THE VALUE OF GREENHOUSE GAS EMISSION REDUCTION IN THE EU: A NON-PARAMETRIC AND SECTOR-WISE APPROACH

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Overview

With the Paris Agreement of 2015, the European Union (EU) aimed to limit global warming to below 2°C degrees and committed to reduce greenhouse gas (GHG) emissions by at least 40% by 2030 compared to 1990 levels. In 2020, the EU further increased its ambitions and, as part of the EU Green Deal, determined to raise the 2030 reduction target to at least 55% compared to 1990. This demonstrates that not only a drastic cut in emissions is required, but also that the timeframe plays a crucial role since the peak in global emissions should be reached as soon as possible. While technological and structural changes, such as the conversion of the energy supply system from conventional to renewable energies, are only feasible in the long term, exploiting inefficiencies in the use of currently available technologies could make a significant contribution to emission reductions in the short and medium term without relying on pollution-reducing innovations. For this purpose, environmental performance analysis can help to identify such reduction potentials and also to estimate abatement costs. Since previous studies on environmental performance analysis have rather focused on a single country or industry sector, our paper aims to provide a comprehensive overview of reduction potentials and abatement costs within the EU by looking at different countries and industry sectors. For this, we apply a benchmarking approach and analyse the production and emission activities of 16 member states and 7 industrial sectors over a period from 2008-2016. Therefore, our paper will provide useful policy implications regarding the cost-effective distribution of emission reduction targets across EU member states and industry sectors.

Methods

For the estimation of emission reduction potentials and abatement cost in the EU, we perform a Data Envelopment Analysis (DEA). DEA is a non-parametric benchmarking method which is already frequently used to measure environmental efficiency or performance. It allows the comparison of the production performance of different decision-making units (DMUs), such as countries or industry sectors, taking into account multiple inputs and outputs. This is done by estimating a production function or frontier composed of the best or "efficient" DMUs. For inefficient DMUs, i.e. DMUs that are not on the frontier, it is then possible to determine how they could increase their output or decrease their input to eliminate inefficiency and be placed on the frontier. While "conventional" benchmarking approaches typically consider only the production of good or desirable output, environmental performance analysis also considers the simultaneous production of a bad or undesirable output, such as waste or emissions. Thus, it is no longer estimated how DMUs could increase (decrease) their output (input), but rather how the bad output could be decreased to eliminate inefficiency. Therefore, the distance to the frontier indicates the degree of inefficiency and possible reduction potential of the bad output.

In our paper, we use such a DEA model that accounts for the production of bad outputs. Four variables are included in our model: two input variables (labour and capital), a single (good) output variable (gross value added), and a bad output variable (total GHG emissions). The variables originate from two sources (EU-KLEMS[i] and Eurostat Air Emission Accounts[ii]) and our compiled dataset provides complete data coverage for 16 EU countries and 7 industrial sectors (classified by NACE rev. 2) for a period from 2008 to 2016. In order to identify changes over time, the data are further divided into two time periods: t1 (2008-2012) and t2 (2012-2016). Therefore, median values were calculated for both periods.

In our analysis, we follow a sector-wise approach, i.e. emission reduction potentials and abatement costs are calculated separately for each sector. For this purpose, a separate DEA model is estimated for each industry sector. While reduction potentials correspond to the potential decrease in bad output, abatement costs are expressed as the potential or foregone enhancement of good output if inefficiency is eliminated by solely exploiting the reduction potential (and good output is held constant).

Results

Considering the absolute emission reduction potentials, we observe a reduction potential of 951 mt (megatons) of CO_2 equivalents across all countries and sectors in the first subperiod t1, which corresponds to almost 30 % of all GHG emissions in this period. Looking at the distribution of reduction potentials across sectors, we find that reduction potentials are comparatively high in the sectors agriculture and forestry (A), manufacturing (C), electricity and gas supply (DE), and transport (H), and comparatively low in the sectors of wholesale and retail trade (G) and construction (F). Therefore, the highest reduction potentials are found in sectors C and H, which also accounted for 65% of total GHG emissions in t1. In addition, we find that the largest reduction compared to actual emissions can be achieved in the manufacturing sector (C). However, given the abatement costs, reducing emissions in this sector would be quite costly, while reducing emissions in the other sectors would involve less foregone output enhancement. Comparing the results with those of the second subperiod t2, we observe that the total reduction potential has slightly increased, which is mainly due to a large increase in the reduction potential in the agriculture sector (A). Therefore, the reduction potentials in sectors A, C, and DE account for 90% of the total reduction potential in t2. Regarding abatement costs, it can be observed that, similar to t1, emission reduction is feasible at relatively low cost in most sectors, while in sector C emission reduction is associated with a higher foregone output enhancement.

In a nutshell, we find that by eliminating inefficiencies and exploiting reduction potentials in the use of currently available technologies, a significant share of total GHG emissions could be reduced. However, as this is still work in progress, the next step is to analyse how feasible the reduction potentials are in the short and medium term by taking into account the heterogeneous industrial structures of the countries. Finally, we will formulate precise policy implications for an appropriate and cost-effective distribution of emission reduction targets among countries and sectors.

Conclusions

As global emissions need to peak as soon as possible to limit global warming to less than 2°C, the EU aims to increase its emission reduction ambitions under the Paris Agreement. However, since technological and structural changes are generally only feasible in the long term, exploiting reduction potentials related to inefficient use of currently available technologies could be useful to reduce emissions in the short and medium term. As our preliminary results show, there are significant emission reduction potentials related to inefficiency that could also be achieved at relatively low cost. In particular, large untapped reduction potentials can be found in the most emission-intensive sectors, such as manufacturing and electricity generation and supply.

In sum, our paper contributes to a deeper understanding of emission reduction potentials and abatement costs in the EU by differentiating between various countries and industry sectors. Thereby, our results will provide valuable information on an appropriate and cost-effective distribution of emission reduction targets for policy makers.

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[i] Available at: https://euklems.eu/

[ii] Available at: https://ec.europa.eu/eurostat/web/environment/air-emissions