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Are fluctuations in electricity consumption per capita in Sub-Saharan Africa countries transitory or permanent?

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ABSTRACT

This paper examines the random walk hypothesis for electricity consumption in sub-Saharan Africa countries over the period 1971–2013 by applying univariate and panel unit root tests. In addition to the first and second generation panel unit root tests, we apply the recent Lagrange Multiplier (LM) panel unit root test developed by Im, Lee and Tieslau, (2005). This test does not suffer from bias and spurious rejection because it allows for structural breaks in the intercept and slope. The empirical results of the LM unit root tests show that stationarity in electricity consumption is found in 11 of the 17 countries, which corroborates the findings of the first and second generation panel unit root tests. These results indicate that any shock to electricity consumption has a transitory impact for almost all sub-Saharan Africa countries implying that electricity demand will return to its time trend. Failure to reject the unit root hypothesis for the previous studies may be the result of a loss of power to allow for possible structural breaks.

1. Introduction

Electricity consumption per capita is both a driver and implication of economic development [1,2]. The importance of electricity supply in human activities and economic development cannot be over-emphasised. Access to electricity is essential for economic, social, political and human development [3]. Economic growth and development rely on sufficient and reliable supply of electricity. Electricity is used in homes, businesses and industries. Individuals and businesses use electricity to power their computers, lights and electrical appliances. Industries use electricity to power their machines and production processes. Thus, electricity is an indispensable input in every facet of human life, and improving access to electricity supply is necessary for advancing and sustaining the current quality of life.

However despite the importance of electricity consumption in human life and economic advancement, developing countries including those in Sub-Saharan Africa still have limited access to reliable and adequate supply; and this has largely undermined development efforts in these countries [4]. Based on available data from the World Bank database, countries in Sub-Saharan Africa have the lowest electricity consumption per capita among developing regions despite the enormous energy resources in the region. For instance, despite being one of the largest producers of fossil fuel in the world, Nigeria ranks among the lowest in terms of electricity consumption per capita (149 kWh in 2011). This is extremely low compared to other oil producing developing countries such as Ecuador (1192 kWh), Iran (2649 kWh) and Venezuela (3313 kWh). This is the case with most Sub-Saharan African countries.

As a result of the current situation, energy economists and development experts are making efforts and initiating policies to improve electricity consumption per capita in Sub-Saharan Africa in a bid to enhance the development prospects of the region. In fact, recent research shows that developing countries, including Sub-Saharan Africa, championed by the BRICS nations, will account for major increase in global energy consumption in the future [5]. However, the economies of Sub-Saharan Africa countries are highly vulnerability to both domestic and external shocks such as natural disasters, wars and political instabilities, domestic economic policies and developments, and developments in the global economy [6]. Particularly, the energy sector is vulnerable to policy shocks, natural disasters, continuous economic growth, and developments in the global energy markets, technological invention and

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economic and political instability, and these shocks are cyclically transmitted to the aggregate economy [7,8]. Given this background, there is need to investigate whether shocks to electricity consumption per capita in the region has permanent or temporary effects.

The stationarity properties of electricity consumption per capita indicates whether shocks to electricity consumption per capita have temporary or permanent effects. According to [9]; the effects of fluctuations to energy consumption will be temporary with time, and shocks to energy consumption will have transitory impact if the series of energy consumption is stationary at level. The impacts are eliminated once the series of energy consumption returns to their long run path. As a result, the series of energy consumption can be used to make forecast for the future. Conversely, the effects of fluctuations to energy consumption will be permanent, and shocks to energy consumption will have unending impact if the series of energy consumption is not stationary. Making forecast with such series of energy consumption will result in unreliable projections [10].

A number of studies have investigated the stationary properties of energy consumption in different countries using numerous approaches. [9–23] and [24] made it a subject of their works (See details in Table 1). However, the findings of the studies are conflicting, and this is largely due to the different techniques applied by the studies. In addition, majority of the studies except very few like [9,10,20,24] and others do not consider structural breaks which are very crucial given the vulnerability of the energy sector to economic and non-economic shocks. Besides, those that account for structural breaks mostly focus on developed countries, and their results may not be absolutely applicable to developing countries. [9] and [10] examine the stationarity properties of electricity and coal energy consumption respectively in both developed and developing countries but the results of their studies may be undermined by sample selection bias.

