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Environmental technical efficiency in EU member and candidate countries: A parametric hyperbolic distance function approach

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ABSTRACT

This paper investigates environmental technical efficiency for a panel of European Union (EU) member and candidate countries for the period 1990–2011 using parametric hyperbolic distance function. The paper also examines the environmental technical efficiency convergence among the sampled countries. The main results suggest that environmental technical efficiency scores vary among EU member and candidate countries. The EU-15 countries in contrast to the new members and the candidate countries have a greater potential for reducing CO_2 emissions while increasing GDP and reducing energy use simultaneously. The results also indicate the existence of environmental technical efficiency convergence among EU member and candidate countries.

1. Introduction

United Nations Climate Change Conference, also known as Conference of the Parties (COP) was held on December 2015 in Paris with the objective to reduce the greenhouse gas (GHG) emissions. The Paris Conference holds great significance in terms of establishing a legally binding and global agreement on climate change with the aim of keeping global warming below 2 °C above pre-industrial levels. In this regard, it is similar to its predecessor the Kyoto Protocol that required the parties to reduce their emissions 5% by 2012. The conference is expected to be a turning point against climate change towards motivating the business sector in transitioning to a low-carbon economy. Leaders of the world addressed their concerns and reiterated the significance of climate change during the 10 days. The main aim of the "Draft Agreement" is to enhance action, cooperation and support to limit the temperature increase [1].

Stabilizing the emissions rate and transitioning into a low-carbon economy is crucial to climate change because increasing CO_2 emissions, one of the GHG with the highest concentration, affects not only human health and agriculture but also the biodiversity, and the survival of certain species. In a much broader sense, a low-carbon economy is vital for sustainable growth of environmental quality and biodiversity.[1] Reducing emissions can be accomplished via clean energy and, energy is rendered clean if it does not increase the atmospheric CO_2 concentrations. In that sense, reducing emissions and making energy "clean", can be done by converting to renewable energy, adopting nuclear energy (focusing on nuclear fusion because it does not generate long lived radioactive waste), biofuels and finally, increasing environmental efficiency.

Converting or diversifying energy resources with renewable energy for developed countries might not have the same amount of economic burden as in the case of developing countries, owing to the fact that renewable energy technologies require a great amount of investment. However in some countries with higher awareness

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[1] Sustainable growth refers to promoting growth today without harming the future.

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towards climate change, energy markets are regulated in favor of renewable energy sources with subsidies or creating incentives towards renewables by putting more tax on carbon intense sources. Such policies make renewable energy sources a more cost effective substitute. For example, renewable energy for EU is a significant factor in lowering emissions, therefore it has been regulated and promoted through policies and directorates. According to Eurostat statistics the overall share of renewables in gross final energy consumption has been consistently rising. Fig. 1 presents the share of renewable sources in the EU member states for the years 2004 and 2015. Eleven out of the 28 EU members have been able to reach their 2020 targets. Overall, the EU member states have considerably increased their share of renewable sources in their total primary energy supply

Apart from the economic cost of renewable energy, there is also the availability factor that plays an important role. Despite being able to handle the economic cost and having the adequate technologies, some countries lack the natural resources to fully appreciate renewable energy. Countries without access to sea are not able to utilize waves as a source of energy, or those with no steady wind are unable to utilize wind turbines. Similar other scarcities of natural occurrences, due to a country's geographical location, prevent them from exploiting these resources.

Lowering CO_2 emissions, apart from transitioning to renewable energy sources, can be achieved through increasing environmental technical efficiency which is related to productive and technical efficiency in the sense that maximum number of goods and services are produced with given inputs that are used under an optimum allocation.

