



## Electricity consumption and economic growth in seven South American countries

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### ABSTRACT

This paper attempts to investigate the causal relationship between electricity consumption and economic growth among seven South American countries, namely Argentina, Brazil, Chile, Columbia, Ecuador, Peru, and Venezuela using widely accepted time-series techniques for the period 1975–2006. The results indicate that the causal nexus between electricity consumption and economic growth varies across countries. There is a unidirectional, short-run causality from electricity consumption to real GDP for Argentina, Brazil, Chile, Columbia, and Ecuador. This means that an increase in electricity consumption directly affects economic growth in those countries. In Venezuela, there is a bidirectional causality between electricity consumption and economic growth. This implies that an increase in electricity consumption directly affects economic growth and that economic growth also stimulates further electricity consumption in that country. However, no causal relationships exist in Peru. The documented evidence from seven South American countries can provide useful information for each government with regard to energy and growth policy.

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### 1. Introduction

In the past three decades, numerous studies have been conducted to examine the relationship between electricity consumption and economic growth. The overall findings show that there is a strong relationship between electricity consumption and economic growth. For example, Ferguson et al. (2000) have studied the issue in over one hundred countries, and found that, on the whole, there is a strong correlation between electricity consumption and economic growth.

However, the fact that there exists a strong relationship between electricity consumption and economic growth does not necessarily imply a causal relationship. The relationship may very well run from electricity consumption to economic growth and/or from economic growth to electricity consumption. These causality issues, therefore, suggest the need for further research. A major question concerning this issue is which variable should take precedence over the other: is electricity consumption a stimulus for economic growth or does economic growth lead to electricity consumption?

Although many studies have been conducted on causality issues related to electricity consumption and economic growth in

several countries, case studies for South American countries cannot be found as far as we are concerned. South America occupies a large portion of the Western Hemisphere and comprises many different nations. Most South American countries plan to become advanced economies from being developing countries and public policy makers of those countries have shown a great deal of interest in the role that electricity consumption plays in economic growth. In these countries, the infrastructure for electricity is becoming an increasingly important component of the economy. This situation became more dominant as the weight of economic life in industrial economies increases. To proactively cope with the increased demand for electricity that accompanies rapid economic growth, South American countries should endeavor to uncover the causal relationship between electricity consumption and economic growth and to formulate appropriate electricity policies.

The motivation and necessity of this paper can be illuminated from another angle. As primary industries such as agriculture, forestry, and raw material extraction take up relatively much of the weight in the industrial structures when compared with other more advanced countries, they try to turn to the industrial structure of advanced countries. In an effort to do so, they expand and improve basic infrastructural facilities, among which electricity holds a position of importance and essentiality. Consequently policy makers take an interest and establish political measures about it. For example, Argentina, Brazil, and Columbia are provided a loan from Inter-American Development Bank for

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projects targeted at building facilities to generate electricity. These projects can be regarded as the outcome of economic growth or instruments to reach the goal of economic growth. Thus, policy makers can set more efficient and effective policies by verifying the relationship between electricity and GDP.

Thus, the purpose of this paper is to investigate causality between electricity consumption and economic growth in South American countries, and to derive policy implications from the results. To this end, we choose major countries of South America and attempt to carefully consider causality issues by applying the time-series techniques of Granger causality to South American data. The methods adopted in the present study are as follows. First, stationarity and co-integration are tested. Then, if co-integration is detected, error-correction models are estimated; otherwise, the standard Granger causality method is executed. Finally, the *F*-test is performed to gauge the joint significance levels of causality between electricity consumption and economic growth. In the analysis, suitable information criteria are employed to select the optimum time-lag in lieu of an arbitrary choice of lag length.

The remainder of the paper is organized as follows. A review of the literature on causality studies of electricity consumption and economic growth is provided in Section 2. An overview of the methodology adopted here is presented in Section 3. Section 4 explains the data employed and reports the empirical findings. Some concluding remarks are made in the final section.

## 2. Literature review

The empirical findings of the causality tests between electricity consumption and economic growth are summarized in Table 1. Most studies focus on Asian and African nations. Thoma (2004) dealt with the causality issue for the US, while Fatai et al. (2004) and Narayan and Smyth (2005) addressed the Australian context. Recently, some studies looked into the causality issue in a cross-country setting. Yoo (2006) investigated causal relationships in the ASEAN countries. Narayan and Prasad (2008) examined causal relationships in 30 OECD countries and Lee and Chang (2008) studied the same issue in Asian countries. Causality analysis of member countries of the OPEC was conducted by Squalli (2007). In terms of the direction of causality between electricity consumption and economic growth, the literature is divided: several studies support bidirectional or unidirectional causality, while other investigations find no evidence of causality. In short, the empirical evidence is inconclusive with regard to causality issues.

Evidence of either direction will have a significant bearing upon policy. For example, if there is unidirectional causality running from electricity consumption to economic growth, a reduction in electricity consumption could lead to a fall in economic growth. Such unidirectional causality was detected by Shiu and Lam (2004) for China as a whole, Wolde-Rufael (2004) for the Shanghai region of China, and Wolde-Rufael (2006) for Benin, the Democratic Republic of Congo (Congo, DR), and Tunisia. Most recently, Narayan and Prasad (2008) found the same relationship in Australia, the Czech Republic, Iceland, Italy, Portugal, and the Slovak Republic.

