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# Trivariate causality between economic growth, urbanisation and electricity consumption in Angola: Cointegration and causality analysis



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## HIGHLIGHTS

- We consider the link between electricity consumption and economic growth in Angola.
- Urbanisation is added to turn the research into a trivariate investigation.
- Various time series procedures are used.
- Results show that increasing electricity will improve economic growth in Angola.
- Results show urbanisations reduced economic growth during civil war.

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## ABSTRACT

This paper investigates the causal relationship between economic growth, urbanisation and electricity consumption in the case of Angola, while utilizing the data over the period of 1971–2009. We have applied Lee and Strazicich (2003. *The Review of Economics and Statistics* 63, 1082–1089; 2004. Working Paper. Department of Economics, Appalachian State University) unit root tests to examine the stationarity properties of the series. Using the Gregory–Hansen structural break cointegration procedure as a complement, we employ the ARDL bounds test to investigate long run relationships. The VECM Granger causality test is subsequently used to examine the direction of causality between economic growth, urbanisation, and electricity consumption. Our results indicate the existence of long run relationships. We further observe evidence in favour of bidirectional causality between electricity consumption and economic growth. The feedback hypothesis is also found between urbanisation and economic growth. Urbanisation and electricity consumption Granger cause each other. We conclude that Angola is energy-dependent country. Consequently, the relevant authorities should boost electricity production as one of the means of achieving sustainable economic development in the long run.

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## 1. Introduction

Energy is increasingly becoming a major force in the pursuit of sustainable development. The attribute of neutrality ascribed to energy by the neoclassical model is becoming more contestable as consistent growing sources of modern energy could directly aid livelihoods, and indirectly via promotion of economic growth (IEA, 2006). As a principal source of energy, accessibility to electricity aids the process of meeting residential and domestic needs; positively contributes to capital and labour productivity; promotes

export potentials of countries (Narayan and Smyth, 2009); creates employment (Narayan and Smyth, 2005) and decreases the poverty level; and ultimately improves socio-economic development (Poveda and Martínez, 2011). Countries' level of development appears to be associated with intensity of electricity usage, as only 24.84% of the population in less-developed countries enjoy electricity, while about 81.41% of the population in middle-income countries had access to electricity in the year 2009. In the same year, electricity consumption in the European Union was eleven fold the total consumption in sub-Saharan Africa, in spite of the African countries having a larger population (World Bank, 2011).

Recognising the importance of electricity in an economic development agenda, there has been an upsurge of empirical studies to verify the true connection between electricity consumption and economic activity in different countries and regions. Causality tests are recurrently employed in existing energy papers

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to determine the relationship between electricity consumption and economic growth. The causality running from electricity consumption towards economic growth infers that electricity influences economic growth and thus electricity expansionary policies are compatible with improvement of economic performance of the country. Causality flowing from economic growth to electricity consumption implies that economic growth is not dependent on electricity usage and therefore, conservation policies should be pursued. Feedback hypothesis between electricity consumption and economic growth means that the variables are interrelated; which supports expansionary policies. The neutral hypothesis between economic growth and electricity consumption suggests the limited role of electricity consumption for economic growth<sup>2</sup>.

Empirical studies on causal relationships between electricity consumption and economic growth are wide-ranging, but with inconsistent results (see Aqeel and Butt, 2001; Yoo, 2005, 2006; Chen et al., 2007; Ho and Siu, 2007; Hu and Lin, 2008; Jamil and Ahmad, 2010; Narayan and Smyth, 2005; Shahbaz et al., 2011; Shahbaz and Lean, 2012b; Shahbaz and Feridun, 2012). Further, few studies have considered electricity consumption and economic growth relationship in selected African economies (see Jumbe, 2004; Wolde-Rufael, 2006; Akinlo, 2009; Squalli, 2007; Odhiambo, 2009a, 2009b, 2010; Solarin, 2011; Solarin and Bello, 2011). However, we are not aware of any study that has investigated causal relationship between electricity consumption and economic growth in the case of Angola.

