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CHALLENGES FOR THE EUROEPAN STEEL INDUSTRY AND THEIR POSSIBLE IMPLICATIONS ON ENERGY, EMISSIONS AND SOCIAL ASPECTS

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ABSTRACT

The steel industry in the European Union, important for the economy as a whole, faces various challenges. These are inter alia volatile prices for relevant input factors, uncertainties concerning the regulation of CO_2-emissions and market shocks caused by the recently introduced additional import duties in the US, which is an important sales market. We examine primary and secondary effects of these challenges on the steel industry and stress impacts on European and global level. Particularly, we analyse the impacts of changes in competitiveness on energy demand and CO_2-emissions taking transport of raw materials and steel into consideration. By applying information on Human Development Index values (reflecting aspects of life expectancy, education, and per capita income) we show that relocating energy-intensive industries from Europe may not only increase energy demand and global CO_2-emissions, but may also affect developing countries.

Keywords: Steel industry; competitiveness; transport cost; energy efficiency; Human Development Index)

NONMENCLATURE

Abbreviations	
BF/BOF	blast furnace (BF) - basic oxygen furnace (BOF)
HDI	Human Development Index

1 INTRODUCTION

The European Union (EU) is the second largest steel producer in the world after China accounting for nearly 11% of the global steel output. The European steel sector represents one of the three largest EU-28 subsectors in terms of value added and employment [1]. The status of the EU steel industry is therefore of strategic importance for future prospects of economic growth, innovation and welfare. Currently, the European steel industry faces various serious challenges and risks: Besides the expected heavier burden due to climate policy, there are uncertainties about the development of production costs and floor prices in different respects that challenge the European steel sector (see e.g., [2], [3]). Another challenge is closely related to present international disputes about trading rules and the renegotiations of international trade agreements. The US administration, for example, has recently started collecting duties on those imports of steel that exceed stipulated import quota ([4]). Besides direct effects on competitiveness on the US market, indirect effects will influence the European market since a modification of US tariffs could induce steel exporting countries like Brazil, India and Russia to expand their supply in Europe, for example. This tends to trigger more intensive competition on the European steel sector. For a comprehensive assessment of possible relocations of the steel industry from the EU, we need to consider sustainability aspects in addition to cost aspects. Therefore, we investigate the impact of such relocations on global energy consumption and CO_2-emissions. Another aspect of sustainability is to allow developing

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countries to participate in the value chain and thus to achieve a fair economic balance. Usually the stages of the value chain for steel production are located in different countries. Thus, we consider effects of relocations from the EU on less developed countries as well.

All in all our study does not only provide information on economic aspects of the competitiveness of the EU steel industry but also on implications on social and ecological sustainability aspects of possible relocation processes, which in turn can be a consequence of declining competitiveness.

2 MATERIAL AND METHODS STRUCTURE

Our approach consists of three steps: In a first step we calculate cost of (crude) steel production taking uncertainties about e.g. prices for raw materials, transportation cost, changes in energy efficiencies and CO_2 allowances assuming Europe as supply market. Hence, we are able to assess the competeveness of Germany as representative European steel supplier. For assessing the implications of a possible relocation of steel production from the EU due to decreased competitiveness, we calculate global energy demand and CO_2-emissions related to steel production in a second step. In a third step we extend our assessment by including information on key characteristics of countries being involved in the production chain. Doing so, we aim at including impacts on less developed countries participating in the value chain (Fig. 1).

