A TWO-STAGE APPROACH FOR ENERGY EFFICIENCY ANALYSIS IN EUROPEAN UNION COUNTRIES

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The assessment of energy efficiency is an essential component of sustainable development policies, which seek to achieve a well-balanced trade-off between economic growth and competitiveness, energy security, and environmental sustainability. Energy intensity is often used as a proxy of energy efficiency, but it is now well-documented that changes in energy intensity cannot be solely attributed to energy efficiency policies, as there are other important factors that affect energy intensity, including structural economic and energy-related factors.

In this paper we follow a two-stage approach for assessing energy efficiency and developing an easy to use evaluation model that can be used by policy makers for benchmarking country-wide energy efficiency over time. At the first stage data envelopment analysis (DEA) is employed to measure energy efficiency of the countries in an input-output production framework, using different decompositions of the economic outputs of the countries and their energy

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consumption mix, while controlling for non-energy inputs such as labor, capital, and material consumption. At the second stage a multicriteria decision aiding (MCDA) approach is used to build an energy efficiency evaluation model based on the efficiency classifications obtained with DEA. The resulting model combines energy-related attributes, economic criteria, and environmental factors into an overall energy efficiency and composite performance indicator that enable the evaluation of all countries in a common and standardized setting. The multicriteria model is appropriate for benchmarking purposes, allowing the consideration of all factors that describe (direct or indirectly) energy efficiency and its multiple benefits, and enables analysts and policy makers to perform evaluations and monitor the performance of a country over time using data solely at the country level, without having to resort to relative assessments in comparison to data from a set of peer countries. This modeling approach enables analysts and policy makers to consider a rich list of the impacts of energy-efficiency programs and actions, explore the underlying trade-offs, and ultimately reach more informed decisions

The proposed two-stage approach is applied to a panel data set of 26 European countries over the period 2000–2010. The results of the empirical analysis indicate that despite the considerable improvements achieved in terms of energy intensity, a more refined view of energy consumption and economic activity data shows that there is still much to be done to improve the actual energy efficiency of European countries. The economic crisis of the past few years has had negative effects. Furthermore, it is found that for European countries, the effect due to the consideration of the structure of their economic activity is stronger than the effect due to the introduction of a breakdown by their energy mix.

Taking into account the results of this study, policy makers could identify the main steps that should be followed to improve each country's energy efficiency. Furthermore, the significance of each step can be measured, leading to more informed decisions in terms of

priorities given. Weighing different policy measures is a challenging task; however, the results of this study could significantly help policy makers in their decision process. For example, the finding that services-oriented economies are more efficient than industry-oriented ones or the fact that renewable energy sources should gradually displace fossil fuels could help regulators design policies to support certain sectors of the economy or certain energy sources. Furthermore, combining MCDA with frontier techniques, as suggested in this study, enables policy makers to consider a much wider range of impacts of energy efficiency programs, instead of focusing solely on an input-output energy-economic production framework.