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POLICY BRIEF

# Exposure Of Chinese Exports To Potential Border Carbon Adjustments

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## Introducing the issue

While proposals for border carbon adjustments (BCAs) may be off the table at present, the ongoing debates about international carbon flows and policies suggest that the underlying concerns and issues are still current. China has been central to these debates, and any proposal for a BCA will need to be cast with this in mind.[2]

This brief quantifies the impact of existing proposals for BCAs on exports from China. It shows that not only are there many uncertainties regarding design detail, but also that these uncertainties can have a significant impact on the exposure of exports. Previous studies have highlighted the fact that the products included, the $CO_2$ price applied, and the method for assessing the $CO_2$ content are of critical importance. These three considerations form the basis of the analysis.

## Putting BCAs into the Chinese Context

### Why BCAs are under consideration

As growth in trade continues to outstrip growth in GDP (economic growth), attention has been directed to the $CO_2$ emissions that are embodied in traded goods and how these emissions would be governed by carbon pricing policies. In particular, concern has been raised over the fact that, by implementing carbon prices, a country increases the cost of domestic production

[1] Research conducted by Qiu Wei, PhD student at University of International Business and Economics, Beijing, while completing an internship at the IISD. Full paper forthcoming.

[2] The inclusion of aviation into the EU Emissions Trading System (ETS) as of 2012, and the possible exemption of those countries taking equivalent measures to mitigate emissions, has been discussed as the first practical application of a BCA.

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relative to imported goods, and in doing incentivizes changes in trade and/or production patterns to the detriment of domestic industry. It is possible that such changes could in turn lead to carbon leakage, as emissions reductions in the $CO_2$-constrained region are offset by increased emissions elsewhere.

In response, it has been suggested that given uneven implementation of carbon pricing policies, those countries that do choose to implement such measures would be advised to try and limit the distortions in consumption and production that arise from the resultant cost asymmetries. BCAs, which require payment of a tax or purchase of emissions certificates in line with carbon content of imports, are one such measure.

### Why China matters

The growth in both Chinese GDP and exports is well documented: in 2009, GDP was $4,985 billion[3] (8.6 per cent of world total) and merchandise export value was $1,202 billion (9.6 per cent of world total), making China the world's third largest economy and largest exporter.[4] Chinese production is relatively carbon intensive on average, with data from the Energy Information Administration indicating that in 2009, 2.2 $MtCO_2$ (million tonnes of carbon dioxide) was emitted for each $1,000 of output, compared to 0.3 $MtCO_2$ in Europe.[5] These statistics suggest that China is pivotal to any discussion of BCAs. On the one hand, they imply that an effective BCA should seek to include emissions from Chinese production, while on the other that the impact of BCAs on Chinese exports could be significant.

### The current status of BCA proposals

BCAs have been considered by a number of countries, but discussions have advanced furthest in the EU and the U.S. For both regions, proposals exist that give some guidance as to possible designs for future schemes. The analysis is based on these proposals, but does not imply that the design will follow exactly or that implementation would be restricted to these regions.

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## *Assessing $CO_2$ content: What's in a product?*

Assessing how much $CO_2$ is emitted during production of a good, while appearing simple, quickly becomes a complex exercise. These complexities can have a significant impact on how policy works.

### Key assumptions

Scope: Products do not contain $CO_2$. Rather, emissions of $CO_2$ are considered to be "embodied" within products if they are emitted during their production. The emissions embodied within a product can be assessed on a variety of bases (see Box One). A key distinction can be drawn between approaches that only include $CO_2$ arising directly from the production of the final good, and those that also capture $CO_2$ emitted "indirectly," i.e. in the production of the inputs required to make the final good. When referring to China, it is particularly important to consider whether emissions

[3] All dollar figures in U.S. dollars here and elsewhere.
[4] WTO International Trade Statistics (2010)
[5] Energy Information Administration, International Energy Statistics, www.eia.gov

arising from the electricity used in the production process are included within the scope since the sector accounts for nearly half of total $CO_2$ emitted. Also of potential importance are the emissions embodied in those items that are imported into the economy for use in the production process, with consideration being given to whether these emissions are included in the calculations, and to whether the calculations reflect the emissions intensity of production in the country from which the input originated or in the country in which it is subsequently used. Finally, the inclusion or exclusion of other greenhouse gases (GHGs) beyond $CO_2$ is likely to have a significant effect, particularly due to emissions from agriculture.[6]

**BOX ONE: DEFINING EMBODIED EMISSIONS**

This study uses the following terminology when referring to emissions scope:

*Direct*—$CO_2$ emitted in the production of a good itself, directly from fuel combustion and process emissions.

