European Industries' Energy Efficiency under Different Technological Regimes: The Role of CO_2 Emissions, Climate, Path Dependence and Energy Mix

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As a part of national efforts to achieve green development and mitigate GHCs emissions, European industries have perceived the huge potential benefits from adopting energy saving policies and environmental friendly technologies following European as well as country specific policies. A clean and energy saving manufacturing sector has been targeted as a key area for Europe, particularly, since the launch of Energy Efficiency Directives 2012/27/EU and 2018/2002/EU. Thus, building up an energy efficient European industry can benefit European countries to improve their welfare with greater levels of energy independence and security, achieve the underlying objective of cost minimization and face successfully the threat of energy rising prices. Additionally, it can evolve into a valuable asset for reducing CO_2 emissions, fulfilling Kyoto protocol and Paris Agreement (2015), enhancing industry competitiveness and promoting economic growth through continual innovation (European Commission, 2011).

On the basis of the above mentioned, a detailed estimation of total factor energy efficiency estimates, at a European industry level is essential for policy makers, economists, environmentalists and scholars. Moreover, it is important to evaluate and detect possible factors that affect total factor energy efficiency scores. Less immediate for this research, but equally important from a production theory perspective, is to incorporate in our total factor energy efficiency estimations the presence of CO_2 emissions and examine the convergence-divergence hypothesis. Finally, this research aims at enlightening the role of technological heterogeneity and any country hierarchies in the benchmarking process revealing specific idiosyncrasies at national and European level. The adopted methodology operates in three stages. In the first stage we adopt a fully non-parametric approach to perform benchmarking on total factor energy efficiency scores across industries using Data Envelopment Analysis (DEA) and Directional Distance Function (DDF). In the second stage, econometric approaches provide us a concrete evaluation as whether some groups of variables are likely to increase energy efficiency with respect to the different technologies. Finally, in the third stage, we proceed with a convergence analysis for our total factor energy efficiency estimates.

Our results are important for the analysis of governmental policies regarding energy efficiency and the environment such as carbon taxes. Regarding total factor energy efficiency, our results reveal that small-scale economies exhibit a persistent high performance. In addition, the results regarding its determinants suggest that path dependence phenomena have a strong presence, revealing technological lock-in, climatic characteristics occurs, while energy mix displays linear and non-linear relationships. Finally, regardless of the method employed, there is a strong evidence of conditional and unconditional convergence for total factor energy efficiency scores.

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