ELSEVIER

Energy Policy 34 (2006) 1106–1114

ENERGY POLICY

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Electricity consumption and economic growth: a time series experience for 17 African countries

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Available online 18 November 2004

Abstract

While the availability of electricity by itself is not a panacea for the economic and social problems facing Africa, the supply of electricity is nevertheless believed to be a necessary requirement for Africa's economic and social development. This paper tests the long-run and causal relationship between electricity consumption per capita and real gross domestic product (GDP) per capita for 17 African countries for the period 1971–2001 using a newly developed cointegration test proposed by Pesaran et al. (2001) and using a modified version of the Granger causality test due to Toda and Yamamoto (1995). The advantage of using these two approaches is that they both avoid the pre-testing bias associated with conventional unit root and cointegration tests. The empirical evidence shows that there was a long-run relationship between electricity consumption per capita and real GDP per capita for only 9 countries and Granger causality for only 12 countries. For 6 countries there was a positive uni-directional causality running from real GDP per capita to electricity consumption per capita; an opposite causality for 3 countries and bi-directional causality for the remaining 3 countries. The result should, however, be interpreted with care as electricity consumption accounts for less than 4% of total energy consumption in Africa and only grid-supplied electricity is taken into account.

Keywords: Africa; Electricity consumption; Causality

1. Introduction

Despite the immense energy potential Africa possesses, energy consumption in general and electricity consumption in particular is very low (Karekezi and Kimani, 2002; Economic Commission for Africa (ECA), 2004).[1] The average African is still using less energy than the average person used energy in England more than a century ago (Davidson and Sokona, 2002). The disparity in electricity consumption, let alone between Africa and the rest of the world even among African countries themselves, is glaring. Even more glaring is the wide disparity within African countries themselves. For instance, in Ghana 62% of the urban population has access to electricity while only 4% of the rural population has access to electricity (Saghir, 2002). Electrification rates range from as low as 3.7% in Uganda, 4.7% in Ethiopia and 5.0% in Malawi to as high as 45% in Ghana, 50% in the Ivory Coast and 66% in South Africa (International Energy Agency (International Energy Agency (IEA), 2002). Similarly, electricity power consumption per capita ranged from as high as 556 kWh in Zambia, 698 kWh in Gabon and 845 kWh in Zimbabwe to low as 22 kWh in Ethiopia, 47 kWh in the Democratic Republic of the Congo and 58 kWh in Tanzania (World Bank, 2003). The average per capita electricity consumption for Sub-Saharan Africa (excluding South Africa) was 112.8 kWh in 2000, representing a

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[1]The problem with Africa's electricity sector is not that of scarcity but the lack of "… institutions, rules, financing mechanisms, and regulations needed to make markets work in support of energy for sustainable development" (UNDP, 2004).

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doi:10.1016/j.enpol.2004.10.008

mere 5% of the world average.[2] With only 23% of its population electrified compared to the world average of 73%, Africa has the lowest electrification rate of any major world region (IEA, 2002). More than 500 million Africans are still without access to electricity. To make matters still worse, while the world electricity per capita consumption has been rising steadily over the past three decades, Sub-Saharan Africa's per capital electricity consumption has been stagnant. In fact, the electricity per capital consumption of Sub-Saharan African countries (excluding South Africa) declined from 132.6 kWh in 1980 to 112.8 kWh in 2000 (World Bank, 2003). To aggravate the problem further, less than 10% of the Sub-Saharan Africa population has access to electricity, with electricity largely confined to the energy-intensive sub-sector of the commercial and industrial enterprises and to the high-income households, while the electrification of the rural and urban poor is 'woefully inadequate' or non-existent (Karekezi, 2002). The number of people without electricity in Africa has doubled in rural areas and tripled in urban areas in the last 30 years. Most of the people without access to electricity in 2030 will still be in Sub-Saharan Africa (650 million) and South Asia (680 million) (IEA, 2002), with the population of Sub-Saharan Africa without electricity increasing steadily until 2025. It is estimated that at the rate of connections of the past decade, it would take more than 40 years to electrify South Asia and almost twice as long for Sub-Saharan Africa (IEA, 2002). If the transition to modern fuels is usually complete by the time per capita income reaches US$1000–1500 (Toman and Jemelkova, 2003), Sub-Saharan Africa has a long way to go: "… access to electricity for the poor is a dream that is unlikely to be realised in the near future" (Karekezi and Kimani, 2002).

The purpose of this paper is to investigate the long-run and causal relationship between electricity consumption and economic growth for 17 African countries using a newly developed cointegration test due to Pesaran et al. (2001) and using a modified version of the Granger causality test proposed by Toda and Yamamoto (1995). Cointegration is preferred over conventional methodology for two main reasons. In the first place, the relationship found using ordinary regression analysis of time series data could be spurious as the time series properties of the data are not taken into consideration. Granger and Newbold (1974) have shown that when using non-stationary data, standard statistical *t*- and *F*-tests are misleading. In a spurious regression, there is no relationship between the series under consideration. Tests of ordinary regression to time series data may often suggest a statistically significant relationship between variables, where none in fact exists. Cointegration provides a way of avoiding the misleading inference associated with a spurious regression (see Enders, 2004). Moreover, while the use of ordinary regression is useful in detecting correlation between two or more variables, it cannot detect whether there is a long-run or a casual relationship between or among the time series data under consideration; correlation does not imply causation. From a policy perspective, it is important to know the direction of causality, say, between energy consumption and economic development, so that energy conservation measures may or may not be taken depending on the direction of causality between energy consumption and economic growth.

Despite the burgeoning literature on the study of causality between electricity consumption and economic growth, there are not many time series studies concerning African countries (see Jumbe, 2004). Apart from filling this gap, we focus on electricity for two other reasons. While 89% of Sub-Saharan people rely for their energy consumption on biomass, long-term time series data for biomass are only available since 1994 (IEA, 2002). Electricity seems to be the only sub-sector where long-term time series data are available from the World Bank, World Development Indicators (2004), and this is one of the factors that motivated this paper. More importantly however, we focus on electricity because of the pivotal role it plays in economic development and technological progress. While the availability of electricity is not by itself a panacea for the economic and social problems facing Africa, the supply of electricity is nevertheless believed to be a necessary requirement for Africa's economic and social development (IEA, 2002). Even at the individual level, research shows that electricity service appears to be one of the most important services for improving the welfare of the poor individual (IEA, 2002). At the national level, in this era of the digital economy, it is really difficult to envisage development without the use of electricity. Electricity and other modern energy sources are necessary requirements for economic and social development (IEA, 2002). "No country in the world has succeeded in shaking loose from subsistence economy without access to the services of modern energy provides" (World Bank, n.d.). Apart from the physical availability of energy, change in the quality of energy service is one of the most important drivers of economic productivity (see Toman and Jemelkova, 2003). The process of economic development necessarily involves a transition from low levels of energy consumption to higher levels where the linkages among energy, other factor inputs and economic activity change significantly

[2]This contrasts with 40.8% for South Asia, 86.6% for Latin America and 89.6% for East Asia/China (International Energy Agency (IEA), 2002). The electricity power consumption kWh per capita was 456 for South Asia, 1493 for Latin America and 2159 for the world (see World Development Indicators (2004); African Development Indicators, 2004).