Industrial relocation in a green hydrogen economy: a multiregional input-output analysis

Topic: Energy Policies
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Introduction
Industrial decarbonization will lead to a reconfiguration of global value chains (Egerer et al., 2024). As industrial production moves away from fossil fuels, higher transport costs for renewable energy sources (i.e. biomass, electricity and low-carbon hydrogen) will increasingly determine industry location decisions (Day, 2022). An emerging literature on this â€œrenewables pullâ€• effect (Samadi et al., 2023) points out that such â€œgreen relocationâ€• would impact industrial production structures in different regions, through either relocation of existing production plants or changes in location patterns for new production capacities. Here, renewable energy rich countries with already strong mining sectors like Chile, Brazil, South Africa, and Australia would be in a favourable position to attract such industries and promote green industrialization.

Research gap and aims of the study
As the green transition accelerates, understanding the potential of industrial relocation induced by renewables pull for promoting development in regions becomes ever more crucial. Nonetheless, the full economic impacts of such an industry relocation in different regions has remained an under-researched field. Studies have focused on how relocation of energy-intensive industries such as steel (Gielen et al., 2020) and ammonia (Egerer et al., 2024) could increase cost-effectiveness while contributing to achieve climate change mitigation goals. Since both â€œgreen steelâ€• and â€œgreen ammoniaâ€• production would use low-carbon hydrogen as inputs, but would be easier to transport, studies have pointed out to opportunities for these activities to co-locate with renewables-based hydrogen production to overcome transport challenges (Arnaiz del Pozo & Cloete, 2022).
This paper analyses the potential economic impacts of a relocation of European industries to Brazil due to a new â€œgreen corridorâ€• established between Brazil and the European Union via the Ports of PecÃ©m (in Brazil) and the Port of Rotterdam (in the Netherlands). Green hydrogen hubs in Brazil are expected to provide one fourth of European green hydrogen imports and could lead to relocation of European industries to Brazil. The potential economic impacts in all world regions stem from additional investment in the green technologies (in Brazil), relocation (in the EU) and trade reallocation (all regions).

Methods
This is done in MRIO framework with 5 world regions (EU, Brazil, USMCA, India, China) where the relocation and the simultaneous establishment of green hydrogen are dealt with as change in the technical coefficient matrix of the MRIO system. Green technologies for steel and ammonia production are introduced as new technical coefficients in the domestic matrix and the column of technical coefficients in the steel and the chemical industry is the weighted sum (with output weights) of the old and the green technology. Relocation will also change the part of the technical coefficient matrix that describes inter-regional linkages. This is analysed in a type I and type II model version, integrating the MRIO price model. From this price model, cost and price effects of new green technologies and potential trade reallocation can be derived. The latter is derived by applying trade elasticities to the most important trade flows in this context. Prices therefore exert several impacts and feedback mechanisms on quantities in our approach. In a first step, the cost/price effects lead to multi-regional price-spillovers, which are in turn influenced by trade substitution effects. One main indicator for the cost and welfare effects of â€˜green industry relocationâ€™ is the

aggregate consumer price index in the 5 regions. As the price and the quantity side are integrated, this consumer price effect exerts a feedback mechanism on consumption in all regions in terms of a real income effect.

Arnaiz del Pozo, C., & Cloete, S. (2022). Techno-economic assessment of blue and green ammonia as energy carriers in a low-carbon future. Energy Conversion and Management, 255, 115312.
Day, C. J. (2022). Why industrial location matters in a low-carbon economy. Structural Change and Economic Dynamics, 63, 283â€“292.
Egerer, J., Farhang-Damghani, N., Grimm, V., & Runge, P. (2024). The industry transformation from fossil fuels to hydrogen will reorganize value chains: Big picture and case studies for Germany. Applied Energy, 358,
Gielen, D., Saygin, D., Taibi, E., & Birat, J. (2020). Renewablesâ€•based decarbonization and relocation of iron and steel making: A case study. Journal of Industrial Ecology, 24(5), 1113â€“1125.

Samadi, S., Fischer, A., & LechtenbÃ¶hmer, S. (2023). The renewables pull effect: How regional differences in renewable energy costs could influence where industrial production is located in the future. Energy Research & Social Science, 104, 103257