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Analyzing the causal relations between electric power consumption and economic growth in India

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ABSTRACT

An examination of the relationship between economic growth and electric power consumption in India from 1974 to 2014 using the Johansen co-integration method suggests an absence of a long-run relationship among the study variables. Granger Causality indicates a one-way causal direction from economic growth to electric power consumption, suggesting to policymakers that electricity conservation strategies can be implemented without hindering economic growth.

1. Introduction

Electricity is a key element of the energy infrastructure of any nation and plays a vital role in its development (Gupta and Chandra, 2009). Electricity directly enables production functions and raises output levels, helping improve the economic status of a country (Payne, 2010). It plays an important role in our daily lives, as routine activities such as cleaning, cooking, lighting, working and entertainment greatly depend on electricity. It also supports in improving education and health standards of poor communities (Gupta and Chandra, 2009). Indeed, it is almost impossible to imagine a life without electricity (Ghosh, 2002). In essence, it can be said that electricity is an essential element for the socioeconomic development of a nation.

The relationship between electricity consumption and economic growth has been widely explored in many countries, whether developed, developing, or underdeveloped. Since the 1970s, various studies have examined the causal relationship between electricity consumption and economic growth. Some of them found strong long-run relationships between the two (Narayan and Singh, 2007; Ho and Siu, 2007; Shiu and Lam, 2004; Shahbaz and Feridun, 2012; Acaravci, 2010; Akinlo, 2009; Yuan et al., 2007; Lorde et al., 2010; Bélaïd and Abderrahmani, 2013) while others did not (Abosedra et al., 2009; Ghosh, 2002; Adhegaonkar, 2015). Ferguson et al. (2000) conducted a study on a sample of 100 countries and concluded that developed economics have a stronger causal relation between electricity consumption and economic growth than deprived nations. Various researchers have found four types of causal directions between electricity consumption and economic growth: unidirectional causality running from electricity consumption to economic growth, known as the growth hypothesis (Ramcharran, 1990; Wolde-Rufael, 2004; Aqeel and Butt, 2001; Altinay and Karagol, 2005; Yuan et al., 2007; Ho and Siu, 2007; Narayan and Singh, 2007; Abosedra et al., 2009; Chandran et al., 2010; Ighodaro, 2010); a unidirectional causal relation flowing from economic growth to electricity consumption, known as the conservative hypothesis (Ghosh, 2002; Shahbaz and Feridun, 2012; Hu and Lin, 2008); bidirectional causality between electricity consumption and economic growth, or the feedback hypothesis (Yang, 2000; Jumbe, 2004; Yoo, 2005; Zachariadis and Pashourtidou, 2007; Alam et al., 2012); and no causal relation, the neutrality hypothesis (Narayan and Prasad, 2008; Wolde-Rufael, 2006). Understanding these causal relationships between electricity consumption and economic growth may help policymakers devise and implement effective energy policies. Each type of causality plays a vital role in decision-making for electricity plans. For instance, if there is a causal relation flowing from electric power consumption towards economic growth, the supply of electricity would be emphasized. On the other hand, if a unidirectional causality runs from economic growth to electricity consumption, electricity conservation policies may be initiated (Ghosh, 2002).

The rest of the article is organized as follows. Section 2 presents a review of the literature on the relation between electricity consumption and economic growth. Section 3 gives an overview of the scenario of electricity consumption in India. Section 4 describes the rationale and scope of the study. Section 5 explains the objectives of the study. Section 6 covers the data collection

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procedure and methodology. Section 7 comprises findings and discussion, and Section 8 concludes the study.

2. Review of literature

Since the 1970s, the causal relationship between consumption of electricity and economic growth of a country has received significant research attention. While most studies (Ramcharran, 1990; Shiu and Lam, 2004; Ho and Siu 2007; Altinay and Karagol, 2005; Yuan et al., 2007; Narayan and Singh, 2007; Tang, 2008; Yuan et al., 2008; Odhiambo, 2009a; Akinlo, 2009; Aqeel and Butt, 2001; Abosedra et al., 2009) have recognized the growth theory and found one-way causality running from electricity consumption to economic growth, others have established a reverse one-way causal relation flowing from economic growth to consumption of electricity (Ghosh, 2002; Narayan and Smyth, 2005; Hu and Lin, 2008; Mozumder and Marathe, 2007). Some studies (Yang, 2000; Jumbe, 2004; Yoo, 2005; Zachariadis and Pashourtidou, 2007; Tang, 2008; Odhiambo, 2009b) have established a bi-directional causality between electricity consumption and economic growth.

