TRACKING INDUSTRY'S CO_2 EMISSIONS IN AUSTRIA: AN LMDI DECOMPOSITION ANALYSIS

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Overview

Greenhouse gas emissions and particularly CO_2 emissions of the Austrian manufacturing sector have been constantly rising over the past years. In this paper the development of energy-related CO_2 emissions in the Austrian manufacturing sector in the period 1990 to 2012 is analysed using an extended LMDI decomposition approach. Changes in sectoral emissions are traced back to changes in six different factors: industry gross value added (activity effect), the structure of the industry (structural effect), the category of final energy use (mix effect), energy intensity (energy intensity effect) and carbon intensity (CO_2 intensity effect). In addition to the analysis of total energy-related CO_2 emissions of the manufacturing sector the decomposition approach is applied to CO_2 emissions from energy use in industrial furnaces, in steam production, for space heating and cooling.

Methods

Changes in energy-related CO_2 emissions of the Austrian manufacturing sector are traced back to the underlying factors in a decomposition analysis. Decomposition analysis has been widely used for analysing the drivers of energy consumption and GHG emissions (see e.g. Xu and Ang, 2013, or Ang and Liu, 2007, for an overview). The approach breaks down changes in an aggregate indicator and assigns the effects to a number of predefined factors. Ang et al. (2009) provide an extensive overview of different decomposition techniques (see also Xu and Ang, 2013; Ang et al., 2003; Ang, 2004). Ang (2004) recommends the LMDI I approach (both in additive and in multiplicative form) based on its theoretical foundation on the one hand, and since it complies with the factor-reversal test and the time-reversal test on the other hand. Furthermore, the estimated contributions of changes in the underlying factors derived from both approaches can be easily translated into the other for the LMDI I method.

Due to these advantages, I opt for the LMDI I approach to study changes in energy-related CO_2 emissions of the Austrian manufacturing sector. I choose the additive form as the communication and presentation of results is more straightforward. The 'small value' strategy (Ang and Liu, 2007) is used to handle zero-values in the data set.

The LMDI approach used in this paper is formulated as follows

$$C = \Sigma_i \Sigma_j C_{i,j} = \Sigma_i \Sigma_j C_{i,j}/E_{i,j} * E_{i,j}/E_i * E_i/V_i * V_i/V * V = \Sigma_i \Sigma_j C_{i,j} * M_{i,j} * EI_i * S_i * V$$

where C denotes the energy-related CO_2 emissions and $C_{i,j}$ denote CO_2 emissions from the combustion of fuel j in sector i; $CI_{i,j}$ ($=C_{i,j}/E_{i,j}$) is the CO_2 emission factor of fuel j in sector i; $M_{i,j}$ ($=E_{i,j}/E_i$) denotes the share of fuel j in sector i's final energy consumption; EI_i ($=E_i/V_i$) stands for the energy intensity of sector i; S_i ($=V_i/V$) gives sector i 's share in industrial gross value added; and V denotes the level of industrial gross value added, which is used as a proxy for industrial activity.

In the analysis, changes in energy-related CO_2 emissions of the Austrian industry sector between the base year, year 0, and year t (ΔC) are hence be traced back to five factors:

$$\Delta C = C^t - C^0 = \Delta C_{ci} + \Delta C_m + \Delta C_{ei} + \Delta C_s + \Delta C_v$$

The carbon intensity effect ΔC_{ci} describes the impact of changes in the CO_2 content of fossil energy sources on energy-related industrial CO_2 emissions. The energy mix effect ΔC_m accounts for effects resulting from changes in the share of fossil energy sources in the sub-sectors' final energy consumption. The energy intensity effect ΔC_{ei} describes the impact of changes in energy intensity on energy-related CO_2 emissions. The structure effect ΔC_s accounts for the effects of structural changes in the manufacturing sector. Finally, the activity effect ΔC_v reflects the contribution in the level of industrial activity to changes in CO_2 emissions.

In addition to the analysis of total energy-related CO_2 emissions of the manufacturing sector the decomposition approach is applied to CO_2 emissions from energy use in industrial furnaces, in steam production, for space heating and cooling.

Results

In the Austrian manufacturing sector, energy-related CO_2 emissions have been roughly constant over the period 1990 to 2012. While changes in carbon intensity and in the energy mix as well as changes in the structure of the manufacturing sector had a dampening effect on emissions, they could ultimately not set off increasing energy intensity and changes in the level of economic activity.

At the level of useful energy categories, it becomes evident that a shift towards low carbon energy sources has not occurred in all areas: In steam production a shift from electricity towards gas contributed to rising emissions.

Conclusions

In Austria, greenhouse gas emissions from manufacturing increased by 3% between 1990 and 2012 and now account for one third of Austrian emissions. Rising emissions are in stark contrast to the challenging greenhouse gas emissions reductions envisaged for the sector. The European Union aims for a transformation into a low carbon economy by 2050 (European Commission, 2011), implying an 80% reduction of total greenhouse gas emissions and a reduction of emissions from the manufacturing sector by 83% to 87%.

Among other things, an increase in energy efficiency will be of crucial importance in order to reach these targets. This holds especially true for Austria which exhibited an increase in energy intensity over the past years, especially with respect to industrial furnaces and space heating and cooling. The required emission savings will, however, not be achieved by continuous technological improvements, but will require 'radical new technologies' (Schnitzer, 2014). A further exploitation of renewable energy sources can also help achieving the aspired emission reductions, but the potentials are limited.

So far, climate policy has not been successful in tackling greenhouse gas emissions of the manufacturing sector in Austria, albeit some shift towards renewable, low-carbon energy sources has been observed. A credible climate policy with ambitious long-term targets would be necessary to achieve the required transformation of the sector. The EU Emission Trading Scheme could be one instrument of such a policy. This would, however, require fundamental changes of the scheme, especially regarding its ability to deliver a stable and significant price signal for the investment in low carbon technologies that prevails even if an exogenous shock such as the financial and economic crisis occurs. These reforms have to go well beyond those currently discussed by the European Commission.

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