Environmental and energy efficiency analysis of EU electricity industry: An almost spatial two stages DEA approach.

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Overview

Environmental and energy efficiency (EEE) in production, transformation and consumption allows to reach European Union (EU) greenhouse gas reduction target faster (EEA, 2016). EEE is a crucial key in the transformation sector to make carbon free power generation. Internal and external factors are changing the traditionally largely asset-based industry moving to a new and more complex decentralized generation system. Internal factors refer to technological changes (Jamasb and Pollitt, 2008) and to the fuel energy mix that deeply changed in EU countries also due to the widened spread of renewable energy sources (RES) (Krozer, 2013). External factors involve policy and regulatory interventions (Knittel, 2002), changes in consumers' preferences (Stigka et al., 2014) and environmental attitude (Bigerna et al, 2016). This paper intends to contribute to the literature developing a framework to measure the technical EEE of EU electricity industries taking into account: i) both non-separable "good" and "bad" outputs; ii) both "discretionary" and "non-discretionary" inputs; iii) spatial component in technical inefficiency explanation.

Methods

Using data from 2007 to 2015 for 19 major EU countries a two-steps procedure is used. According with recent literature (Apergis et al., 2015; Liu and Wu, 2015) in the **first step** a slack based measure model is used employing three inputs (capital -installed capacity-, labor and fuels) and two outputs (electricity produced and sectorial CO2 emission). Different hypothesis of technologies returns are tested (Zhou et al., 2008). Giving the panel data structure of the data we adopt two out five approaches suggested by Fried et al. (2008, pp. 54-55). Initially, data are pooled to estimate a single frontier assuming invariant best-practice technology, then four separate frontiers are estimated for each period

that refer to three years average data. In this way we mitigate the potential variation of efficiency scores across independent frontiers. Using these two approaches it is possible to control for industrial technological change and other change in internal factor. In the **second steps,** according to Simar and Wilson (2007), we adopt a spatial probit that is able to explain inefficiency due to external (e.g non-discretionary) factors controlling for serial correlation of non-parametric efficiency scores.

Final considerations and expected results

The paper wants to enrich the current literature applying non parametric frontier methodology in the EEE field. EEE is a term advocated by policy makers, analyst and environmentalist given that in the public opinion better environmental performance might bring stakeholders great potential benefits. Our outcomes will be compared with the findings of mainstream researches in order to deep knowledge on the relationship between EEE and internal and external factors. These results can help stakeholders in defining new policy and regulatory interventions.

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