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Policy Note

CO_2 Emissions Embodied in Austrian International Trade

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This study quantifies the CO2 emissions embodied in Austrian exports and imports, using a two region-input output approach (Austria and the rest of the world). The approach considers differences in production technologies between Austria and the rest of the world, concerning the CO2 coefficients (per unit of output) and the input-output structure (both are taken from data for EU 27). The CO2 emissions embodied in Austrian imports are considerably higher than CO2 emissions embodied in exports, i.e., CO2 for Austrian demand is leaking to the rest of the world. From 1995 to 2005 this negative balance of CO2 in trade has diminished in absolute terms, from 11 million tons (1995) to 6.4 million tons (2005), as CO2 embodied in exports has grown more rapidly than CO2 embodied in imports, thereby creating a huge potential for future carbon leakage.

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In the Framework of the Centre of Excellence "Research Centre International Economics"
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This study quantifies the CO_2 emissions embodied in Austrian exports and imports, using a two region-input output approach (Austria and the rest of the world). The approach considers differences in production technologies between Austria and the rest of the world, concerning the CO_2 coefficients (per unit of output) and the input-output structure (both are taken from data for EU 27). The CO_2 emissions embodied in Austrian imports are considerably higher than CO_2 emissions embodied in exports, i.e., CO_2 for Austrian demand is leaking to the rest of the world. From 1995 to 2005 this negative balance of CO_2 in trade has diminished in absolute terms, from 11 million tons (1995) to 6.4 million tons (2005), as CO_2 embodied in exports has grown more rapidly than CO_2 embodied in imports, thereby creating a huge potential for future carbon leakage.

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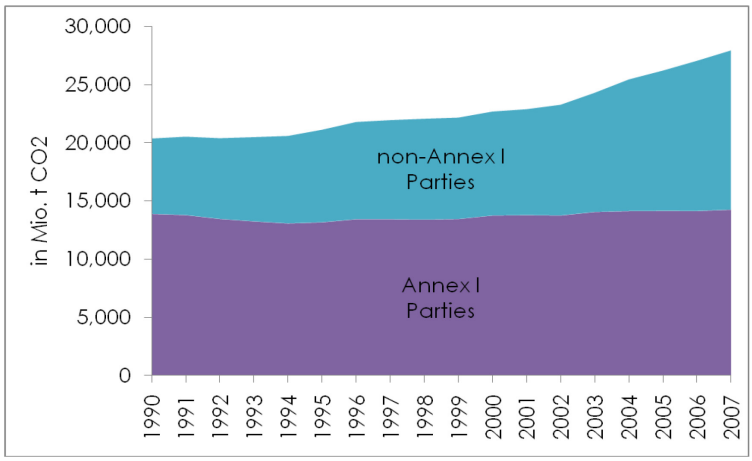
Contents

1 Introduction

Efforts to mitigate greenhouse gas (GHG) emissions to prevent dangerous anthropogenic interference with the climate system might be undermined, if countries committed to legally binding emissions reductions satisfy their demand for carbon-intensive goods by imports from countries that do not pledge any binding emissions reduction. Within the Kyoto Protocol, a protocol to the United Nations Framework Convention on Climate Change (UNFCCC), industrialized countries, so-called Annex I countries, commit themselves to a reduction of GHG emissions by 5.2% from 1990 levels. Non-Annex I countries, by contrast, do not have binding emissions reduction target for the first commitment period (2008-2012) of the Kyoto Protocol. The ratified countries have put some efforts in reducing GHG emissions by implementing various energy-related policies such as the EU Emission Trading Scheme (EU ETS), the EU directive on the promotion of the use of energy from renewable sources (EC, 2009), and the promotion of energy-efficient technologies (EC, 2008).

