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The relationship between woody biomass consumption and economic growth: Nonlinear ARDL and causality

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ABSTRACT

In this paper, the structure of the relationship between woody biomass energy consumption and real per Capita GDP was analyzed in the period of 1980–2012 for the selected African countries by ARDL (Autoregressive Distributed Lag), nonlinear ARDL, Granger causality and forecast error variance decomposition methods. After a symmetric relationship between woody biomass energy consumption and economic growth was determined by the nonlinear ARDL (NARDL) model, ARDL and Granger Causality methods were applied. According to results of the Granger Causality method, there is a unidirectional causality running from economic growth to woody biomass energy consumption for Botswana, Cameroon, Uganda, and Zambia and from woody biomass energy consumption to economic growth for Burkina Faso, Malawi, Central African Republic, Namibia, Côte d'Ivoire, Djibouti, Gabon and Zimbabwe. The bidirectional causality was supported for Kenya, Lesotho, Madagascar and Togo. Lastly, forecast error variance decomposition method was applied to support the results obtained from Granger Causality method. The forecast error variance decomposition results of real per Capita GDP and woody biomass energy consumption showed that woody biomass energy and real per Capita GDP made the important contribution to the forecast error variance of itself and each other.

Introduction

Biomass is a substantial source which is generally found in the nature, abundantly and free and meets world's energy needs in various areas such as heating, cooking, industrial productions. Biomass energy from forests embodies two different types of sources: biomass from wood and residues (logging residues, processing, wood wastes) (Holm-Nielsen and Ehimen, 2016). Woody biomass, including potential of merchantable or non-merchantable wood, offers opportunities for national and regional biomass energy supplies. However, despite the widespread advantage of woody biomass, availability of which, diminishes over time because of forest land scarcity and the rate of forest growth (Galik et al., 2009).

From the perspective of this paper, woody biomass is one of the most important source of energy in the world. Wood and charcoal are basic and essential alternatives of cooking and heating sources in poor countries (EIA, 2016). Woody biomass energy has large scales of usage potential (Lauri et al., 2014).

Almost 81% of the Sub-Saharan African population depends on woody biomass energy consumption for cooking; this ratio is far more than the other part of the world. Especially in Burundi, Burkina Faso, Central African Republic, Chad, Liberia, Rwanda, the Gambia, Uganda and Sierra Leona, over 90% of the population lacks access to modern energy and a poor population needs woody biomass energy, essentially for cooking. While the other types of energy resources help to satisfy additional energy needs for the world, a vast majority of Sub-Saharan African countries proceed to consume woody biomass energy to meet their energy needs. Additionally, the woody biomass energy sector provides a substantial alternative to employment for the poor segment of society which generally does not have a chance of achieving a standard of formal employment (AFREA, 2011).

Many African countries have a high rate of woody consumption, but some of them are oil export countries. Especially in Angola and Nigeria, oil production is highly extensive and provides almost 75% of the region's oil production. Nigeria and Cameroon who have a relatively small scale of oil production consists of exception in Sub-Saharan African countries. As a differentiation from other oil

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Table 1
Biomass energy consumption and economic growth.

Study	Country(ies) and Period	Variables	Methodology	Result(s)
Payne (2011)	USA (1949–2007)	BEC; Y	ARDL; Toda-Yamamoto Causality	Growth Hypothesis
Bildirici (2012)	Argentina, Bolivia, Brazil, Chile, Colombia, Jamaica, and Guatemala (1980–2009)	Y; BEC	ARDL model; Granger Causality	Growth Hypothesis in Bolivia, Brazil, Chile, Colombia, and Guatemala
Bildirici (2013)	10 developing and emerging economies (1980–2009)	Y; BEC	ARDL model; Granger Causality	Feedback hypothesis except Paraguay.
Bildirici and Ozaksoy (2013)	10 Countries (1960–2010)	Y; BEC	ARDL model; Granger Causality	Feedback hypothesis
Bildirici (2014)	Transition countries (1990–2011)	Y; BEC	PARDL model; Granger Causality	Feedback hypothesis
Bildirici and Ozaksoy (2014a)	Transition countries (1980–2011)	Y; BEC	ARDL; Granger Causality	Conversation hypothesis for Croatia, Hungary, Slovenia and Slovakia; Growth Hypothesis for Bulgaria and Romania.
Bildirici and Ozaksoy (2014b)	USA (1973–2012)	OP; BEC; Y	NARDL; Nonlinear Causality	There is uni-directional Causality between OP and BEC in asymmetric cases.
Bildirici and Ersin (2014)	10 Countries (1970–2013)	BEC; OP; Y	ARDL; Granger Causality; Toda and Yamamato	Feedback and Conservation Hypothesis
Bilgili and Öztürk (2015)	G7 Countries (1980–2009)	Y; CS; HC; BEC	Panel Models	Growth Hypothesis
Öztürk and Bilgili (2015)	51 Sub-Saharan African Countries (1980–2009)	Y; BEC	Panel Analysis	Growth Hypothesis
Shahbaz et al. (2016)	BRICS Region (1991–2015)	Y; BEC; C; TO	Panel Models	Feedback Hypothesis

