Applied Energy 137 (2015) 110–116

Contents lists available at ScienceDirect

Applied Energy

journal homepage: www.elsevier.com/locate/apenergy

Economic growth and biomass consumption nexus: Dynamic panel analysis for Sub-Sahara African countries

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HIGHLIGHTS

- We examine long run dynamics of biomass energy consumption and GDP growth for 51 Sub-Sahara African countries.
- The paper finds significant effect of biomass consumption on GDP in 51 Africa countries.
- Economic growth is affected by biomass consumption, openness and population.

ARTICLE INFO

Article history:
Received 7 June 2014
Received in revised form 28 August 2014
Accepted 4 October 2014

Keywords:
GDP growth
Biomass consumption
Panel data

ABSTRACT

This paper investigates the long run dynamics of economic growth and biomass consumption nexus by applying dynamic panel analyses for 51 Sub-Sahara African countries for 1980–2009 period. The results show that economic growth is affected by biomass consumption, openness and population significantly and positively in African countries. GDP elasticity with respect to biomass consumption is close to unity and the elasticities of GDP in terms of openness are found statistically significant (between 0.259 and 0.348). According to homogeneous variance structure, one percent increase in variables of biomass, openness and population will lead GDP to increase by 1.818%, 0.269% and 0.676%, respectively. However, according to estimations from heterogeneous variance structure indicate that one percent increase in biomass, openness and population variables will cause GDP to increase by 0.820%, 0.259% and 0.811%, respectively. In conclusion, this paper finds significant effect of biomass consumption on GDP in 51 Africa countries.

Introduction

Energy plays a vital role for all countries in the world. Fluctuations in energy prices, energy dependency, environmental problems, climate change, energy security and limited fossil energy sources have forced countries to replace fossil energy sources with renewable and sustainable energy sources. Thus, renewable energy, especially biomass has been accepted as a new energy source for sustainable development in the world. In addition, increases in the greenhouse gases (GHGs) have renewed concerted interest in renewable energy to safeguard the environment to mitigate the impacts of climate change.

The majority of people in Sub-Sahara Africa (SSA) exceedingly depend on biomass, especially combustibles for primary energy generation for domestic cooking and heating purposes. Therefore, biomass is one of the prime sources of renewable energy in SSA which is used mostly by low income earners.

Some recent works emphasize (i) the negative impact of biomass usage on Green House Gas emission (GHG), (ii) and/or considerable cost of energy production from biomass, (iii) and/or positive effect of biomass on GHG. Bilgili [1] following US data yields negative impact of biomass consumption on GHG and positive influence of fuel usage on GHG. Khanna et al. [2] employing Illinois data emphasize the potential role of biofuels in mitigating the carbon emission. Acaroglu and Aydogan [3] considering Turkish data indicate both significant role of biofuels consumption in mitigating GHG and remarkable cost of biofuels production from vegetable oils, animal fats and energy crops. Fischer et al. [4] observing EU data concludes that efficiency of biomass is subject to change from country to country depending on land use efficiency and first or second generation feedstock and sustainability of feedstock. Reinhardt and von Falkenstein [5] explore that,

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http://dx.doi.org/10.1016/j.apenergy.2014.10.017
0306-2619/

although biofuels have some negative effects on environment in terms of GHG, the biofuels are considered favorable in comparison with their fossil alternatives.

This paper mainly considers the effect of biomass consumption, among other renewable consumption, on GDP growth in Sub-Saharan Africa since biomass is main primary energy source in this continent. IEA [6] and Stecher et al. [7] reveal the shares of energy sources within total primary energy supply in Sub-Saharan Africa. In terms of 2009, these energy sources and their shares in parentheses are solid biofuels (61%), other renewables (0.2%), coal and peat (19.7%), oil (14.1%), natural gas (2.7%), nuclear (0.6%) and hydro (1.4%), respectively [7]. Stecher et al. [7], hence, consider biomass favorable and primary source of total energy supply among other energy sources in Sub-Sahara African countries.

Biomass energy, mainly through wood and charcoal, represents approximatively 80% of the total energy consumption in Sub-Saharan Africa, and up to the equivalent of one third of the total household economy. Wood is the largest biomass energy resource used today but biomass sources include also tree and grass crops and forestry, agricultural, and urban wastes. Biomass is by far the main source of household fuel in Africa. In comparison, biomass accounts for about 3% of final energy consumption in OECD countries. In Sub-Saharan Africa, biomass is used by a large majority of the population to meet its energy needs, from a 68% in Kenya and up to a 94% in Burundi. Also, 80–90% of the residential energy needs of low-income households are met by traditional biomass, mostly fuel wood or charcoal. Internationally, the total number of people relying on traditional biomass as a source of heating and cooking fuel went from an estimation of just under 2.4 billion people in 2002 and should, with 8% increase, reach 2.6 billion in 2030. This figure is due to the important growth of biomass use in Africa, as the number is to increase from 646 to 996 million in the same period (54% increase).[1] In Africa, a total of 657 million people (80% of the population) rely on the traditional use of biomass for cooking. The IEA [8,9] estimates that the total final consumption biomass/waste share will lie between 51% and 57% by 2035 depending on which scenarios are assumed. The total primary energy demand (TPED) for Africa is predominantly determined by biomass demand with almost half of the energy demand being covered by biomass and waste [9].