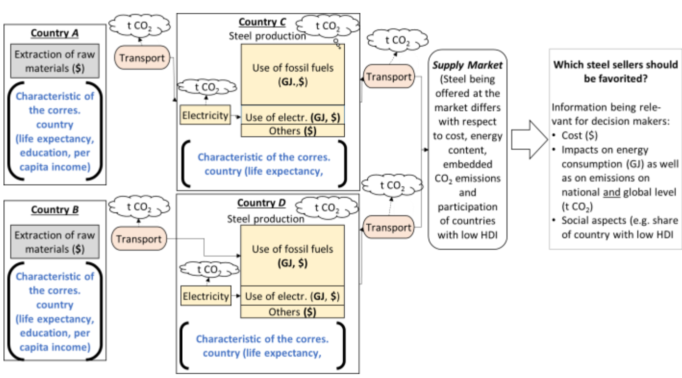

Fig 1: Overview

The model is calibrated using data for 2014. In order to reflect uncertainties with respect to prices of coal and iron ore as well as to the transportation cost and technological progress, we consider ranges for future developments of these factors: Regarding raw material prices and the transport cost, we assume an increase up to 400% until 2030 (compared to 2014). Variations of the energy efficiency in the model may be comparable with the results of the study of Arens et al. [4], where the authors assess the technical potential for EE improvements and CO_2 savings. According to [4], the model assumes a range up to a max. 20% increase in energy efficiency of the BF/BOF processes with respect to the specific energy use at different stages of these technological processes. We do not specifically consider different technology options other than BF/BOF represented here by a typical production plant in the modelled countries. We assume changes in the energy efficiency and CO_2-emissions as a result of changes in the specific fuel and electricity use, improved utilization of the byproduct gases and energy. For assessing social aspects of sustainability, we adapt an approach of the UNDP and use the Human Development Index (HDI) as proxy [5], since a complete assessment of sustainability is beyond the scope of this study. This indicator comprises aspects of long and healthy life, knowledge and standard of living and is available for 189 countries. Following UNDP, we cluster countries based on HDI in the categories very high (HDI index 0.8 and higher), high (0.8 > HDI index >= 0.7), medium (0.7 > HDI index >= 0.55) and low (0.55 > HDI index). Using information obtained by applying the floor price model and information on how different countries participate in the value chain, we sum up the cost shares by HDI-category. Based on calculated shares we draw conclusions to which extend countries with medium or low HDI are positively or negatively impacted by relocation of steel production.

3 THEORY/CALCULATION

In order to compare prices, we apply an extended technology-based floor price model. The model reflects the floor price structure of crude steel production in a typical steel plant in the country analyzed. The floor price is assessed by taking the complete value chain from delivery of raw materials to distribution of steel products to the markets into consideration. Our model considers the floor prices of steel offered at market assessing additionally transportation costs and envisaged profits of the producer. Costs for CO_2-emission allowances where included when appropriate. For being able to analyze changes of the steel floor prices due to changes in freight cost, particular attention is paid to the consideration of transportation routes in the model. The model applies an approach presented in [6] and assumes different types of bulk carriers. It incorporates the duration of transport, charter rates as well as fuel, harbor-specific and other costs. Additionally we consider fuel costs, accounting for specific fuel use during the time on route and congestion time.

Energy consumption is determined by a representtative plant type for the producing region, energy carrier and is given per one tonne of crude steel. The model accounts for byproducts as steam and gases that can be reused for heating, onsite electricity production and other purposes. These energy byproducts are considered as opportunities to increase energy efficiency. The overall energy consumption is calculated by summing up the energy used for steel producing processes, for the transport of goods and for electricity production. Raw materials like coking coal are taken into account by using information on their specific energy content. CO_2-emissions are calculated by multiplying energy use with fuel specific emission coefficients.

4 RESULTS

4.1 Competition on the European steel market

In a first step we analyze the outcome of the floor price model with respect to different competing countries:

Germany – Brazil: For a price of CO_2 allowances of 0 and current conditions, the floor price advantage for Brazilian steel is 23.0$/tonne ($409.4/tonne for German steel vs. $386.4/tonne for Brazilian steel) or relatively 5.6%. Equality of floor prices is reachable under today's conditions, if the German steel industry increases its energy efficiency by at least 16.0% assuming unchanged energy efficiency for Brazil. This is quite ambitious, so it is unclear whether the cost savings due to the increased energy efficiency justify the additional costs. However, raising transport costs slightly mitigate Germany's floor price disadvantage. Growing cost for raw material increases differences in floor prices to Germany's disadvantage (Fig. 2, left), however, it takes less efficiency improvements then to close the floor price gap (Fig. 2, right).

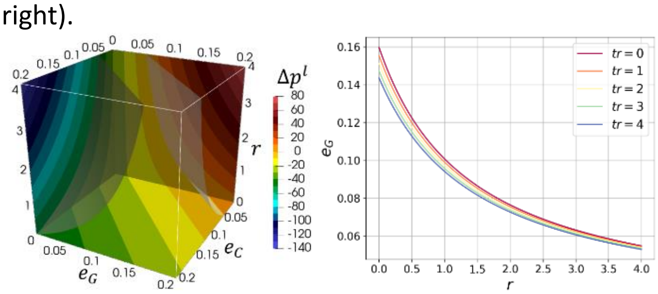

Fig. 2: Differences in floor prices: Brazil – Germany including level sets for difference of 0 to 50 $/tonne given unchanged transport cost (left); necessary increase in energy efficiency in Germany for floor price equality depending on price for raw materials and transport cost if energy efficiency remains on the level of today(right).

Assuming 30 Euro as price for CO_2 allowances, Brazil's floor price advantage rises to $56.0/tonne (relatively 12.7%) under current conditions. Floor price equality becomes unattainable if the transportation cost as well as the prices for raw material remain on the level of 2015 by increasing energy efficiency in Germany However, significant efficiency improvements in Germany combined with high cost for raw materials still result in floor price equality.

