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ACCOUNTING FOR CARBON EMISSIONS: PRODUCTION VERSUS CONSUMPTION

Addressing climate change is a complex challenge. The problem is global in scope, and it is demonstrably hard to secure cooperation among a large number of nations with diverse industrial structures and at very different levels of economic development. One important concern of policy-makers in jurisdictions committed to taking strong action on climate change is that reductions in emissions required of firms operating within their borders may lead to a decline in industrial activity and employment in sectors subject to regulation. A related worry is that emissions reductions actually achieved by their own industries may be counteracted by higher emissions in jurisdictions with weaker/non-existent regulations – a situation often referred to as "carbon leakage." Leakage is most likely to occur in the case of relatively emissions-intensive industries in developed economies. For such jurisdictions, it is clear that climate policy, by imposing a cost on greenhouse gas (GHG) emissions, "has the potential to negatively affect carbon-intensive industries that compete with foreign producers, either at home or abroad, and for which energy is a significant share of total production costs."[1]

Concerns about carbon leakage and the loss of industrial production/jobs apply in the case of British Columbia, a small trade-dependent economy whose government has legislated unusually aggressive targets to lower GHG emissions over the medium term.[2] Because it has adopted GHG targets that are more stringent than those embraced by its principal trading partners, BC is at risk of losing production and employment in the resource, manufacturing and transportation industries that form the backbone of its export base. British Columbia also stands out – at least within North America – in having imposed a broadly-based carbon tax on the use of all types of fossil fuels by domestic households and firms. The province's aggressive GHG reduction targets and gradually rising carbon tax may make BC increasingly uncompetitive for several industries that represent a substantial share of its current exports.

Carbon Emissions and International Trade

According to recent data, global emissions of carbon dioxide attributable to the burning of fossil fuels rose by 3.4% per year from 2000 to 2008, up sharply from 1.0% per year over

[1] Trevor Houser, Rob Bradley, Britt Childs, Jacob Werksman, and Robert Heilmayr, Leveling the Carbon Playing Field, Peterson Institute for International Economics and World Resources Institute (2008), p. xvi.
[2] BC has passed legislation requiring a 33% reduction in annual GHG emissions between 2007 and 2020.

the 1990s.[3] This rate of increase exceeds even the "pessimistic" scenarios outlined by the Intergovernmental Panel on Climate Change (IPCC) in its 2001 and 2007 assessment reports.

What explains the faster-than-expected growth in emissions? An expanding global population and steady increases in per capita income across much of the world are certainly part of the answer (although these trends presumably were incorporated into the IPCC's 2001 and 2007 projections). But there is another factor at work: rapid economic growth and ongoing industrialization in China and other emerging economies, coupled with the increasing role these countries are playing as suppliers of manufactured goods to the global market.

China is an informative case of the more general phenomenon of carbon leakage. This year, China is expected to overtake Japan as the world's second largest economy, measured in terms of annual output. It is already the single biggest source of GHG emissions. China also ranks as the world's leading exporter, with a heavy focus on traded manufactured goods. Importantly, most of the growth in its production of manufactured products is for export, with a sizable majority of these exports destined for developed countries such as Japan, the US, Canada and the nations that are part of the EU.

The issue raised by China (and, by extension, other developing economies) is not simply that carbon-intensive industries may choose to locate there to escape the cost of climate mitigation policies implemented by advanced countries. It also has to do with China's integration into the global economy, the rapid-fire development of the modern industrial sector of its economy, and the rising standard of living and material desires of hundreds of millions of Chinese households. As two US climate experts have noted, China is best described as an example of "weak carbon leakage," inasmuch as a significant fraction of the growth of its GHG emissions since the mid-1990s is embodied in goods produced there but ultimately transported to and consumed in other countries.[4]

Reported national inventories of carbon dioxide and other GHGs capture emissions produced within sovereign territories; they generally ignore the role of international trade and the benefits which consumers obtain from imports produced elsewhere. To overcome this limitation, researchers have started to develop consumption-based emissions inventories to complement existing production-based inventories. This involves quantifying the emissions embodied in trade flows – both those generated by the production of traded goods, as well as those stemming from the transportation of these goods to where they are consumed. Consumption-based emissions inventories have not been used to assign responsibility for emissions within the discussions occurring under the United Nations Framework Convention on Climate Change, nor (to our knowledge) have they been considered in the context of the Western Climate Initiative process in which British Columbia is a participant.

