Trade in Virtual Carbon

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What drives carbon dioxide emissions? The question has been answered in many forums through the use of basic accounting techniques. Here we are interested on a slightly different question, that is, 'who' drives emissions? The answer can be obtained from two perspectives. The first perspective, which is referred to as production-based approach, imputes emissions to the countries physically burning fossil fuels in their industrial processes. On the other hand, the consumption-based perspective imputes emissions to the countries that are consuming goods and services whose manufacturing has required the burning of fossil fuels at some point during their production cycle. The amount of carbon that passes through intermediate goods until it ends up embedded into final goods is termed 'virtual' carbon. The calculations are not trivial, but the comparison of emissions under the two perspectives provides striking insights.

First let us think about the production angle: carbon emissions vary greatly across world regions. The largest per capita emissions can be found in high income countries, but as for absolute emissions, economies like Brazil, China, India, Mexico and Russia are all amongst the top ten emitters.[1] Emissions of a region are linked to its level of development. the structure of the economy, and resource endowments. When virtual carbon flows are taken into account, things change substantially. Recently, a number of studies investigate the carbon content of international trade. According to Caldeira and Davis (2010), 6.2 gigatonnes of CO_2 have been traded globally in 2004; in wealthier countries like Sweden, Switzerland, Britain or France over 30 percent of consumption-based emissions accrue from imports. The data below is based in the calculations by Atkinson *et al.* (2011), who follow a similar procedure. In order to examine the virtual carbon content for traded goods, the authors use a multiregional input-output analysis where trade data is merged with domestic input-output tables.[2]

In the maps below, the difference between production-based and consumption-based emissions is shown. Such difference can also be interpreted – more intuitively – as the net exports of virtual carbon. Atkinson *et al.* (2011) group countries according to their size, income, location as well as their status under the Kyoto protocol.[3] The upper map in Figure 1 shows the level of net exports in virtual carbon, the two lower maps illustrate intensities – net exports of virtual carbon per Gross National Income (GNI) and per capita.

The patterns are quite similar across all maps in Figure 1. EU15, Japan and the United States are the top net importers in absolute terms.[4] This also holds in relative terms (see intensity measures in the two lower maps). Other net importers include Mexico and the group of 'Other Annex I'[5]. Clearly, for high income countries a substantial share of the emissions embodied in consumed goods is produced abroad. Not surprisingly, most of this virtual carbon originates in fast industrialising countries like Brazil, China, India and Russia. The upper map shows Brazil, Canada, India, South Africa and transition economies[6] are all moderate net exporters of virtual carbon. China, Russia and 'Other middle income' countries are all high net exporters. Notice that while Canada appears as a net-exporter, Mexico is a net-importer.

The data also allows to break up a given country's exports (or imports) by country of destination (or ori-

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[1] In 2005, according to the World Resource Institute (www.cait.wri.org).

[2] Only CO_2 from fossil fuel consumption in the database.

[3] The study divides the world into 15 countries/regions: Brazil, Canada, China, EU15 , India, Japan, Low income, Mexico, Other Annex I, Other high income, Other middle income, Russia, South Africa, Transition economies, United States. Annex I countries are required to meet greenhouse gas emission reduction targets under the Kyoto Protocol.