Four types of causal relationships between electricity consumption and economic growth have been revealed by various authors:

1. EPC → PCY (Unidirectional causality runs from EPC to PCY)
2. EPC ← PCY (Unidirectional causality runs from PCY to EPC)
3. EPC ↔ PCY (Bi-directional causality exists between EPC and PCY)
4. EPC – – – – – PCY (No causality exists between EPC and PCY),

where, EPC stands for electricity consumption and PCY stands for economic growth. In the present study, Tables 1–4 provide a summary of literature on the various hypotheses or relationships established among EPC and PCY in different nations. The authors have used several methodologies such as Granger causality, Cointegration, Vector Error Correction (VEC), Vector Autoregressive (VAR), the ARDL bounds test, Johansen-Juselius co-integration, Toda-Yamamoto causality, and Zivot-Andrews to explore the long-term associations and type of causality among EPC and PCY.

Table 1 offers a sequential view of empirical studies which establishes the growth hypothesis in a particular country. Table 2 summarizes literature which proved the conservative hypothesis of a specific nation. Table 3 presents literature confirming the feedback hypothesis in a specific economy. Table 4 presents a sequential view of the various empirical literature conducted to determine the causal relation between consumption of electricity and economic growth while considering a sample comprising more than one country. Tables include methodologies used, time period considered, and countries where studies have been conducted.

Table 4 summarizes those studies where authors have considered more than one country to determine the relationships and their causal directions between electric power consumption and economic growth of countries. It is clear from the table that the majority of studies have used the panel causality and panel co-integration approach. Further, the four types of causal relationships mentioned earlier have also been determined by studies in Table 4.

Table 1
Empirical literature that declares growth hypothesis (one way causal route from EPC to PCY).

Country with Time periods	Authors	Methodology
Jamaica, 1970–1986	Ramcharran (1990)	Granger causality
Pakistan, 1955–1996	Aqeel and Butt (2001)	VAR and Granger approach (Engle causality)
Shanghai, 1952–1999	Wolde-Rufael (2004)	Toda-Yamamoto causality, Zivot- Andrewa structural break test
China, 1971–2000	Shiu and Lam (2004)	Error Correction Model (ECM) and Co-integration
Turkey, 1950–2000	Altinay and Karagol (2005)	DL test (Dolado-Lutkepohl) and standard Granger causality
Taiwan, 1954–2003	Lee and Chang (2005)	JJ, VEC, co-integration, Hansen parameter stability test, Zivot- Andrews and Parron structural break test, Gregory and Hansen structural break test
Hong Kong, 1966–2002	Ho and Siu (2007)	Co-integration, VECM
Fiji Islands, 1971–2002	Narayan and Singh (2007)	Co-integration, GC (Granger causality approach)
China, 1978–2004	Yuan et al. (2007)	Co-integration
Malaysia, 1972–2003	Tang (2008)	ARDL bound test, Toda-Yamamoto causality, Brown parameter stability test
China, 1963–2005	Yuan et al. (2008)	Johansen co-integration, Vector Error Correction (VEM)
Lebanon, 1995–2005	Abosedra et al. (2009)	Granger causality
Nigeria, 1980–2006	Akinlo (2009)	JJ cointegration approach (Johansen-Juselius), Cointegration, VEC (Vector Error Correction)
Tanzania, 1971–2006	Odhiambo (2009a)	Granger causality method, Autoregressive Distributed Lag (ARDL) bonds test, VECM (Vector Error Correction Model)
Malaysia, 1971–2003	Chandran et al. (2010)	Autoregressive Distributed Lag (ARDL) bonds test
Nigeria, 1970–2005	Ighodaro (2010)	Granger causality test and Cointegration approach
Turkey, 1968–2005	Acaravci (2010)	Cointegration and VECM
Nigeria, 1971–2012	Iyke (2015)	VECM