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[3] C.. Le Quere, et al, "Trends in the sources and sinks of carbon dioxide," Nature Geoscience, number 2 (December 2009).

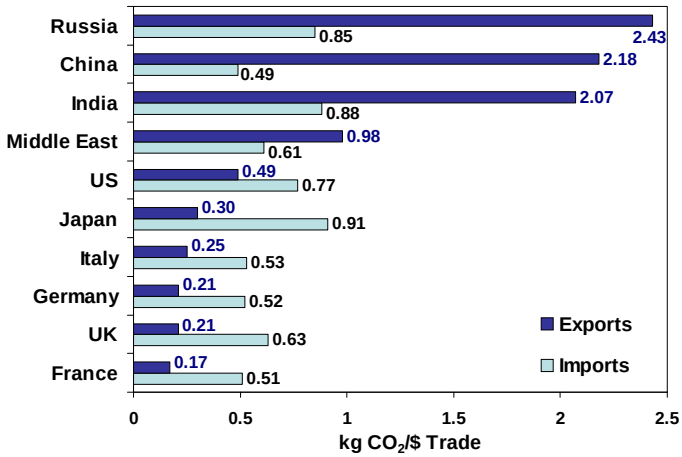
[4] Steven J. Davis and Ken Caldeira, "Consumption-based accounting of CO2 emissions," Proceedings of the National Academy of Sciences, Early Edition (www.pnas.org).

A recent US study attempts to allocate global CO_2 emissions to countries and industry sectors based on patterns of final demand for finished goods – i.e., excluding demand for raw materials and other intermediate goods used to produce final goods. Using this method, it is possible to determine emissions associated with final consumption in regions and countries, based on estimates of CO_2 emissions per unit of output of traded goods and services. According to the authors of the study, the reported calculations "trace all emissions associated with consumed goods back to the original source that produced the emissions even if products were trans-shipped through other countries/regions or were intermediate constituents in a multi-regional supply chain." Under this particular model, "the difference between production emissions and consumption emissions…represents the net effect of emissions embodied in trade…"[5]

The results highlight the impact of international trade on the ultimate locus of CO_2 emissions. It turns out that almost one-quarter of global emissions from the burning of fossil fuels are linked to traded goods consumed in a different country from the country of production.[6]

Figure 1

Mean CO2 Intensity of Imports and Exports



Source: Davis and Caldeira.

Figure 1 provides data on the average CO_2 intensity of imports and exports for a number of major trading nations. The data underscore the high average carbon intensity of exports from emerging economies like China, Russia and India – a finding that partly reflects the carbon-intensity of their domestic energy systems (notably electricity), but that also speaks to the issue of carbon leakage. In contrast, in advanced economies like the US, Japan and Germany, exports are significantly less carbon-intensive than imports, indicating, *inter alia*, that these economies depend on energy- and energy-intensive goods produced elsewhere.

On a regional basis, China is the largest "net exporter" of emissions, due to the volume of exports, the carbon-intensity of its industrial mix and the emissions associated with shipping goods to foreign buyers, followed by Russia, the Middle East, South Africa, Ukraine, and India. The primary "net importers" of CO_2 emissions are the US, Japan, the UK, and the big continental West European economies. Although not shown in Figure 1, Canada is a moderate "net exporter" of CO_2 emissions overall.[7]

[5] Ibid., p. 1.
[6] Ibid., p. 4. The data are for 2004. This result is confirmed in Glen P. Peters, "From production-based to consumption-based emission inventories," Ecological Economics, volume 8 (March 2008).
[7] Davis and Caldeira, op. cit., p. 5.