Figure 1: CO_2 emissions (territorial-base)



S.: IEA Database, CO_2 emissions from fuel combustion, Sectoral Approach, 2009

While emissions from Annex I countries have remained more or less constant since 1990 (+2.6%, Figure 1), CO_2 emissions from non-Annex I countries increased substantially (+111% from 1990 to 2007). This growth is partly due to the growing international trade of CO_2-relevant products from non-Annex I parties to Annex I parties. It has been calculated that 5.3 Giga tones (Gt) (21.5%) of global CO_2 emissions are embodied in internationally traded goods (Peters – Hertwich, 2008). The possibility of carbon leakage through international trade, i.e. the relocation of carbon intensive production to non-participants and/or the imports of embodied CO_2 from these countries, is likely to put further pressures on global emission

reduction targets, if the more restricted Annex I countries are going to use these channels as mitigation option.

For instance, the challenge of carbon leakage has prompted the European Commission to carry out an assessment of sectors deemed to be exposed to a significant risk of carbon leakage when facing higher costs through pricing carbon within the EU ETS. The analysis comprises 258 NACE 4-digit sectors covering mining and manufacturing activities. The assessment was undertaken in light of the implementation of the revised EU ETS which will apply from 2013. Installations in sectors that are at risk of carbon leakage due to competitiveness losses will receive a higher share of GHG emissions allowances free of charge in order to lessen the risk of carbon leakage. The risk of carbon leakage could be lessened by an international agreement due to be assigned during the UN climate conference in December in Copenhagen.

2 UNFCCC greenhouse gas inventories and alternative approach

In order to assess emission reduction commitments and performance, all parties to the UNFCCC and/or the Kyoto Protocol are required to submit annual inventories of GHG emissions. The GHG inventory applied by the UNFCCC is defined by the territorial principle, which is the national territory over which the country has jurisdiction (IPCC, 1996). This inventory thus encompasses a country's production including exports, omitting imports from international trade, i.e. it accounts for domestically produced products for households and governmental final demand as well as investments, including emissions associated with the production of products destined for export (see Table 1). This approach therefore is called production-based approach to GHG inventory.

In contrast, the consumption-based approach captures total domestic final demand, considering the net trade balance in emissions. Several studies have stressed the use of consumption-based approached to GHG inventories in order to account for carbon leakage within an internationally binding climate protection agreement (e.g. post-Kyoto agreement). This means, parties that have agreed internationally binding emissions reduction commitments would – under a consumption-based GHG inventory – be prevented from reducing domestic emissions by importing the necessary carbon emitting goods without adjusting final demand patterns or finding more carbon efficient production methods.

Table 1: Production vs. consumption-based approach to GHG inventories

UNFCCC GHG-inventory	Literature
production approach	**consumption approach**
= GHG emissions according to territorial principle (incl. exports)	= production approach - exports + imports

S.: Own illustration.

If consumption-based GHG inventories apply, developed countries will be assigned a greater share of global GHG emissions, thus, emission reduction commitments for developing countries would be much weaker. This is because net trade deficits of embodied carbon are substantial in OECD countries, e.g. France -134 Mt CO_2, Germany -147 Mt CO_2, Italy – 127 Mt CO_2, Japan, -312 Mt CO_2, UK -196 Mt CO_2, United States -858 Mt CO_2 (Nakano et al, 2009). The application of consumption-based GHG inventories would, in addition, create an incentive to trade products from countries with lowest emissions, highest technological efficiency standards and highly decarbonised energy systems. This would shift production to where it is environmentally preferable. International trade could, in this case, increase the ability to reduce GHG emissions in the same way that international trade has been exploited to reduce production costs. A crucial question, however, refers to obstacles to implementation of consumption-based accounts, i.e. practical issues associated with data availability and data construction needs to be addressed. The quality of data finally depends *inter alia* on the quality of the data of main trading partners and the complexity of the international production network for relevant economic sectors. National GHG inventories would thereby become internally linked through trading partners and be influenced by their respective emission profile. This would drive the process of emissions accounting and mitigation more interdependent and international.

The indication of carbon leakage, i.e. carbon embodied in traded goods between participating and non-participating countries, suggests the need to assess carbon emissions embedded in trade. This is, on the one hand, to judge about the effectiveness of efforts to reduce GHG emissions, and, on the other hand, to assess countries' emission profile and scope of carbon responsibility more clearly. It does, however, not seem likely that negotiations on a post-Kyoto agreement in Copenhagen will lead to a shift in the underlying emission reporting scheme, namely the GHG inventory employed by the UNFCCC. But more stringent mitigation policies by countries and regions will likely drive issues such as border-tax adjustments or sectoral approaches (IEA, 2009) of mitigation more topical if stringent abatement regimes continue to be asymmetric across countries.

