THE FUTURE OF STEEL PRODUCTION IN GERMANY IN CONTEXT OF INTERNATIONAL COMPETITION AND CO_2 REDUCTION

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Overview

Shifting an energy intensive industry from one country to another could help reaching the greenhouse gas reduction targets of the industry-exporting country. However, the reallocation will result in higher emissions on the global level if the production in the industry-importing country is associated with higher specific emissions. Cost advantages could foster such reallocation of production and the respective emergence of carbon leakage. In this study, we consider the example of relocations in the iron and steel industries of China and Germany in order to ascertain resulting effects on CO_2 emissions. We develop different scenarios for the year 2030 by using a multilevel Cross-Impact Balance (CIB) approach and analyse these scenarios in a technology-based cost model. As we find out, due to cost advantages there tends to be a shift of iron and steel production towards China that is associated with higher overall CO_2 emissions. This is a consequence of a rather polluting Chinese iron and steel production sector, whose specific emissions clearly exceed that of the respective German sector.

Methods

In the past, the steel sector faced large fluctuations in prices of raw materials and in the demand for steel (see e.g., [1, 2]). Furthermore, it experienced changes due to the increasing competition, as well as due to the implementation of measures for reducing greenhouse gases. Forecasts of future prices of raw materials and changes on political level involve a high degree of uncertainty. Possible futures can be assessed with the help of scenarios, taking existing uncertainties into account. Prices, demand and policies depend directly and indirectly on a lot of quantitative (e.g. prices for raw materials, transportations cost) and qualitative factors (e.g. GHG reduction policies). Thus, the use of an approach which can deal with different kinds of factors on different levels, is needed in order to allow for the assessment of the broad range of possible developments. In this study, we apply a two-stage approach: In the first stage, we implement the cross-impact-balance approach for the identification of possible pathways for the steel industry in general. This approach allows us to take various quantitative and qualitative factors into consideration. Pathways derived from the CIB approach are strongly shaped by the qualitative aspects and usually provide information only on the aggregated level [3]. Thus, in the second stage, we use the identified pathways as a framework for numerical calculations applying a technology based cost model.

In our case study 41 descriptors have been selected. Beside “price for raw material needed for steel production”, “transportation costs of steel”, “energy efficiency increases in Germany and China” as well as “restrictions on the trade of steel”, “demand for steel on global level” and “overcapacity in the steel industry” the list of descriptors includes descriptors like oil price, economic growth on national and global level, demographic developments, international climate policy, CO_2-reduction targets on national and European level and price for CO_2-allowances. Based on information on the interlinkages beetwen the descriptors consistent combinations of parameters on an aggregated level can be identified. For getting concrete numbers on cost advantages, CO_2 emissions, etc. the resulting CIB-scenarios have to be specified more precisely. In this study we use the identified CIB-scenarios as storylines. These storylines are used as a framework for the analysis conducted by using a technology based cost model.

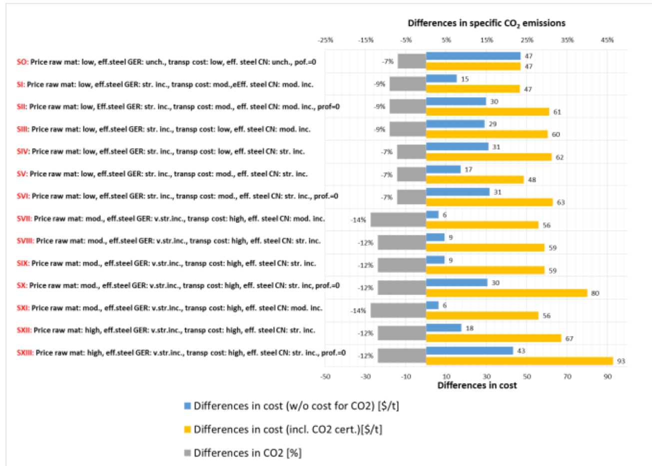
Based on the information about inputs needed for the production of crude steel, prices for the input factors, transportation costs, as well as costs resulting from legal and non-legal constraints, the floor price for a crude steel producer on a selected market is assessed. For being able to take changes in freight cost into account, a transport model is used, which has been developed following to the approach used by [4]. The approach is based on the assumption that the main inputs needed for steel production are transported by sea.

Results

Taking the interlinkages between the descriptors into account we identified 13 consistent scenarios for the year 2030. The scenarios represent different developments of GDP, oil prices, transportation cost and climate change policies. The analysis shows inter alia the indirect dependencies of cost factors on non-monetary factors.

Fig. 1 shows results of the calculations. Scenario “S0” is calculated using information on prices and overcapacities of 2015. Assuming that due to high overcapacities in China the resulting competitive pressure will lead to Chinese steel producers offering steel in Europe at profit margin rate of zero, the German steel producers will have a cost disadvantage of 47 \$/t. The emissions of crude steel produced in China and transported to Europe will be linked with 7% higher CO_2 emissions than the steel produced with BF-BOF in Germany. If in Germany the energy efficiency increases more strongly than China and China offers steel at prices that includes appropriate profit margins, the price difference between Germany and China will become small. In addition the gap in the emissions will increase. Without free CO_2 permits the situation for Germany will become worse again. If in China energy efficiency of the BF-BOF production route increases or the Chinese steel producers offer steel at low profit margins (“SII”, “SVI”, “SX”, “SXIII”) the price gap will increase whereas the difference in the emissions will decrease. Despite the fact that German steel sector is strongly dependent on the imports of raw materials, increases in transportation cost affect the overall production cost and therefore, Chinese steel producers will suffer more from increases in transportation cost because of long transportation distances to Europe (see e.g. “SIV“, “SV”). In the chosen example, German steel producers will benefit from higher transportation cost. Taking into account other sale markets, like USA, the situation can be different because of higher transportation cost for German steel and lower transportation cost for steel produced in China. Since the steel sector in Germany will also be affected by energy and environmental policy, the development of energy efficiency measures in Germany have to be considered within the political framework.

Fig. 1: Differences in cost and CO_2-emissions of crude-steel production (comparison of Germany and China, BF-BOF)



Conclusions

The iron and steel industry belongs to the top five CO_2-intensive industries. With respect to national GHG reduction targets, a reduction in the economic activities of these sectors might be helpful for reaching the targets. Cost disadvantages resulting e.g. from additional cost for mitigation measures might foster the attitude towards relocation of economic activities. Since a relocation of economic activities usually is linked with higher emissions in other countries and since the reduction of GHG-emission is a global target, possible effects (i.e. carbon leakage) have to be analyzed in a global context. In the past, the industry has experienced large fluctuations in prices of raw materials and in the demand for steel. In addition, there have been large changes in the policy framework (i.e. environmental regulations). There is much uncertainty with regard to future prices for raw materials and other factors. For taking uncertainty into account we analyzed the future of the steel industry in a broader context. Using a multilevel cross-impact balance approach in combination with a bottom-up cost model we present an approach that enables to take the links between several quantitative and qualitative descriptors into account. For the year 2030, all scenarios show cost advantages for the Chinese steel industry selling steel in Europe. Since our calculations are based on average figures on national level and not on plant-specific data the results reflects possible developments on a rather aggregate level. However, the results can nevertheless be employed to identify possible general developments and to indicate challenges for climate policy as well as for industrial policy.

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