*Indirect*—$CO_2$ emissions from inputs used when producing a good, notably from the generation of electricity used.

*Life-cycle*—all $CO_2$ arising from production of the good itself and its inputs, including electricity used. It refers to $CO_2$ emitted at all stages of a good's manufacturing process, from the mining of raw materials through the distribution process, to the final product provided to the consumer.[7]

**Product Disaggregation:** Although conducting an analysis for each individual product type and each production method is most accurate, doing so for the entire economy is unlikely to be possible on a consistent and comparable basis. There tends to be a trade-off between coverage and accuracy, with figures covering the whole economy available at only a relatively high level of aggregation. Conducting analysis at the product group level loses some accuracy, but is likely to be more practical.

**Materiality:** Where the embodied $CO_2$ content of a product is very small, its inclusion in a BCA scheme is likely to result in administrative costs in excess of any benefits which may accrue. Persson (2009) reviews administrative costs and concludes that the greater the degree of precision of a BCA, the higher the administrative costs.[8]

## Data used

Reliable assessment of $CO_2$ content is clearly dependent on the availability of good quality data for production, emissions intensity and trade. Where this data is incomplete or out of date, there is the risk that the calculated emissions for exports and subsequent assessments of charges payable are distorted.

[6] Frank Ackerman. "Carbon embodied in China's trade." Working Paper WP-US-0906, Stockholm Environment Institute, 2009.
[7] A full life-cycle approach would also include the use and disposal of the product.
[8] Sofia Persson. "Practical aspects of border carbon adjustment measures—Using a trade facilitation perspective to assess trade costs." ICTSD Programme on Competitiveness and Sustainable Development, Issue Paper No.13, International Centre for Trade and Sustainable Development, Geneva, Switzerland, 2010.

## Approach in this study

This analysis is based on input–output tables showing the interdependence of each sector of the economy with production from one sector using the output of, and being used as an input to, the production of other sectors. By coupling these tables with emissions data, the $CO_2$ arising from production by any one sector can be calculated (see Box Two); adding in bilateral trade statistics then allows carbon flows between countries to be mapped. This approach enables a comprehensive assessment of emissions within and across the entire economy, albeit at an aggregated product level. By layering assumptions on the design of BCAs over these flows, it is possible to assess the $CO_2$ flows and product value that would be captured.

The practical design and implementation of a system is, however, another consideration, and it is not necessarily appropriate to use input–output tables for this purpose. In particular, input–output tables are only available at the subsector level and are published only infrequently. Other approaches, such as life-cycle analysis, allow examination at the product level but are time-consuming, and to comprehensively apply them across the economy requires data which does not yet exist and is unlikely to be available in the future.

Based on Box One, this analysis considers the effects of levelling charges based on direct and life-cycle emissions. The analysis does not take account of imports into China or GHGs other than $CO_2$.

**BOX TWO: USING INPUT–OUTPUT TABLES TO ILLUSTRATE $CO_2$ FLOWS**[9]

A. Total emissions from fuel combustion are calculated using fuel consumption statistics (China Energy Statistical Yearbook, 2008) and $CO_2$ emissions factors for each fuel type (IPCC, 2006).

B. Direct emissions from each sector are calculated through applying the Tier 1 approach introduced by IPCC 2006 and estimates of fuel usage by each sector.

C. Direct emissions are converted into life-cycle emissions using a Leontief inverse input–output matrix, giving cumulative emissions associated with production by any sector.

D. These results are coupled with trade data to calculate emissions associated with exports to the U.S. and EU in 2007 (data retrieved from Eurostat External Trade Database and the U.S. Department of Commerce).

## *What prices might be implemented?*

Since BCAs are aimed at leveling the costs between domestic and overseas production, the price applied to imports should be the same as that faced by domestic producers. What such a price could be is far from clear, but assumptions of \$20/$tCO_2$ and \$50/$tCO_2$ (roughly corresponding to €15/$tCO_2$ and €30/$tCO_2$) are used to reflect recent prices in the EU carbon markets and long term planning assumptions used in the EU. The effect of existing policies also needs to be considered in order to best reflect how BCAs are likely to be implemented in reality. For example, in the EU ETS, the value of free allowances needs to be subtracted from the carbon price in order to arrive at the BCA, giving an effective price much closer to zero.

