



# Electricity consumption and economic growth in South Africa: A trivariate causality test

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## ABSTRACT

In this paper we examine the causal relationship between electricity consumption and economic growth in South Africa. We incorporate the employment rate as an intermittent variable in the bivariate model between electricity consumption and economic growth—thereby creating a simple trivariate causality framework. Our empirical results show that there is a distinct bidirectional causality between electricity consumption and economic growth in South Africa. In addition, the results show that employment in South Africa Granger-causes economic growth. The results apply irrespective of whether the causality is estimated in the short-run or in the long-run formulation. The study, therefore, recommends that policies geared towards the expansion of the electricity infrastructure should be intensified in South Africa in order to cope with the increasing demand exerted by the country's strong economic growth and rapid industrialisation programme. This will certainly enable the country to avoid unprecedented power outages similar to those experienced in the country in mid-January 2008.

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## 1. Introduction

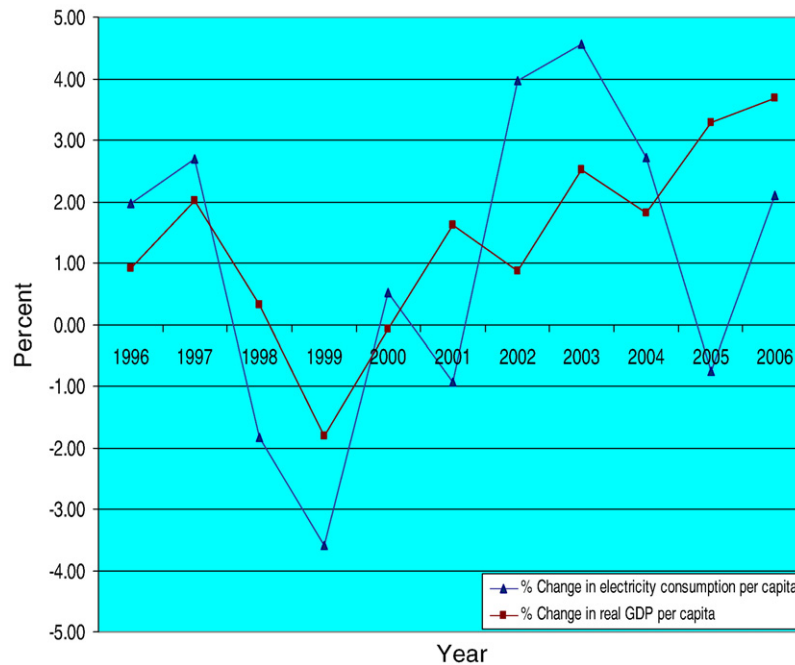
The debate regarding the causal relationship between electricity consumption and economic growth has attracted increasing attention in recent years. The thrust of this debate has been whether electricity consumption Granger-causes economic growth or whether it is economic growth that Granger-causes electricity consumption. From a policy standpoint, the causal relationship between electricity consumption and economic growth has important implications (see Asafu-Adjaye, 2000; Ghosh, 2002; Paul and Bhattacharya, 2004; Narayan and Smyth, 2005; Narayan and Singh, 2007). A finding in favour of a positive unidirectional causality running from GDP to electricity consumption may imply that a country is not entirely dependent on electricity for its economic growth, and that energy conservation policies may be implemented with little or no adverse effects on economic growth. However, a unidirectional causality running from electricity consumption to economic growth implies that economic growth is dependent on electricity consumption and that a decrease in electricity consumption will inevitably lead to a decrease in real income, which may have a negative effect on employment and job creation (see also Narayan and Singh, 2007:1142). The latter outcome may have far-reaching implications

for a country like South Africa, which is currently targeting a sustained GDP growth rate of 6% by the year 2010. The finding of no causality in either direction, i.e. the so-called 'neutrality hypothesis', on the other hand, implies that energy conservation policies do not have a significant effect on economic growth (see Asafu-Adjaye, 2000; Paul and Bhattacharya, 2004).

