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What drives energy consumption in developing countries? The experience of selected African countries

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HIGHLIGHTS

- Key drivers of energy use in 12 African countries are examined.
- Economic growth, industrial GDP, population and urbanization play a leading role in explaining energy use.
- Urbanization has a positive effect on energy use in six countries and a negative effect in four countries.
- The results obtained have useful policy implications.

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ABSTRACT

This study investigates the drivers of energy consumption in Sub-Saharan African countries. It applies the bounds testing approach to cointegration to time series data at individual country levels over the period from 1970 to 2011. The study finds that energy consumption is cointegrated with real GDP per capita, industrial output, imports, foreign direct investment, credit to private sector, urbanization and population. Furthermore, the sign and magnitude of long-run estimates vary significantly for a single country and across countries depending on the energy consumption variable used. Overall, the findings confirm the leading role of economic growth, industrial output, population and urbanization. Economic growth, industrial output and population have positive effects on energy consumption in the majority of countries. Given the urgent need to address climate change, African countries should adopt policies to improve energy efficiency and accelerate transition toward renewable energy. The African Renewable Energy Initiative launched at the 21st session of the United Nations Conference of the Parties (COP21) is an opportunity for African countries to provide and maintain widespread access to reliable and affordable environmentally cleaner energy to meet the requirements of rapid economic growth and improved living standards.

1. Introduction

Energy has become the lifeblood of all modern economies. It drives the wheels of economic growth as it is a key factor of production of almost all goods and services, along with capital and labor. In addition, there are existing empirical studies that have further highlighted the contribution of energy in economic growth (see Narayan and Smith (2008), Odhiambo (2009), Wolde-Rufael (2009), among others). Therefore, insufficient supply of energy will affect all aspects of economic and social development. On the other hand, energy use is regarded as the major underlying cause of greenhouse gas emissions and global warming. According to the World Resources Institute, 61.4% of total greenhouse gas emissions come from the energy sector (Sadorsky, 2010). The projections of the Energy Information Agency indicated that energy demand is expected to increase considerably in the coming years as the result of population growth and economic development (EIA, 2007). The bulk of this increase will take place in developing countries where the share of energy consumption will increase from 46% to 58% between 2004 and 2040. Energy consumption in developing countries is projected to grow at 3% per year, while energy demand in industrialized countries will grow at 0.9% per year. The bulk of the increase in the global energy consumption is generated from non-renewable energy, specially oil, coal and gas. These trends do not take into account recent and future energy policies in support of the development of alternative energy. The 21st session of the United Nations Conference of the Parties (COP21) held in Paris in December 2015 is a major milestone in efforts to combat climate change. According to the projections of the International Energy Agency, COP21 pledges provide a boost to lower-carbon fuels and technologies, increasing the share of non-fossil

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Table 1
Results of bounds test for cointegration.

	Lags structure (m_1, m_2, m_3, m_4, m_5, m_6, m_7)	*F*-stat	Case	5% exact critical values		Cointegration?
				I(0)	*I*(1)	
Benin	(0,5,5,0,0,5,0)	26.536	1	2.312	2.659	Yes
Cameroon	(2,0,2,2,0,2,2)	10.152	4	3.048	4.281	Yes
Congo, Rep.	(1,5,4,0,0,0,0)	8.574	4	3.048	4.281	Yes
Congo DR	(0,4,0,0,0,0,1)	23.032	3	2.795	4.193	Yes
Cote d'Ivoire	(4,1,5,0,0,0,0)	30.309	1	2.312	2.659	Yes
Gabon	(2,3,0,4,0,0,1)	8.467	3	2.795	4.193	Yes
Ghana	(3,4,0,1,2,5,5)	23.974	3	2.795	4.193	Yes
Kenya	(0,0,0,0,0,0,4)	5.295	3	2.795	4.193	Yes
Nigeria	(0,0,0,4,3,0,0)	4.842	3	2.981	4.508	Yes
Senegal	(3,5,0,0,0,5,0)	13.167	3	2.964	4.435	Yes
South Africa	(0,0,0,5,4,1,3)	14.858	3	2.795	4.193	Yes
Togo	(3,3,5,0,0,0,0)	10.184	3	2.795	4.193	Yes

Note: Lag length on each variable is selected using the general-to-specific approach, with maximum lag set to five. Critical values for *F*-statistics are calculated using stochastic simulations based on 40,000 replications.