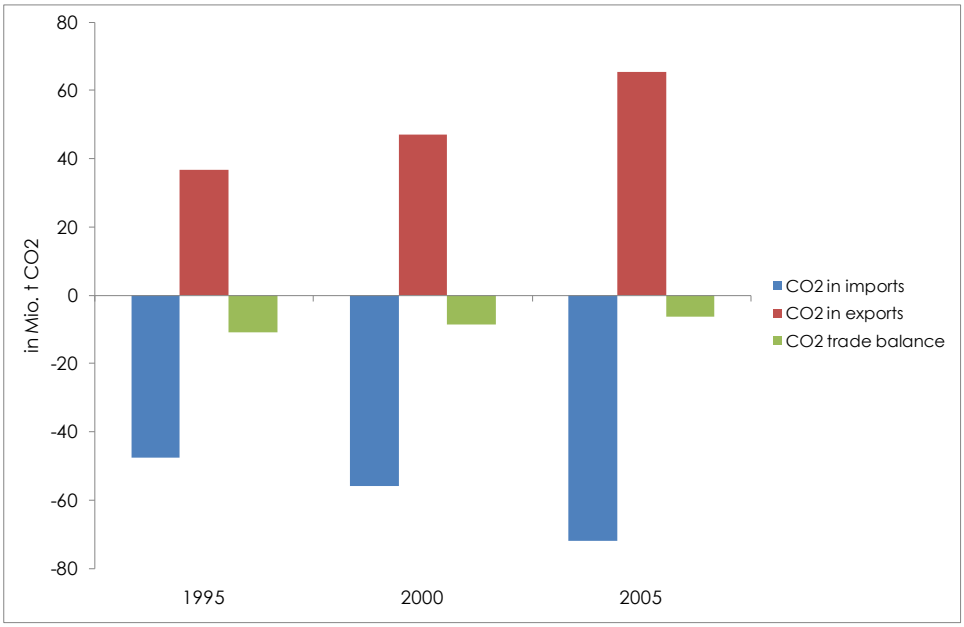
3 Emprical results of CO_2 emissions embodied in Austrian international trade

The present study quantifies Austria's emissions embodied in international trade in order to calculate net imports of carbon emissions. The calculation draws on trade balances and is equivalent to a consumption-based approach of GHG accounting. The main reason to apply a consumption-based approach to carbon emissions is to gain additional insight into possible causes of changes in emissions, i.e. to assess whether changes are the result of changes in the composition of final consumption, production or indeed changes in international trade. Deriving a picture of the emission performance of Austria taking into account emissions embodied in trade, the development of CO_2 emissions at three different points in time, 1995, 2000 and 2005, is compared. The change in the net imports of CO_2 emissions in this period reveals, if the burden of emission reduction in Austria has been shifted to other countries (carbon leakage) or if Austria has attracted emissions due to consumption growth in other regions.

The results for Austria show that both carbon embodied in imports and in exports increased in absolute terms from 1995 to 2005 (Figure 2). Carbon embodied in Austrian international trade has therefore been growing over the years underlining the trend of accelerating global integration by trade. In sum, the trade balance of embodied emissions has yet been shrinking, i.e. net imports of carbon embodied in trade were in decline. This development stands in contrast to developments that have been calculated for other countries, e.g. USA, Germany, Italy, UK and Japan, where the trade balance deficit of embodied emissions grew substantially (Nakano et al., 2009). Table 2 shows the amounts of CO_2 emissions embodied in Austrian trade flows in 1995, 2000 and 2005. According to this, imports of carbon embodied in imported goods grew by 50% between 1995 and 2005, while carbon embodied in exports increased by over 78%. In total, the trade balance reduced net carbon imports by 42%. In % of total CO_2 emissions (including the direct household emissions) the net carbon imports have fallen from 17% in 1995 to 8.3% in 2005.

