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Output, renewable energy consumption and trade in Africa

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HIGHLIGHTS

- We examine the relationship between renewable energy consumption, trade and output in African countries.
- There is a bidirectional causality between output and trade in both the short and long-run.
- In the short-run, there is no causality between renewable energy consumption and trade or output.
- In the long-run, renewable energy consumption and trade have a statistically significant positive impact on output.
- African authorities should encourage trade openness because of its positive impact on technology transfer and on output.

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ABSTRACT

We use panel cointegration techniques to examine the relationship between renewable energy consumption, trade and output in a sample of 11 African countries covering the period 1980–2008. The results from panel error correction model reveal that there is evidence of a bidirectional causality between output and exports and between output and imports in both the short and long-run. However, in the short-run, there is no evidence of causality between output and renewable energy consumption and between trade (exports or imports) and renewable energy consumption. Also, in the long-run, there is no causality running from output or trade to renewable energy. In the long-run, our estimations show that renewable energy consumption and trade have a statistically significant and positive impact on output. Our energy policy recommendations are that national authorities should design appropriate fiscal incentives to encourage the use of renewable energies, create more regional economic integration for renewable energy technologies, and encourage trade openness because of its positive impact on technology transfer and on output.

1. Introduction

The interaction between international trade and renewable energy consumption has not been previously studied, and it is the aim of the present paper which considers a panel of African countries. Nevertheless, it is accepted that the use of renewable energy is linked to the transfer of technology which is directly linked to international trade. It was recognized by both the Rio and Johannesburg conferences that trade helps achieving more efficient allocation of scarce resources, makes it easier for countries, rich and poor, to access environmental goods, services and technologies (World Trade Organization, 2011).

There are several empirical studies analyzing the causal relationship between economic growth and the consumption of renewable energy (e.g. Apergis and Payne, 2010a, 2010b, 2011, 2012; Sadorsky, 2009b). Other papers analyze the causal relationship between economic growth, renewable energy consumption and CO_2 emissions (e.g. Sadorsky, 2009a). All these studies prove that renewable energy consumption plays a vital role for increasing economic growth, and an energy policy planned to increase the share of renewable energy in total energy consumption is very effective in reducing greenhouse gas emissions. Capital, labor, and renewable energy consumption are not the only factors determining economic growth. Indeed, there are other factors that can be incorporated in the production function to explain the growth of gross domestic product (GDP) such as trade openness. This latter can be defined as exports, or imports, or the sum of both divided by the value of GDP.

Many papers study the relationship between energy consumption (total energy use), trade, and output. Lean and Smyth (2010a)

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examine the dynamic relationship between economic growth, electricity generation, exports and prices for Malaysia. The results from Granger causality tests show the existence of a unidirectional causality running from economic growth to electricity generation. Lean and Smyth (2010b) examine the causal relationship between aggregate output, electricity consumption, exports, labor, and capital in a multivariate model for Malaysia. They find that there is a bidirectional causality between aggregate output and electricity consumption. They conclude that Malaysia should adopt the dual strategy of increasing investment in electricity infrastructure and encouraging electricity conservation policies to reduce unnecessary wastage of electricity. Narayan and Smyth (2009) find the same conclusion for a panel of Middle East countries. Indeed, for the panel as a whole, they find feedback effects between electricity consumption, exports and GDP. Sadorsky (2011) uses panel cointegration techniques to show how trade can affect energy consumption for 8 Middle East countries. He finds a Granger causality from exports to energy consumption, and a bidirectional relationship between imports and energy consumption in the short-run. In the long-run, he achieves that an increase in both exports and imports affect the demand of energy. Considering a sample of 7 South American countries, Sadorsky (2012) confirms the long-run relationship between trade and energy consumption. One important consequence of these results is that environmental policies designed to reduce energy use will reduce trade.

To our knowledge, there is no study, in any country and particularly in Africa, trying to know the linkage between trade and renewable energy consumption. The aim of this paper is to explore the causal relationship between renewable energy consumption, trade, and output by considering a panel of 11 African countries.

The paper is structured as follows. Section 2 gives an idea about the renewable energy sector and trade in Africa. Section 3 describes the data. Section 4 is designated for descriptive statistics. Section 5 deals with the empirical models and results, and Section 6 concludes.