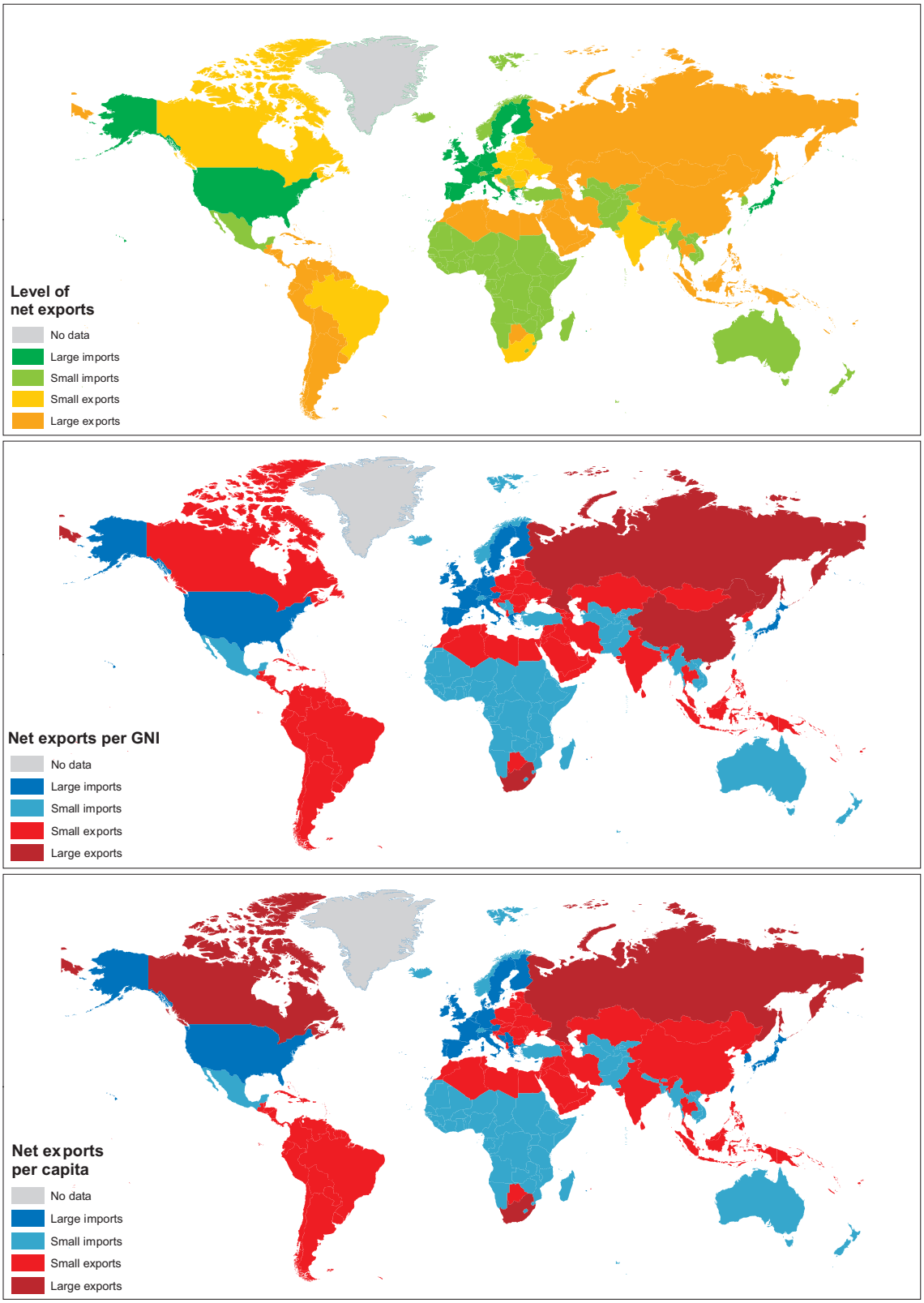
[4] EU15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

[5] Other Annex I include Australia, Iceland, Liechtenstein, New Zealand, Norway, Switzerland and Turkey.

[6] The group of transition economies consists of Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak republic, Slovenia, Ukraine.

Figure 1

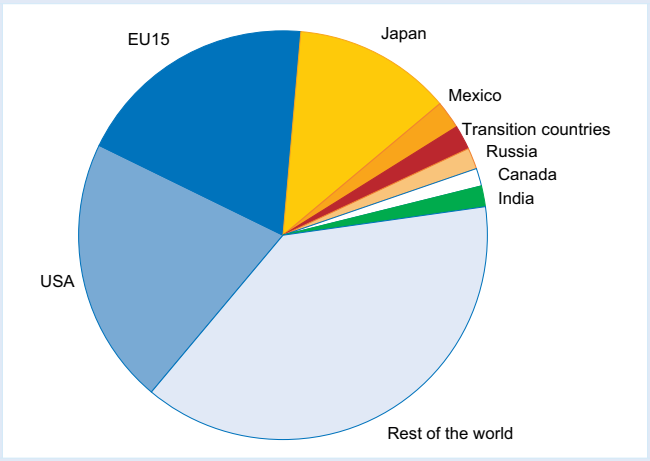
Net Exports of Virtual Carbon



Source: Atkinson *et al.* (2011).

Figure 2

CHINESE EXPORTS OF VIRTUAL CARBON BY COUNTRY, 2004



Source: Atkinson *et al.* (2011).

gin). For example, Figure 2 decomposes Chinese exports of virtual carbon by destination. More than half of China's virtual carbon is exported to the EU15, Japan and the United States. But carbon-intensive products are delivered to other emerging economies such as Mexico, India and Russia.

In the two lower maps in Figure 1, the data is adjusted for the size of the economy and its population. The general picture remains, however some changes can be observed. In both intensity illustrations, South Africa becomes a large net exporter, whereas the net exports of 'Other middle income' countries take a more moderate level. The Latin American counties which are part of this group now range in the same category as Brazil. In the bottom map, after adjusting for population, Canada becomes a large net exporter and China a small net exporter. This reflects that Canada in contrast to China is not a very populous country.

Carbon emissions are a global pollutant and it is important to stabilize global atmospheric concentration of emissions. However, when deciding on global mitigation strategies and debating global climate agreements, it is necessary to be aware of the differences between production- and consumption-based emissions. In the debate about appropriate policy measures a tax on the carbon contents of final consumption has been proposed. This tax would have substantial distributional effects. Atkinson *et al.* (2011) calculate the effective tax rate that would fall on countries' exports by adopting a globally uniform consumption-based carbon tax. Such a tax would increase prices of e.g. Chinese products as much as a production-based tax and therefore curb Chinese exports. However, the tax revenue will be created in Europe or any of the other importing countries. As the world comes to grips with the climate change challenge, distributional issues are not of secondary importance. And data can take us a great deal into a better understanding of the issues at stake.

References

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