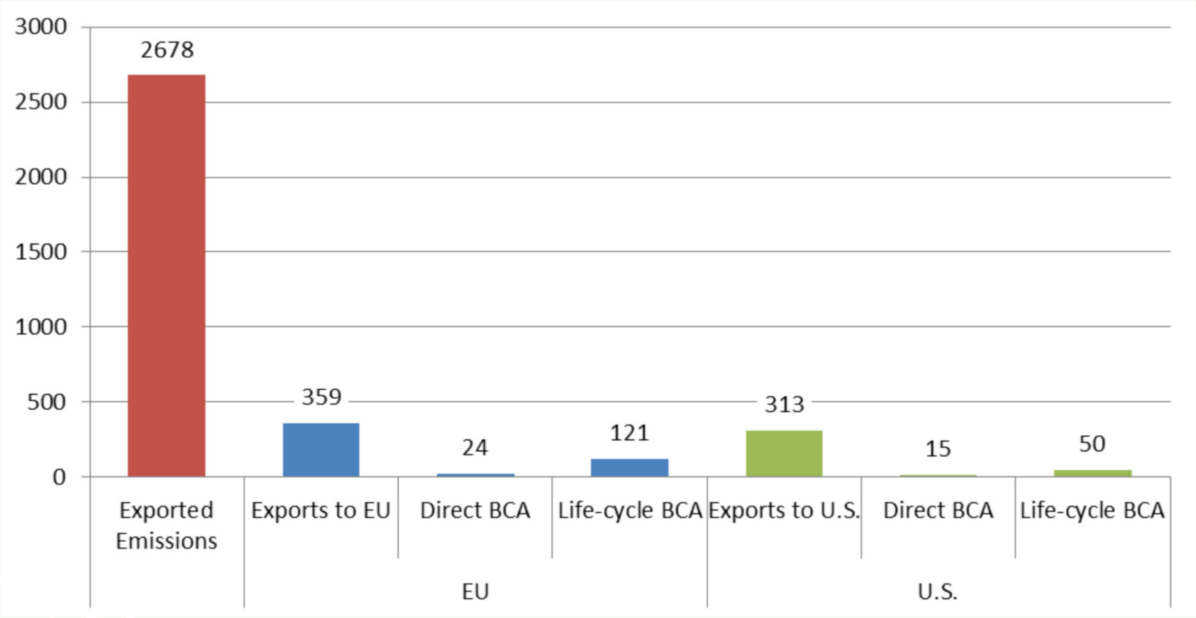
[9] See also Boqiang Lin and Chuanwang Sun. "Evaluating carbon dioxide emissions in international trade of China." Energy Policy, 2009.

## Coverage: Emissions captured under BCA Proposals

The EU is the largest export market for Chinese goods, accounting for 20 per cent of total goods exports in 2009 and 13 per cent of exported life-cycle emissions. As the second largest export market for Chinese goods, the U.S. accounted for 18 per cent of total goods exports in 2009 and 12 per cent of exported life-cycle emissions.[10]

The analysis of BCAs for the U.S. is based on the American Clean Energy and Security Act[11] and focuses on the 46 sectors identified as likely to be covered by BCAs.[12] Analysis of the EU is based on proposals in Phase III of the EU ETS for including imports from energy intensive industries in the scheme, and assumes that BCAs would be applied to the sectors and subsectors identified by the European Commission (2009) as being at risk of carbon leakage.[13] The direct and life-cycle emissions associated with exports from these sectors are calculated using input–output tables and bilateral trade data. For the purpose of simplifying the calculations, sectors where Chinese goods accounts for less than 5 per cent of total imports (U.S.) or less than €5 million (EU) are excluded.[14] Based on this analysis, Figure One shows total life-cycle emissions associated with exports from China, the proportion accounted for by exports to the U.S. or EU (based on embodied emissions), and the proportion of emissions captured by different BCA designs.

**Figure One: Emissions from Chinese exports as captured under different BCA proposals ($MtCO_2$)**




[10] Trade data based on WTO International Trade Statistics, 2010. Emissions data based on 2007 input–output tables

[11] The American Clean Energy and Security Act of 2009 (H.R. 2454), also known as the "Waxman Markey" bill.

[12] "Effects of H.R. 2454 on international competitiveness and emission leakage in energy-intensive trade-exposed industries: An interagency report responding to a request from Senators Bayh, Specter, Stabenow, McCaskill, & Brown," (2009)

[13] Commission Decision of 24 December 2009. Those goods that are identified as being at risk solely on the basis of trade intensity, with no requirement to demonstrate carbon intensity (paragraph 16b goods) are excluded.

[14] Sensitivity analysis shows that decreasing the cut-off to less than 1 per cent or €0.5 million has only a very small impact in terms of emissions and import value captured.

