A-Time series studies					
13.	Sari et al. [34]	USA	1969–1999	ARDL approach	Conservation hypothesis
14.	Payne [28]	USA	1949–2006	TY approach	Neutrality hypothesis
15.	Menyah and Wolde-Rufael [18]	USA	1960–2007	Granger causality tests	Conservation hypothesis
16.	Bowden and Payne [8]	USA	1949–2006	TY approach	Neutrality hypothesis among income and commercial and industrial renewable energy consumption (REC). Growth hypothesis (among residential REC and income)
17.	Payne [30]	USA	1949–2007	TY approach	Growth hypothesis
18.	Salim and Rafiq [33]	6 countries	1980–2006	Granger causality	Feedback hypothesis (in the short-run) Conservation hypothesis (in the long-run)
19.	Tugcu et al. [37]	G-7 countries	1980–2009	Hatemi-J causality tests	Neutrality hypothesis: France, Italy, Canada, U.S.A Feedback hypothesis: England and Japan Conservation hypothesis: Germany
19.	Yildirim et al. [42]	USA	1949–2010	Toda-Yamamoto and Hatemi-J causality tests	Neutrality hypothesis, Growth hypothesis (causality from biomass-waste-derived energy
20.	Pao and Fu [27]	Brazil	1980–2010	ECM	Feedback hypothesis
B- Panel data studies					
21.	Sadorsky (2009)	18 emerging countries	1994–2003	Bivariate panel error correction model	Conservation hypothesis
22.	Apergis and Payne [4]	13 Eurasia countries	1992–2007	Panel ECM (Granger causality)	Feedback hypothesis
23.	Apergis and Payne [5]	20 OECD countries	1985–2005	Panel Granger causality	Feedback hypothesis
25.	Apergis and Payne [6]	6 Central American countries	1980–2006	Panel ECM	Feedback hypothesis
26.	Menegak [17]	27 European countries	1997–2007	Multivariate panel framework	Neutrality hypothesis
27.	Apergis and Payne [7]	80 countries	1990–2007	Panel ECM	Feedback hypothesis

Notes: VECM refers to the vector error correction model, ECM refers to the error correction model, TY approach refers to Toda–Yamamoto approach to Granger causality, and ARDL refers to the auto regressive distributed lag procedure.

use has considered as a potential source of economic growth, which has triggered interest in empirically identifying the nature of causal linkages between energy consumption and economic growth in either existence or lack of causality. So identifying the direction of causality between energy consumption and economic growth provides important inferences in establishing sound energy policies.

The empirical literature on the causal relationship between energy consumption and economic growth could be synthesized into four testable hypotheses: feedback, growth, conservation and