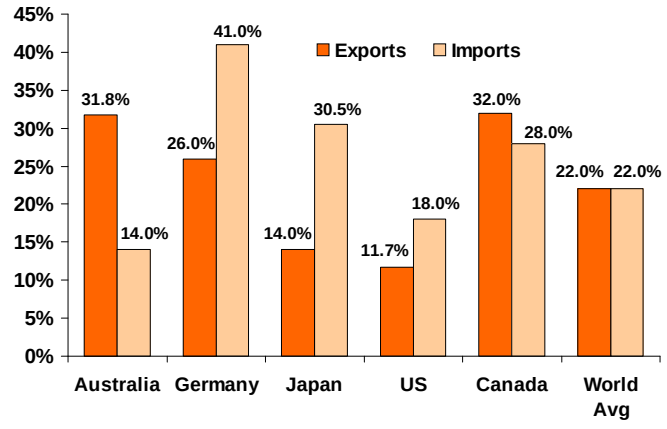
To summarize, analyzing the carbon emissions embodied in traded goods and services indicates that significant quantities of emissions are "exported" from some nations – notably emerging markets – to other nations (mainly advanced economies) that are importers, and ultimately consumers, of energy and manufactured goods produced by the net carbon "exporters."

Of interest, Canada and Australia stand out among developed countries in that the pattern of their international trade puts them closer to emerging economies than to the leading advanced economies like the US, Japan and Germany – that is, their export bundles are more carbon-intensive than their import bundles. This is shown in Figure 2, which provides data on CO_2 emissions embodied in exports and imports, measured as a percentage of each country's total domestic emissions in 2001.[8] In Canada's case, while the country buys increasing volumes of manufactured goods from China and other emerging markets (and also depends on imported petroleum products in some parts of the country), it is a net exporter of energy, minerals/metals, energy-intensive industrial goods (e.g., aluminium, cement, chemicals), and various agricultural commodities. That a large share of Canada's production of carbon-intensive goods is consumed elsewhere does not figure in the determination of its national GHG emissions inventory under the United Nations Framework Convention on Climate Change.

Figure 2

Emissions Embodied in Trade

(CO2 emissions as percentage of total domestic production emissions, 2001)



British Columbia's Position

A similar observation applies to British Columbia, where resources and resource-based manufactured goods comprise three-quarters of international merchandise exports (Figure 3). Although the studies referenced above don't include information on sub-national jurisdictions, it is likely that, like Canada as a whole, BC is a "net exporter" of carbon, mainly because of its exports of natural gas, coal, metallic minerals and fabricated metals, but also because it sells pulp/paper products, building materials, cement, chemicals, and selected agricultural products. In some important respects, BC differs from the United States – and even more so from California, the dominant participant in the Western Climate Initiative (WCI) process with which BC is also involved. California, like the US, has a strategic interest in pushing the cost of GHG mitigation "upstream," onto the suppliers of the energy and energy-intensive goods of which it is a net importer. British Columbia does not share this

[8] Glen P. Peters and Edgar G. Hertwich, "Trading Kyoto," Nature Reports on Climate Change (March 2008); available at www.nature.com.

interest. We see a risk that BC stands to be disadvantaged by an emerging GHG regulatory system – whether pan-North American or regional in scope – that absolves consumers/importers of responsibility for the emissions embodied in traded goods/services, and instead shifts all of the associated costs upstream. That said, on current evidence this is the type of regulatory regime that appears most likely to evolve through the WCI discussions – or, indeed, under a potential future US-Canada climate accord based on a cap-and-trade model.

Figure 3
Composition of BC's Merchandise Exports
(% of total exports, 2008)

Wood products	16.3%
Coal	16.2%
Pulp/paper	14.2%
Machinery and equipment	10.2%
Metallic mineral products	10.0%
Natural gas	9.5%
Agricultural products	4.8%
All other goods NES	4.1%
Fabricated metals	3.7%
Other energy products	3.4%
Chemicals	3.2%
Fish	2.7%
Other manufactured goods	1.7%

Source: BC Stats.

Although the BC government is keen to pursue opportunities to sell renewable electricity to California, as part of its participation in the WCI process and as an element of its climate and energy policy agenda, policy-makers need to be sensitive to the economic realities confronting our export-oriented industries, some of which are quite carbon-intensive. Depending on the rules governing the proposed WCI cap-and-trade scheme, and on the domestic implementation details adopted by each WCI partner jurisdiction, there is a possibility that, in the event that a WCI cap-and-trade regime comes into effect in 2012 or shortly thereafter, British Columbia could end up shouldering a disproportionate share of the WCI-wide economic burden of reducing GHG emissions. In this case, several of our export industries may be put at a competitive disadvantage, both within the WCI and on a wider global basis, owing to higher operating costs and/or the imposition of more stringent emissions caps emitting facilities.

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