It is clear that BCAs imposed in the EU and / or the U.S. will only be able to directly cover those emissions associated with imports from China to these countries and that the level of coverage is limited by restrictions on the sectors included in the scheme. Accordingly, the proposals capture only a fraction of the emissions associated with Chinese exports, with higher levels of coverage achieved by considering life-cycle rather than direct emissions (5.1 per cent of total exported emissions compared to 1.5 per cent). This suggests that the environmental effects of BCAs are likely to be limited at the level of the economy as a whole, although the effect on covered sectors could be greater.

## *Quantifying the economic impact—How exposed are Chinese exports?*

Based on the coverage given above, the total amount payable under the EU and U.S. schemes is calculated by applying a carbon price to the emissions associated with these products. Table One summarises the results of the analysis, showing likely total charges under different calculation and price assumptions, and these total charges as a percentage of the value of exports covered by the BCA proposals in either the EU or the U.S.[15] The table shows that at $20/tCO_2$, the additional cost could range from $0.3 billion if the U.S. alone applied them to direct emissions through to $3.5 billion if both the U.S. and EU applied to life-cycle emissions.

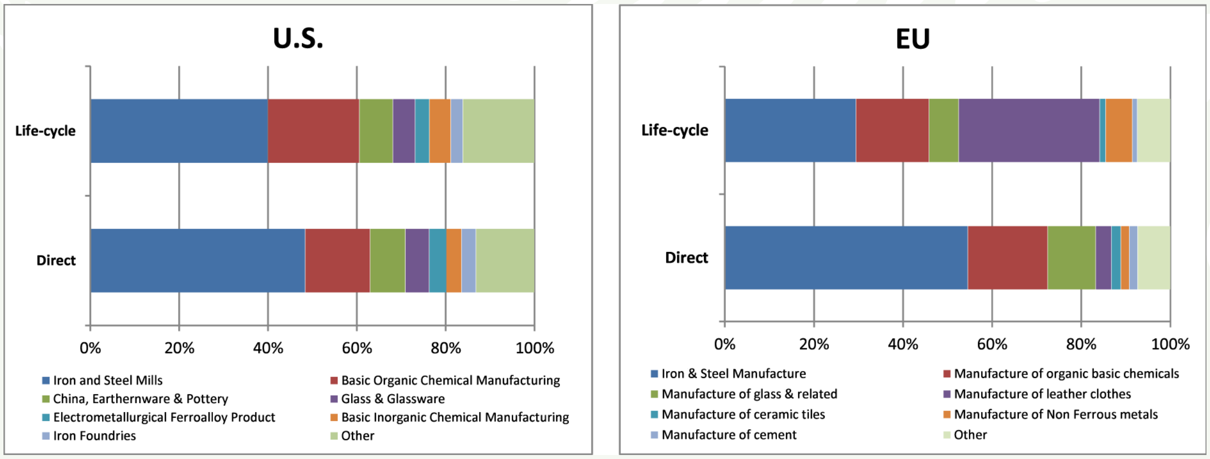
**Table One: Charges from levelling BCAs on Chinese Manufactured Exports**

| | | US BCAs | | EU BCAs | | US & EU | |
|---|---|---|---|---|---|---|---|
| | | $20/ton $CO_2e$ | $50/ton $CO_2e$ | $20/ton $CO_2e$ | $50/ton $CO_2e$ | $20/ton $CO_2e$ | $50/ton $CO_2e$ |
| Based on direct emissions | charge (bn $) | 0.3 | 0.8 | 0.5 | 1.2 | 0.8 | 2.0 |
| | charge as % of export value of covered sectors | 2.3% | 5.7% | 0.9% | 2.2% | 1.2% | 2.9% |
| Based on life-cycle emissions | bn $ | 1.0 | 2.5 | 2.4 | 6.1 | 3.4 | 8.6 |
| | charge as % of export value of covered sectors | 7.6% | 19.1% | 4.4% | 11.3% | 5.1% | 12.8% |

Looking at individual subsectors, Figure Two shows that Iron and Steel Mills, and Basic Organic Chemical Manufacturing account for the majority of charges in the U.S., when calculated on either a direct emissions or a life-cycle approach. For the EU, the same two sectors account for the majority of the charges when based on direct emissions, but on a life-cycle emissions basis, the manufacture of leather products attracts the highest charges. This reflects the high export volume from China to the EU.

[15] Calculated using 2007 input-output tables

**Figure Two: Build-up of total charges by each subsector**




The total charge is converted into an ad valorem tax equivalent for separate sectors to give an indication of relative price effects. In both the EU and the U.S., the highest rates are attracted by the Iron and Steel Sector with an average rate of 8.3 per cent for the EU and 3.4 per cent for the U.S. and when calculated at \$20/t$CO_2$ and on the basis of direct emissions, and 18.9 per cent for the EU and 9.4 per cent for the U.S. when calculated on life-cycle emissions.[16] It is these products that could be considered most exposed to the effects of BCAs. However, here, as elsewhere, it is worth noting that the subsector analysis is not necessarily representative of the effects that may occur at the product level.