Table 2
Long-run determinants of energy consumption per capita.

	GDP	M	FDI	IND	FD	URB
Benin	−2.210*	0.047*	−0.028*	0.057*	0.006*	0.088*
	(−9.210)	(2.714)	(−3.090)	(3.716)	(2.821)	(4.164)
Cameroon	0.256*	−0.010*	0.025*	0.002*	−0.003*	0.007
	(4.660)	(−7.272)	(4.587)	(3.120)	(−5.922)	(1.141)
Congo, Rep.	1.928*	−0.004*	−0.003	0.002	−0.002	−0.197*
	(7.324)	(−2.502)	(−1.246)	(0.533)	(0.562)	(−6.358)
Congo DR	0.130*	0.001	−0.002	−0.001	−0.001*	0.011*
	(3.853)	(1.285)	(−1.177)	(−1.116)	(−3.480)	(2.373)
Côte d'Ivoire	0.893*	−0.002	−0.037*	0.004	−0.014*	−0.000
	(30.989)	(−0.515)	(−4.256)	(1.115)	(−5.405)	(−0.850)
Gabon	0.569*	−0.001	0.012*	0.005*	−0.011*	−0.030*
	(2.804)	(−0.141)	(3.339)	(3.655)	(−2.157)	(−7.159)
Ghana	0.763*	0.001*	−0.008*	0.003*	−0.021*	0.003*
	(18.626)	(8.097)	(−18.994)	(9.136)	(−25.077)	(5.392)
Kenya	0.222	−0.001	−0.023*	0.001	−0.002	−0.005*
	(0.921)	(−0.705)	(−2.221)	(0.187)	(−1.182)	(−2.467)
Nigeria	0.048	0.002**	−0.017*	0.003*	−0.003*	−0.001
	(1.510)	(1.932)	(−5.600)	(2.493)	(−6.058)	(−0.218)
Senegal	0.479	0.006*	−0.029*	−0.009	−0.005	−0.001
	(1.043)	(3.648)	(−3.820)	(−1.006)	(−1.744)	(−0.085)
South Africa	0.472**	0.010*	−0.091*	−0.005	−0.006*	0.048*
	(1.865)	(2.260)	(−4.556)	(−0.642)	(−2.709)	(3.112)
Togo	0.519*	−0.008*	0.011	−0.012	−0.001	0.023*
	(2.331)	(−2.214)	(1.506)	(−1.681)	(−0.207)	(2.068)

Notes: Figures in parenthesis are *t*-statistics.
* Denote statistical significance at the 5%.
** 10% levels, respectively.

fuels from 19% of the global energy mix today to 25% in 2040 (IEA, 2015). However they do not alter the picture of rising global needs for energy. Energy consumption is expected to grow by one-third to 2040, driven primarily by Asian and African countries. Energy efficiency will play a critical role in limiting world energy demand growth to one-third by 2040. The transition to renewable energy combined with improved energy efficiency could help lower global emissions (IEA, 2015; IRENA, 2015; IRENA and C2E2, 2015).

The objective of this study is to investigate the key determinants of energy consumption in 12 Sub-Saharan African countries. A growing body of empirical studies has investigated this topic, the energy–GDP nexus being the most widely examined. Results from these studies are however mixed and controversial across countries, data, energy variables and modeling techniques (see Ozturk (2010), Narayan et al. (2010), Omri (2015), for a review). Sub-Saharan Africa is an interesting case study given that air pollution is now becoming a subject of great concern for policy makers and environmentalists given the significant rise in pollutant emissions in recent years. More than 75% of the population in Sub-Saharan Africa relies on energy sources which are polluting, and indoor air pollution associated with solid fuels use is responsible for more than 4000 premature deaths per day (IEA, 2006). On the other hand, many Sub-Saharan African countries have been experiencing periodic power shortages for the past two decades and one of the main reasons has been the inability to forecast the rapid growth in energy consumption and to make the required investments. The extent of power shortages has become acute in recent years due to increasing demand from growing population and urbanization. Inadequate provision of modern energy infrastructures and services has long been cited as a major constraint to economic growth and poverty alleviation efforts (World Bank, 1994; UNECA, 2004). During COP21 Africa has pledged its support for renewables by announcing the launch of the African Renewable Energy Initiative (AREI). The overall goal of