2. Renewable energy and trade in Africa

Many studies underline the great potential of Africa regarding renewable energy production and consumption. Indeed, with their solar, wind, hydropower and geothermal capacities, among others, many African countries have set themselves ambitious strategic objectives and launched large-scale integrated energy programs from which they expect benefits involving reduction of greenhouse gas emissions, direct and indirect job creation, local industrial development and the improvement of human capital. Renewable energies also offer the opportunity to serve isolated regions remote from the national electricity grid and so improve the access to energy particularly for the poorest.

According to the United Nations Industrial Development Organization (2009), the most used renewable energy sources for large-scale applications in Africa are hydropower, modern biomass, geothermal, wind and solar. These sources are usually grid connected. Only about 5% of Africa's hydropower potential estimated to 1750 TWh has been exploited. The total hydropower potential for Africa is equivalent to the total electricity consumed in France, Germany, United Kingdom and Italy put together. The Inga River in the Democratic Republic of Congo (DRC) holds great potential for hydropower generation in Africa with an estimated potential of around 40,000 MW. The DRC alone accounts for over 50% of Africa's hydropower potential. Other countries with significant hydropower potential include Angola, Cameroon, Egypt, Ethiopia, Gabon, Madagascar, Mozambique, Niger and Zambia. Despite the low percentage use, large-scale hydropower so far provides over 50% of total power supply for 23 countries in Africa.

The use of wind energy for a large-scale electricity production has been increasing faster than any other renewable energy technology over the past decade. In 2007, new installations were about 21 GW, even more than hydropower. The development of wind energy projects is primarily limited by the lack of precise information about the wind potential. In terms of installed capacity at the beginning of 2008, Africa had about 476 MW of installed wind energy generation capacity compared to a global estimation of 93,900 MW. Many countries as Morocco, Egypt, Tunisia, South Africa, and Ethiopia are developing large-scale wind energy projects.

Large-scale solar energy projects are very limited in Africa because of their high cost. Many studies have established that Africa has great potential for concentrated solar thermal power generation from desert areas like the Sahara and Namibia. Egypt plans to install solar thermal plant of 300 MW by 2020. Several countries in North Africa are planning to install solar thermal plants in partnership with European countries. The United Nations Economic Commission for Africa Office of North Africa (2012) reports a number of current initiatives such as the Mediterranean Solar Plan (MSP), the Euro-Mediterranean partnership, the agreements that exist between the European Union and some countries of North Africa, the DESERTEC project. These partnerships aim to develop projects, increase investments, produce and distribute renewable energies, strengthen interconnections and create an expanding regional market for electricity.

Small-scale renewable energy systems are used to provide to communities energy services that are not accessible by existing conventional energy supply systems such as the electricity grid. Unfortunately, poor households have not benefited as much as high income households from solar photovoltaic (PV) systems because of their relatively high costs.

Countries in Africa can increase their energy efficiency without decreasing economic output or lowering the standards of living. Studies by the International Energy Agency show that in Africa energy intensity, i.e., total energy consumed per GDP, is at least twice the world average. Experiences so far show that the adoption of energy efficiency is inhibited by barriers including lack of appreciation of the benefits, initial capital requirements, resistance to change, absence of policy and regulatory frameworks. Africa can increase its energy efficiency by encouraging the use of renewables and more efficient technologies.

Recognizing that national energy markets are narrow (United Nations Industrial Development Organization, 2009), Africa is experiencing a shift towards regionally integrated energy markets. Regional Economic Communities (RECs) as Economic Community of West African States (ECOWAS), East African Community (EAC) and Southern African Development Community (SADC) are already working on regionally integrated policy planning, development and energy access programs. These efforts should strengthen the use of renewable energies. Indeed, RECs should play a more active role in promoting regionally integrated markets for renewable energy technologies that are commercially viable in order to realize economies of scale that attracts private sector investments. Moreover, RECs should encourage coherence and greater networking among their member states to promote sharing of experiences and best practices in renewable energy. This could be realized by establishing regional institutions that promote greater partnerships with similar institutions from other regions of the world in order to promote research and technology transfer, among other things.

3. Data

Annual data from 1980 to 2008 are collected for a sample of 11 African countries, namely: Algeria, Comoros, Egypt, Gabon, Ghana,