## *Guidance for Policy Makers*

Models based on multi-region input-output tables can be a useful first step in understanding the potential coverage and outcomes of BCAs. In particular, they can be used to highlight the flows of $CO_2$ through trade, and the key sensitivities that affect the outcomes of BCAs. Analysis here shows that:

- **Coverage:** the charges imposed under a BCA regime will vary across subsectors depending on emissions intensity of production. It is likely that only a limited number would be materially impacted by a workable BCA. While recognising the challenges of implementation, basing a scheme on life-cycle emissions would ensure the fullest coverage and would better align incentives to production.
  However, using the tables to design and apply schemes across the entire economy is likely to be problematic. The data required for an input-output analysis is updated infrequently (tables are published only every five years or so and use data which is even older). Further, significant detail is lost by focusing on the subsector level available in input-output tables, with implications for both the economic effectiveness and political viability of the approach. Measuring emissions at company and product levels would be ideal, but establishing and operating a scheme for collecting the necessary data would be a significant undertaking on an economy-wide basis, demanding resources almost certainly well out of proportion to any possible benefits. However, further development of the approach for key sectors identified may be worth exploring.

[16] For the EU, this includes manufacture of basic iron and steel and of ferroalloys, cold drawing, and manufacture of cast iron tubes. For the U.S., it includes Iron and Steel Mills, Electrometallurgical Ferroalloy Product Manufacturing and Iron Foundries.

- **Incentives:** Assuming implementation by the U.S. and the EU, the value of exports captured under current proposals for BCAs would be around 10 per cent of the value of exports from China to these regions, or 6 per cent of the value of total exports from China. The corresponding charges paid by exporters would range from $0.8 billion (or 0.2 per cent of the value of exports to the EU & U.S.) at a price assumption of $20/tCO_2$ and based on direct emissions, through to $8.6 billion (or 1.8 per cent of the value of exports to the EU & U.S.) at a price assumption of $50/tCO_2$ and based on life-cycle emissions.

  Given the limited share of Chinese export value at risk, the impact of such BCAs on incentivising $CO_2$ emission reductions is likely to be limited. Exporters may find that it is both possible and more cost effective to divert this production to other destinations, rather than pay the charges applied under the BCA. Further exploration of these and other responses would require a dynamic modelling approach.

## *Next steps*

This research has provided insights into the use of models based on multi-region input–output tables in tracking the carbon embodied in trade flows and the proportion of these trade flows that are captured under various BCA scenarios. The IISD will continue to build on this work in collaboration with the Sustainability Research Institute at Leeds University by developing scenarios for BCAs to use in a Multi Region Input–Output (MRIO) analysis.

A range of other studies using MRIO models are being undertaken by organisations including Leeds University and the Carbon Trust.[17] Comparing the results from the various studies will generate more confidence in the interpretation of their results. The models can also be used to investigate other key issues around the impacts on BCAs and other potential carbon policies, for example highlighting the sectors where exports from a country are concentrated in a limited number of countries, notably if these countries are the most likely to implement BCAs or other carbon policies.

Whether MRIO models can be used as the basis for workable BCA schemes still requires further examination, but there are very considerable challenges.

[17] The Carbon Trust's work on International Carbon Flows, which presently covers sectors including Automotive, Steel, Aluminium, Cotton and Clothing, is available at: **http://www.carbontrust.co.uk/policy-legislation/international-carbon-flows/pages/default.aspx**

## IISD's TRI-CC Program

This work is an output of IISD's Trade, Investment and Climate Change Program (TRI-CC). Related research will aim to deepen understanding of energy intensive industries, so as to better understand the effect of policies on these sectors. In particular, it forms part of an assessment of trade impacts of BCAs in developing countries, and will be followed by a complementary analysis of how BCAs affect exports from South Africa. Related research will aim to deepen understanding of energy intensive industries, so as to better understand the effect of policies on these sectors. Together, these analyses will inform research on the practical aspects of developing and implementing a BCA system.

Other similar areas of work in the TRI-CC Program include developing guidance for policy makers in elaborating and implementing BCAs, deepening understanding of climate policy for the steel and cement sectors, and work on emerging issues such as GHG-intensity standards and subsidies for green industrial development. Under TRI-CC's Investment and Climate Change theme, IISD will work with host country governments to develop policies that help catalyse flows of climate friendly investment.

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