Germany – China: Under current conditions, Germany's floor price exceeds China's by 29.8$/tonne. An increase in the energy efficiency in the BF/BOF production route in Germany by 20% reduces this cost gap to 1.1$/tonne. Germany's steel industry benefits from raising transportation cost whereas China's industry profits from raising prices for raw materials such that mainly depending on these input factors, floor prices may or may not be equal.[1]

Germany – India: Under current conditions, Germany's floor price exceeds India's by $60.0/tonne or relatively 14.7%. Raising transport cost may improve Germany's competitiveness substantially. However, even if the transport cost increases by factor 4, the floor price difference will remains at 17.6$/tonne. For Germany a floor price advantage is predicted for an increase in energy efficiency by more than 11.2 %. It turns out that the difference in the floor prices significantly depends on the cost for raw materials with growing transportation cost favoring India. Germany's competitiveness for a price of CO_2 allowances of 0 Euro depends on the cost side on the transportation cost and the cost of raw materials, which cannot be directly influenced by measures taken by industry. Competiveness with respect to floor prices will completely lost if the price of CO_2 allowances increases.

Other countries: We additionally analyze the situation for Japan, South Korea and Russia, as neither of these countries enjoys a floor price advantage on the US market and may therefore turn to the European market. If the price of CO_2 allowances remains low, the floor price for Japanese steel will exceed the one for German steel under all conditions considered here. Under current conditions, the cost difference is $46.8/tonne and thus significant. Given price of CO_2 allowances of 30 Euro, the Japanese steel industry may achieve floor price equality, if the cost of raw material remains low and Japan increases the efficiency of its steel mills significantly. For a price of CO_2 allowances of Euro 50, however, Germany's

[1] For details and additional analysis, we refer to [7]

cost advantage is lost. The Japanese steel industry cannot compete with the German steel industry regarding floor price on the European market unless the pricing of CO_2 certificates raises significantly. Under current conditions, the Korean steel industry has a floor price disadvantage of $10.4/tonne on the European market ($409.4/tonne for German steel vs. $419.8/tonne for Korean steel). The Korean steel industry will not achieve significant floor price advantages under conditions that are foreseeable today. If the price of CO_2 allowances rise up to 30 Euro Germany's steel industry will suffers under today's conditions from a floor price disadvantage of 22.6$/tonne steel or 5.1% in relative terms.

4.2 Implications on energy consumption and CO_2 emissions on national, European, and global level

As expected a relocation of steel production will reduce CO_2-emissions in Europe. However, CO_2 – emissions linked to the transport steel to Europe as well as a substituting of changes in production in e.g. Germany by extension in the use of carbon-intensive steel production processes in other countries could be support an increase in global emissions. Hence there could be a trade-off between reduction of emissions in Europe and reduction on global. The discussion on the impacts of relocation of energy intensive sectors will become more complex if impacts on overall economy (i.e. employment), relevance of steel as intermediate good and feedbacks on other economies are taken into consideration. The calculated floor prices for crude steel give an initial rough estimation of the challenges the steel industry of Germany is facing. As mentioned our calculations indicate that German steel producers will have a competitive disadvantage if the transport cost does not increase significantly and if they are not able to expand their technological lead. Increases in prices for raw material strengthen the position of China, Russia and Brazil as players on the European steel market. Since transport of steel from China is more costly than from Russia, we expect a cost advantage for Russia if the cost of transport rises. According to our calculations, steel producers from the US have and will have a hard time on the European market. The production of steel in Germany and South Korea is linked with economic values generated in countries categorized by a medium HDI-index whereas the production of other countries comprises only activities in high or very high rated countries. Hence, a relocation of steel production in countries like China, Brazil or USA will indirectly impacted countries which show weaknesses with respect to long and healthy life, knowledge or standard of living, and which may still need some support from developed countries to reach a greater standard of life.

5 CONCLUSIONS

Among the key challenges faced the steel industry in Europe are uncertainties about the volatility of transport costs and of prices of input factors like raw materials and environmental regulations. Furthermore, recently tightened US import regulations may trigger hardly predictable consequences (e.g. harsh responses in the trade context by major steel-producing countries may be pending). We expect that the implementation of duties for steel products in the US will force steel producing countries to shift their activities towards the European markets besides others. This holds particularly for China, Brazil and Russia. According to our calculations, preserving the competitiveness of Germany's steel industry with respect to floor price requires intensive measures to improve energy efficiency. However, even significant improvements in that field do not necessarily lead to equality of floor prices. Raising cost of transport are advantageous for Germany's steel industry when considering differences of floor prices in all cases considered. By applying information on Human Development Index values (reflecting aspects of life expectancy, education, and per capita income) we show that not only energy demand and CO_2-emissions on global level but also developing countries may suffer from relocation of energy intensive industries from Europe.

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