On the other hand, if unidirectional causality runs from economic growth to electricity consumption, it could imply that policies for reducing electricity consumption may be implemented with little or no adverse effects on economic growth. Such unidirectional causality was revealed by Ghosh (2002) for India, Wolde-Rufael (2006) for Cameroon, Ghana, Nigeria, Senegal, Zambia, and Zimbabwe, and Fatai et al. (2004) and Narayan and

**Table 1**

Empirical results from causality tests between electricity consumption and economic growth.

Countries	Sources	Period	Conclusions
Algeria	Wolde-Rufael, (2006)	1971–2001	EC × EG
Australia	Fatai et al. (2004)	1960–1999	EC ← EG
	Narayan and Smyth (2005)	1966–1999	EC ← EG
	Narayan and Prasad (2008)	1960–2002	EC → EG
Bangladesh	Mozumder and Marathe(2007)	1971–1999	EC ← EG
Benin	Wolde-Rufael (2006)	1971–2001	EC → EG
Cameroon	Wolde-Rufael (2006)	1971–2001	EC ← EG
China	Shiu and Lam (2004)	1971–2000	EC → EG
	Yuan et al. (2007)	1978–2004	EC → EG
Shanghai, China	Wolde-Rufael (2004)	1952–1999	EC → EG
Congo, DR	Wolde-Rufael (2006)	1971–2001	EC → EG
Congo, Rep.	Wolde-Rufael (2006)	1971–2001	EC × EG
Czech, Rep.	Narayan and Prasad (2008)	1960–2002	EC → EG
Egypt	Wolde-Rufael (2006)	1971–2001	EC ← EG
Fiji	Narayan and Singh (2007)	1971–2002	EC → EG
Finland	Narayan and Prasad (2008)	1960–2002	EC ← EG
Gabon	Wolde-Rufael (2006)	1971–2001	EC ↔ EG
Ghana	Wolde-Rufael (2006)	1971–2001	EC ← EG
Hungary	Narayan and Prasad (2008)	1965–2002	EC ← EG
Iceland	Narayan and Prasad (2008)	1960–2002	EC → EG
India	Ghosh (2002)	1950–1997	EC ← EG
Indonesia	Yoo (2006)	1971–2002	EC ← EG
Italy	Narayan and Prasad (2008)	1960–2002	EC → EG
Kenya	Wolde-Rufael (2006)	1971–2001	EC × EG
Korea	Yoo (2005)	1970–2002	EC ↔ EG
Malawi	Jumbe (2004)	1970–1999	EC ↔ EG
Malaysia	Yoo (2006)	1971–2002	EC ↔ EG
Morocco	Wolde-Rufael (2006)	1971–2001	EC ↔ EG
Netherlands	Narayan and Prasad (2008)	1960–2002	EC ← EG
Nigeria	Wolde-Rufael (2006)	1971–2001	EC ← EG
Portugal	Narayan and Prasad (2008)	1960–2002	EC → EG
Senegal	Wolde-Rufael (2006)	1971–2001	EC ← EG
Singapore	Yoo (2006)	1971–2002	EC ↔ EG
Slovak, Rep.	Narayan and Prasad (2008)	1971–2002	EC → EG
South Africa	Wolde-Rufael (2006)	1971–2001	EC × EG
Sri Lanka	Morimoto and Hope (2004)	1960–1998	EC → EG
Sudan	Wolde-Rufael (2006)	1971–2001	EC × EG
Taiwan	Yang (2000)	1954–1997	EC ↔ EG
Thailand	Yoo (2006)	1971–2002	EC ← EG
Tunisia	Wolde-Rufael (2006)	1971–2001	EC → EG
Turkey	Altinay and Karagol (2005)	1950–2000	EC → EG
UK	Narayan and Prasad (2008)	1960–2002	EC ← EG
United States	Thoma (2004)	1973–2000	EC ← EG
Zambia	Wolde-Rufael (2006)	1971–2001	EC ← EG
Zimbabwe	Wolde-Rufael (2006)	1971–2001	EC ← EG

Notes: EC and EG denote electricity consumption and economic growth, respectively. → and ←, respectively, indicate unidirectional causality, while ↔ and ×, respectively, imply bidirectional causality and absence of causality.

Smyth (2005) for Australia. Further, Mozumder and Marathe (2007) addressed the case of Bangladesh.

In contrast, if bidirectional causality is detected, economic growth may stimulate the demand for electricity while, in turn, greater electricity consumption may induce economic growth. Electricity consumption and economic growth complement each other and energy conservation measures may negatively affect economic growth. Yoo (2005), Jumbe (2004), Morimoto and Hope (2004), Yang (2000), and Narayan and Prasad (2008) found bidirectional causality between electricity consumption and economic growth in Korea, Malawi, Sri Lanka, Taiwan, and the UK, respectively.

Lastly, the absence of causality in either direction would indicate that policies for increasing or reducing electricity consumption do not affect economic growth, and that a rise in real income may not affect electricity consumption. No causality between electricity consumption and economic growth was found for Algeria, the Republic of Congo (Congo, Rep.), Kenya, South Africa, and Sudan by Wolde-Rufael (2006).

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