This result is corroborated by the results in Nakano et al. (2009), who also find a decrease in Austrian CO_2 trade balance between 1995 and 2000 by 4 mill tons of CO_2. Though, their numbers for the absolute value of the CO_2 trade balance are much higher than in our results. The absolute amount of net carbon imports lies between 10 and 6.4 mill tons of CO_2 in the period 1995 to 2005 according to the calculations based on our model and our data set. Nakano et al. (2009) find a CO_2 trade balance of 31 (1995) and of 28 mill tons (2000). These differences in results might be due to aggregation issues in different categories of the data. On the one hand, in our study we only take into account one aggregate for the 'rest of the world' instead of differentiating between single regions and their trade relations and technologies, which might lead to underestimates of total emissions embodied in Austrian imports. On the other hand, the industry classification in our study is much more detailed, so that emission-intensive sectors are generally more separated from other low emission activities. This property might also lead to lower estimates of embodied emissions in our study.

Figure 2: CO_2 emissions, embodied in trade flows (in 1,000 tons)



S.: Own calculations

Table 2: CO_2 emissions, embodied in trade flows (in 1,000 tons)

	1995	2000	2005
CO_2 in imports	47.638	55.725	71.764
CO_2 in exports	36.666	47.138	65.428
CO2 trade balance	-10.972	-8.587	-6.336
in % of CO_2 in production	-24	-18	-11
in % of total CO_2	-17	-13	-8

S.: Own calculations

At the sectoral level (Figure 3) we observe large CO_2 net imports in 1995 as well as in 2005 for products from the following industries: 'Coke, refined petroleum products' (NACE 23), 'Rubber and plastic products' (NACE 25), 'Furniture and other manufactured goods' (NACE 36) and 'Electricity, gas, steam and hot water' (NACE 40). Large CO_2 net exports in both years can be found in 'Pulp, paper and paper products' (NACE 21), 'Other non-metallic mineral products' (NACE 26) and 'Basic metals' (NACE 27). Between 1995 and 2005 the CO_2 emissions embodied in the exports of these three emission-intensive industries increased by 17% ('Pulp, paper and paper products'), 76% ('Other non-metallic mineral products') and 46% ('Basic metals'), respectively. This can be seen as one of the main drivers behind the development of

decreasing CO_2 net imports between 1995 and 2005. The high growth of world trade in this period, accompanied by trends of globalization (outsourcing) has benefitted the resource-intensive industries in Austria. This large increase in emission-intensive, export-oriented production in Austria might translate into a large potential for future carbon leakage, if CO_2 emissions are strongly regulated in EU countries and are not in developing countries.