Growing interest for biomass energy is driven by the fact among others it contributes to poverty reduction in under developed and developing countries and increase rural employment (biomass production is labor intensive). As also mentioned by Mohammed et al. [10], biomass consumption in SSA varies from country to country depending on the national access to electricity, resources availability and renewable energy policy. The rate of biomass consumption in SSA cannot be likened to any other renewable energy sources because biomass is considered the most easily acquired energy resource available for people from substandard economic backgrounds. The study of Mohammed et al. [10] presented a detailed information about the status of renewable energy consumption and developmental challenges in Sub-Sahara Africa.

Eventually, the aim of this study is to estimate the relationship between biomass energy consumption and economic growth in 51 Sub-Sahara Africa countries for 1980–2009 period. The panel unit root analyses, panel cointegration analyses, conventional OLS and dynamic OLS (DOLS) analyses are run throughout homogeneous and heterogeneous variance structures of the panel data to investigate the relations between the variables.

This study is a complementary to the previous works and it differs from the existing literature of energy economics in many aspects. First, it is the first study in the literature that analyzes the causal relationship between biomass energy consumption and economic growth for the analyzed countries. Second, it considers both homogeneous and heterogeneous variance structures for the panel estimations and by following dynamic OLS methodology as well as conventional OLS methodology for panel data. Third, it employed multivariate model rather than bivariate by adding population and openness variables into the model.

The rest of the paper is organized as follows: In the second section of the study, literature review is presented. Econometric methodology and data are given in Section "Econometric methodology and data". Section "Estimation results" consists of the empirical results, while the last section includes conclusions and policy implications.

Literature review

The relation between energy consumption and economic growth in the context of causality has been investigated in many studies during last two decade. An extensive literature survey of these studies can be seen in the study of Ozturk [11]. The empirical results of the studies which investigate the relationship between these variables are sometimes inconsistent with each other due to the using different data sets, alternative econometric methodologies and different countries' characteristics.

In recent years, the causal relationship between renewable energy consumption and economic growth was investigated in some countries and regions (see Table 1). But there is not any study related with the Sub-Sahara Africa region that investigates relationship between renewable energy consumption and economic growth. Thus, this paper will contribute the literature by filling this gap.

When we analyzed the previous studies shown in Table 1, we found that in the most studies the bidirectional causality is relationship is confirmed. In other words the feedback hypothesis is valid in most cases. *The feedback hypothesis* is supported if there exists bi-directional causality between energy consumption and economic growth. The meaning of the feedback hypothesis is that the energy consumption and GDP are jointly determined and affect each other.

Econometric methodology and data

Econometric methodology

Econometric methodology follows panel unit root analyses under the assumptions of common autoregressive (AR) and individual AR processes, considers panel common AR and individual AR cointegration analyses and employs panel Dynamic Ordinary Least Squares (DOLS) analyses under the both homogeneous and heterogeneous variance structures. Following Eq. (1) below, one concludes that panel data $\{y_{it}\}$ follows unit root process if $|\gamma_i| \geqslant 1$.

$$y_{it} = c_i + \gamma_i y_{it-1} + e_{it}, \quad i = 1, 2, \ldots, N \text{ and } t = 1, 2, \ldots, T. \tag{1}$$

An augmented form of Eq. (1) can be written as is in Eq. (2). Panel data $\{y_{it}\}$ follows unit root process if $\rho_i = (\gamma_i - 1) = 0$.

$$(1 - L)y_{it} = (y_{it} - y_{it-1}) = \rho_i y_{it-1} + \varphi_i w_{it} + e_{it} \tag{2}$$

where L is lag operator and w_{it} represents the variables of individual constants and/or trends of *i*th section at time *t*. The common AR unit root null hypothesis or within dimension indicates that $H_0 : \rho_i = \rho = 0$, for all *i*. The individual AR null hypothesis or between dimension assumes that $H_0 : \rho_i = 0$, for all *i*. When the probability of null hypothesis falls into non-rejection area, one can declare that panel data does not follow stationary process [12–15].

[1] http://ec.europa.eu/europeaid/where/acp/regional-cooperation/energy/documents/biomass_position_paper_en.pdf.