The abbreviations are: CO_2 Emissions (CO_2), Real GDP (Y), Real Oil Price (OP), Biomass Energy Consumption (BEC), Capital Stock (CS), Human Capital (HC), Capital Use (C), Autoregressive Distribution Lag (ARDL), Nonlinear Autoregressive Distribution Lag (NARDL), Panel Autoregressive Distribution Lag (PARDL), Dynamic OLS (DOLS), Fully Modified OLS (FMOLS).

export countries as Saudi Arabia, Iran, Russian etc. in these African countries, woody biomass energy consumption is a very important energy source.

This paper analyses the relationship between economic growth and woody biomass energy consumption in 20 African countries by the nonlinear ARDL model. For analysed 20 African countries, woody biomass energy consumption is a very important energy source. So 80% of the total energy consumption comprises of woody biomass energy consumption in Africa (IEA, 2006, 2010; AFREA, 2011), the ratio raises to approximately 98% in some districts. In this perspective, the causal relationship between economic growth and woody biomass energy consumption will be analysed the cointegration and a causal relationship by using the Autoregressive distributive lag(ARDL), Granger Causality methods and the forecast-error variance decomposition technique, because it is important to identify the direction of causality and long-term coefficients for each of the analyzed countries. This point of view makes significant contributions, especially in the context of energy politics proposals. The relation between economic growth and woody biomass consumption is applied by three stages. Firstly, it is used the nonlinear ARDL method and ARDL approach. Secondly, the Granger causality method is applied. Thirdly, the forecast-error variance decomposition technique proposed by Pesaran and Shin (1998) is utilized to test the strength of the causality analysis. The forecast-error variances of real perCapita GDP and woody biomass energy consumption is decomposed into proportions which are attributed as shocks in all variables in the system including the real per Capita GDP itself.

The literature review is located in the second section. The economic background of woody biomass energy consumption in Sub-Saharan Africa is shown in third section. In the fourth section, econometric theory and methodology are identified. Finally, the fifth section consists of the empirical results while the last section includes the conclusion and policy implications.

Literature review

The papers that examine the relationship between woody biomass energy consumption and economic growth are very scarce. Bildirici and Ozaksoy (2016) examined the relationship for eight of the Sub-Saharan African Countries from the period of 1980–2013 by using ARDL and Granger Causality methods. Accordingly, there is unidirectional causality from woody biomass energy consumption to economic growth for Angola, Guinea-Bissau and Nigeria; from economic growth to woody biomass energy consumption for Seychelles. The bidirectional relationship is supported for Benin, Mauritania, Nigeria and South Africa.

Although the tested papers relationship between woody biomass energy consumption and economic growth are very scarce, energy literature has a number of studies which examines the relationship between biomass energy consumption and economic growth as shown in Table 1.

These papers were generally used with the ARDL and Panel cointegration methods. It used the ARDL method to analyse the relationship between biomass energy consumption and economic growth (Bildirici (2012), Bildirici (2013), Bildirici and Ozaksoy (2013, 2014a), Bildirici and Ersin (2014) and Aslan (2016)). Some of them analyzed the relationship by Panel data analyzes (Bildirici (2014), Bilgili and Öztürk (2015), Öztürk and Bilgili (2015), Shahbaz et al. (2016).

Woody biomass energy consumption in Sub-Saharan africa

Nearly two million people live almost within US$1 purchasing power a day which has the same number of consuming energy on the global scale (FAO COFO, 2005; AFREA, 2011). Especially Sub-Saharan Africa, almost 80% of the people live without electricity in rural areas because accessing electricity in rural regions is more than seven times costly in urban regions. Therefore, while 89%, 81% and 66% of the total energy consumption comprises of woody