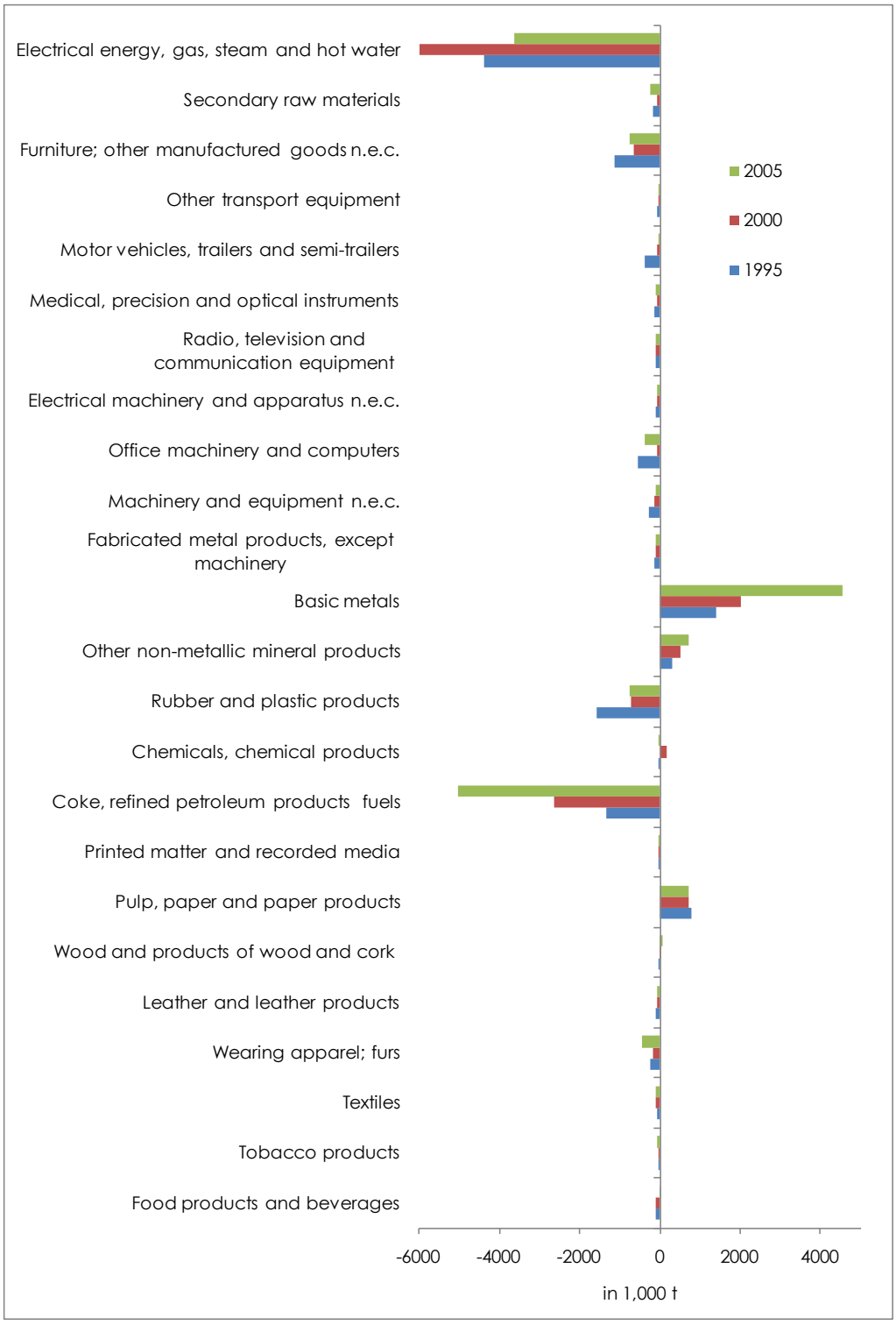
Those industries with negative CO_2 trade balances partially decreased their net imports between 1995 and 2005, like 'Electricity, gas, steam and hot water' and 'rubber and plastic products'. The net imports of 'Coke, refined petroleum products' increased significantly between 1995 and 2005.

4 Conclusions

In this study the CO_2 emissions embodied in Austria's international trade have been quantified. The analysis revealed large net imports of CO_2 in Austria, between 8% and 17% of total CO_2 emissions. One important result is that between 1995 and 2005 these net imports have decreased considerably. This is partly due to decreases of imported CO_2 emissions and of huge increases of exported CO_2 emissions. Especially the basic metal industry has increased its net exports between 1995 and 2005 and the electricity sector has decreased its net imports during the same period. The large increase in exports of CO_2 emissions of Austria between 1995 and 2005 is due the growth of emission-intensive Austrian exports (especially basic metals) together with the high growth in world trade in this period. However, CO_2 embodied in imports also increased significantly in the period 1995 to 2005. The development in this period might translate into a large potential for future carbon leakage, if CO_2 emissions are strongly regulated in EU countries and are not in developing countries. A global regulation and/or pricing of carbon could ease this problem. If a post-Kyoto international climate agreement sticks to highly asymmetric reduction commitments between world regions, issues of international sectoral approaches are likely to become more topical.

The single country approach used in this study should in future work be extended towards a multi-regional approach by integrating bilateral trade data with IO tables. In a dynamic perspective it would also be interesting to integrate further macroeconomic feedback mechanisms into the analysis of carbon leakage.

Figure 3: CO_2 emissions, trade balances (in 1,000 tons)



S.: Own calculations.

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