The contribution of this present study is threefold. First, it considers Sub-Saharan Africa – a region that has been largely neglected in this area of research. The situation of electricity access in the region is the worst in the world. After three decades, the demand for electricity will reach four times what was used in 2010 to achieve increase in GDP, population and urbanization. Second, this paper addresses the problem of sample selection bias because all Sub-Saharan Africa countries were considered subject to data availability. By using heterogeneous panel unit root tests, we can remove the impact of certain forms of omitted variables bias in regression results. Thirdly, it considers structural breaks based on the understanding of the vulnerability of Sub-Saharan Africa economies and particularly the energy sector to economic and non-economic shocks. One way to increase the power of standards panel unit root tests is to use the panel LM unit root test that allows for a finite number of level shifts [31]. This test has the advantage of providing more robust and reliable results because the endogenous break dates can be estimated consistently and it is free of nuisance parameters. Thus, the main objective of this study is to examine whether fluctuations in electricity consumption per capita in Sub-Saharan Africa is transitory or permanent.

The remainder of the paper is organised as follows: Section-2 describes the data and methodology adopted in the study. Section-3 presents and discusses the empirical results. Section-4 is the conclusion and policy recommendations.

2. Overview of electricity consumption in sub-Saharan Africa

Electricity consumption in Sub-Saharan Africa is the lowest in the world, even among other developing regions like South-east Asia, South Asia and Latin America. This mirrors the level of social and economic development of the region. Electricity consumption in the whole of Sub-Saharan Africa in 2011 (354, 714, 000,000 kWh) is only 8% of the level of consumption in China (4,432,901,000,000 kWh) in the same period. In terms of electricity consumption per capita, the region has 535 kWh in 2011 compared to China's 1123 kWh despite a slight difference in population levels. Fig. 1 shows the comparison between electricity consumption and electricity consumption per capita in other developing regions of the world.

It is clear that Sub-Saharan Africa lags behind other developing regions of the world in terms of electricity consumption. The level of electricity consumption in Sub-Sahara Africa stands at 354, 714, 000 kWh compared to 5,061,426,000,000 kWh in East Asia and the Pacific; 793,873,000 kWh in Europe and Central Asia; 1,136,688,000,000 kWh in Latin America and the Caribbean; 557,967,000,000 kWh in Middle East and North Africa; and 967,172,000,000 kWh in South Asia.

Fig. 2 shows the comparison of electricity consumption per capita in developing regions. Sub-Saharan Africa maintains the lowest level at 535 kWh compared to 2582 kWh in East Asia and the Pacific; 2955 kWh in Europe and Central Asia; 1985 kWh in Latin America and the Caribbean; 1696 kWh in the Middle East and North Africa; and 605 kWh in South Asia. The data indicates that taking population levels into consideration, residents of Sub-Saharan Africa countries enjoy less electricity compared to their

Table 1
Summary of literature survey on stationarity properties of energy series.

Authors	Time period	Unit root test	Conclusion
[11]	1954–2003	Zivot and Andrews structural break test	Unit root exists
[12]	1971–2002	Univariate and IPS panel tests	Unit root exists
[14]	1979–2000	Univariate and IPS panel tests	Stationarity exists
[13]	1971–200	Carrion-Silvestre multiple test	Stationarity exists
[15]	1971–2003	Panel seemingly unrelated regressions ADF	Unit root exists
[17]	1980–2005	LLC, IPS and Maddalae Wu (MW) panel tests and CIP test	Mixed results
[16]	1973–2008	Long memory test	Mixed results
[19]	1973–2007	Lee and Strazcich two structural break test	Stationarity exists
[18]	1982–2007	LM structural break test	Stationarity exists
[20]	1970–2006	Lee and Strazicich two structural break test	Stationarity exists
[21]	1980–2006	Kapetanios et al. non-linear test	Mixed results
[22]	1960–2008	LM structural break test	Mixed results
[23]	1970–2006	LM structural break test	Stationarity exists
[24]	1960–2005	LM structural break test	Stationarity exists
[9]	1971–2010	Lee and Strazicich two structural break test	Stationarity exists
[10]	1965–2010	Lee and Strazicich two structural break test	Stationarity exists

Source: [9]