In the environmental efficiency framework, CO_2 is considered as the bad (undesirable) output. The aim is to lower the undesirable output without lowering the overall good (desirable) output. This calls for a production function that treats the good and bad output asymmetrically, therefore when we lower the bad output, the desirable will not be effected. This paper follows a hyperbolic form of the distance function because of its flexible definition of production function. Unlike the conventional distance functions which partially define production functions from either input or output orientations, hyperbolic distance function relaxes this analytical framework and allows for simultaneous output and input characterization. In general, the hyperbolic distance function treats the desirable and undesirable output asymmetrically thus enabling us to lower the undesirable output via preserving or increasing the desirable output.

It is valuable to carry out a study that investigates environmental technical efficiency for a sample of countries following the Paris conference, COP21, which introduced a new agreement on climate change. This study provides evidence on whether policies that addresses the increasing energy and environmental efficiency are successful. Hence, the main objective of this paper is to estimate environmental technical efficiency scores for a panel of European Union (EU) member and candidate countries for the period 1990–2011, employing recently developed parametric hyperbolic distance functions by Cuesta and Zofio [2] and Cuesta et al. [3]. In this study, data for capital stock, labor and energy are used to produce one desirable output GDP and one undesirable output CO_2 emissions.

The other objective of this paper is to examine convergence in environmental efficiency among the sampled countries. To the authors' best knowledge, this is the first paper that investigates environmental technical efficiency and its convergence for the EU member and candidate countries. Efficiency convergence produces valuable information towards assessing the success of energy and environmental regulations, particularly for countries that have common goals and unified policy agendas towards increasing environmental efficiency.

By way of preview, our main empirical results suggest that environmental technical efficiency scores vary among EU member and candidate countries. EU-15 countries, in contrast to the new members and the candidate countries have a greater potential for reducing CO_2 emissions while increasing GDP and reducing energy use simultaneously. The other main finding of our paper is the existence of environmental technical efficiency convergence among EU member and candidate countries.

The rest of the paper is organized as follows. Section 2 reviews the previous literature on energy and environment. Section 3

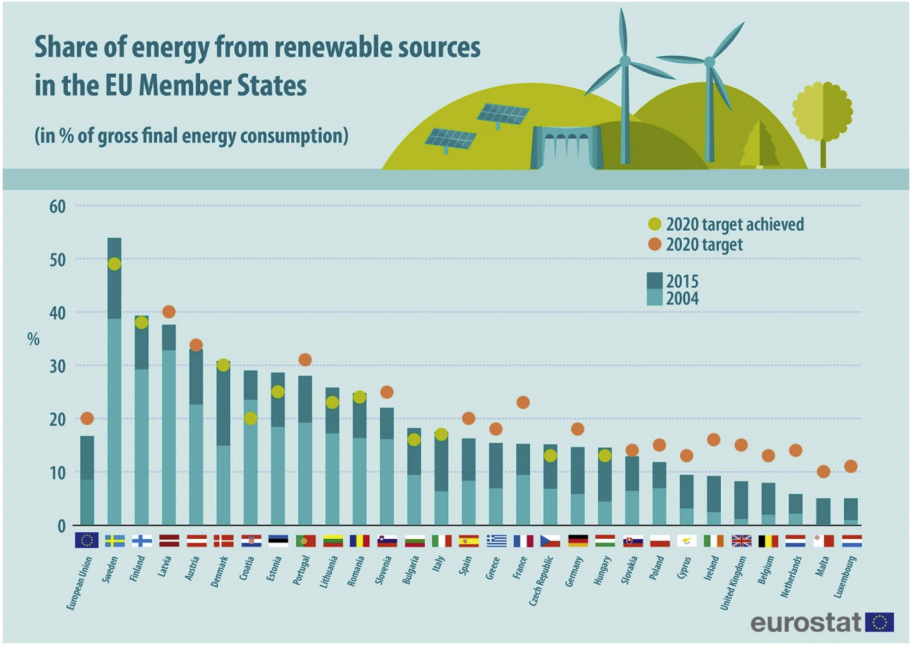

Fig. 1. Share of energy from renewable sources in EU Member State.