In the present study, we investigate the direction of causality between economic growth and electricity consumption by incorporating urbanisation as a potential determinant of both electricity consumption and economic growth in the case of Angola. It is vital to explore the nexus between these variables for Angola, because as one of the fastest growing economies in the world; it is faced with electricity challenges in trying to fulfil its growing energy needs. For instance, the country was among the three fastest-growing economies in the World, upon attaining a 17% economic growth rate between 2003 and 2008 (AFDB, 2011), whereas Angola's power sector is among the least efficient in the World, and even in Africa (Pushak and Foster, 2011) as the access rate to electricity was around 26.2% in the year 2009 (World Bank, 2011). In order to avoid omitted variable bias associated with bivariate models (Lutkepohl, 1982), the urbanisation rate is included to transform the study into a trivariate investigation. In practice, urbanisation and electricity consumption may individually have a direct influence on economic growth. They may also serve as intermediate variables for each other, when impacting the economy. Economic growth may in turn also affect either electricity consumption or urbanisation (Abdel-Rahman et al., 2006; Davis and Henderson, 2003; Liu, 2009; Shahbaz and Lean, 2012a). In the Angola case, inclusion of urbanisation as a control variable is plausible, as there are territorial dimensions to distribution of electricity in the country, with the effect of booming economic activities concentrated in the urban centres, which are responsible for most of the electricity consumed in the country.

The present study augments the ARDL bounds test with the Gregory–Hansen structural break cointegration, when testing for long run relationship in the series. Further, we compute the long run coefficients with the application of ARDL, which is complemented with the fully modified ordinary least squares (FMOLS) procedure of Philips and Hansen (1990), and the dynamic ordinary least squares (DOLS) by Stock and Watson (1993), due to

endogeneity concerns. The current paper provides for two structural breaks with the procedures of Lee and Strazicich (2003), an exercise that is reasonable, considering the fact that the beginning and the end of the civil war in Angola fall within the scope of the analysis.

The remainder of the paper is patterned as follows. Section 2 deals with the literature review related to electricity consumption and economic growth. Section 3 provides a summary of electric power in Angola, and Section 4 illustrates the methodology employed in this study. Section 5 provides the empirical results, and the last section completes the paper.

## 2. Literature review

Theoretical and empirical studies on electricity consumption and economic growth linkage are widespread partly due to the significant role of energy in sustainable economic development. However, researchers are unable to arrive at a consensus on the flow of causality between energy consumption and economic growth. Conflicting results are present in papers on developed countries and which adopt energy as a proxy for energy usage (see Stern, 2000; Fatai et al., 2002; Glasure, 2002; Hondroyannis et al., 2002; Ghali and El-Sakka, 2004; Oh and Lee, 2004; Ho and Siu, 2007; Payne, 2009).

Similarly, papers with emphasis on developing countries that employ electricity use as the proxy for energy consumption do produce different findings, thereby justifying differing hypotheses. For example, Aqeel and Butt (2001) revealed one-way causation actually flows from electricity utilisation to Pakistan's economy. Shahbaz and Lean (2012b) probed the relationship between electricity consumption and economic growth in the case of Pakistan by incorporating capital and labour in the production function over the period 1972–2009. They reported that electricity consumption adds to economic growth and bidirectional causality exists between the series. On the other hand, Jamil and Ahmad (2010) and Shahbaz and Feridun (2012) suggested that electricity conservation policies would be appropriate<sup>3</sup>.

Ghosh (2002) applied Granger causality to examine causal relationship between electricity consumption and economic growth, and reported the presence of expansion hypothesis in the case of India. However, the findings of Ghosh (2009) support conservation policies in the Indian case. Shiu and Lam (2004) used data of electricity consumption and economic growth to test the direction of causality for the Chinese economy. Their results indicated unidirectional causal relation running from electricity consumption to economic growth, and the same inference was drawn by Yuan et al. (2007). Moreover, Yang (2000) applied both Granger causality and Hsiao–Granger causality tests and detected bidirectional causality in the case of Taiwan. On the other hand, Hu and Lin (2008) reported unidirectional causality from economic growth to electricity consumption for Taiwan.

For the Turkish economy, Altinay and Karagol (2005) investigated the relationship between electricity consumption and economic growth. They concluded that electricity consumption Granger causes economic growth. Acaravci and Ozturk, 2012 re-examined the electricity-growth nexus by incorporating employment as control variable in the case of Turkey. They reported unidirectional causality running from electricity consumption to economic growth.

<sup>2</sup> Although this analogy is commonplace in existing energy literature, the signs of the run coefficients are actually required to ascertain if electricity consumption and economic growth are positively related or otherwise.

<sup>3</sup> Findings by Shahbaz and Feridun (2012) may be biased due to avoiding the role of capital and labor in production function and their impact on electricity consumption. Furthermore, Nawaz et al. (2012) reported unidirectional causality running from economic growth to energy consumption.

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