Although the debate regarding the causal relationship between energy and economic growth has generated much literature in both developed and developing countries, the majority of the previous studies concentrated mainly on Asia and Latin America, affording sub-Saharan African countries either very little or no coverage at all. Even where such studies have been undertaken, the empirical findings on the direction of causality between electricity consumption and economic growth have been largely inconclusive. Previous studies on this subject, however, suffer from two major limitations. Firstly, some of the studies have over-relied on the cross-sectional data which cannot satisfactorily address the country-specific issues. Secondly, some studies have used a bivariate framework, and may, therefore, suffer from the omission of variables bias. In other words, the introduction of a third variable affecting both electricity consumption and economic growth in the bivariate framework may not only alter the direction of causality between the two variables, but also the magnitude of the estimate. It is against this backdrop that the current study attempts to examine the intertemporal causal relationship between electricity consumption and economic growth in South Africa by incorporating the rate of unemployment as an intermittent

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**Fig. 1.** Trends of energy consumption and economic growth during the period 1996–2006. Source: author's own computations from the World Development Indicators CD-ROM, 2007; International Energy Agency, 2008; IFS Yearbook, 2007.

variable in a bivariate framework—thereby creating a simple trivariate causality model.

The rest of the paper is structured as follows: Section 2 discusses the trends of electricity consumption and economic growth in South Africa. Section 3 presents the literature review, while Section 4 deals with the empirical model specification, estimation technique and the empirical analysis of the regression results. Section 5 concludes the study.

## 2. Electricity consumption and economic growth in South Africa

South Africa is considered to be the highest electricity producer and consumer in Africa. It is estimated that more than half of the electricity generated in Africa comes from South Africa. Likewise, the country is historically considered to have one of the highest electricity reserve margins. However, the reserve margin has recently decreased somewhat. For example, the electricity reserve margin in South Africa decreased from 25% in 2002 to 20% in 2004, and thereafter to 16% in 2006. The reserve margin estimate for 2008 is projected to be between 8–10%, which is far lower than the target set for the country, i.e. a minimum of 15%. The South African government attributes the unprecedented decline in the electricity reserve margin during the recent years to the robust economic growth and the associated demand for electricity. Indeed the electricity consumption, especially from the residential sector has increased phenomenally since 1994. The electric power consumption/capita, for example, increased from 3644.44 kWh in 1980 to 4433.59 kWh in 1995, and later to 4521.17 kWh in 1996 and 4642.91 kWh in 1997. Although the consumption decreased somewhat between 1997 and 1999, the consumption later increased to 4884.79 kWh in 2004. Currently, the electricity consumption/capita is estimated at about 5039.7 kWh.

It is also worth noting that South Africa has one of the lowest electricity prices in the world. Even after the recent increase in the electricity price, electricity in South Africa is still one of the cheapest in the world. The continued demand for electricity in South Africa and the need to restore a workable reserve margin forced Eskom, a parastatal responsible for the supply of electricity in South Africa, to embark on a number of interventions in early 2008, which included a national awareness campaign, among others. In some instances, load shedding

had to be used as the last resort in order to prevent a system-wide blackout. These interventions enabled Eskom to slightly bring the demand for electricity closer to its supply, while at the same time maintaining a reasonable reserve margin. Currently, the government is working on both medium and long-term programmes, which are meant to enable the country to cope with the future demand for electricity. At the same time, alternative sources of energy are being explored, in order to supplement the supply of electricity. Fig. 1 shows the trends of electricity consumption/capita vis-à-vis the trends of real GDP/capita during the period 1996–2006.

## 3. Literature review

The relationship between energy consumption and economic growth has been examined extensively in the literature since the seminal work of Kraft and Kraft (1978), but with conflicting results. Kraft and Kraft (1978), for example, while conducting a causality test between energy consumption and GNP for the USA, found evidence of a unidirectional causality running from GNP to energy consumption. However, studies conducted by Akarca and Long (1979, 1980) on the causal relationship between energy consumption and GNP for the USA, failed to confirm Kraft and Kraft's (1978) findings. Currently, four views exist in the literature regarding the relationship between energy consumption and economic growth (see Odhiambo, 2009). The first view argues that energy consumption Granger-causes economic growth. The second view argues that it is economic growth that drives the consumption of energy in many countries, and that as the economy grows the demand for energy from different sections of the economy automatically increases. The third view, however, maintains that both energy consumption and economic growth Granger-cause each other, i.e., that there is a bidirectional causality between energy consumption and economic growth. Finally, the fourth view maintains that there is no causality between energy consumption and economic growth. In other words, these studies assert that energy consumption and economic growth are neutral with respect to each other.

The empirical work that is consistent with the first view includes Yu and Choi (1985) for the case of The Philippines, Cheng (1997) for the case of Brazil, Chang et al. (2001) for the case of Taiwan, Soyta and

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