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Carbon tariffs: What might they mean for the North American aluminum sector?

Background

In the past decade, it has become increasingly obvious that even though negotiation of the Kyoto Protocol on Global Climate Change in 1997 was a useful first step, further efforts to develop a comprehensive multilateral agreement for reducing carbon emissions will be necessary if global climate change is to be properly addressed. However, successive failures of the United Nations Climate Change Conference suggest that hopes of reaching agreement by 2015 on the setting of emissions caps after 2020 are optimistic at best. Irrespective of the economic logic supporting a multilateral approach to dealing with a global externality, there has been a shift in many countries from pursuing a legally binding international agreement to one where individual countries decide on their own carbon emission reduction targets and the policy instrument for reaching that target.

Much of the recent discussion as well as actual application of climate policy has focused on the use of market-based instruments such as carbon taxes and tradable emissions permits. Carbon taxes have been proposed in many countries, including China, and either are or have been applied in several countries, most notably Australia. In the case of the current European Emissions Trading Scheme, Canadian provinces such as Québec, and also previously proposed US climate policy legislation, the choice of instrument is a system of tradable permits or what is usually referred to as cap-and-trade.

Whether a carbon tax or cap-and-trade system is used, the expectation is that certain energy-intensive industries downstream from electricity production, such as the steel, aluminum, chemicals, paper and cement industries, will face increased costs of production. As a consequence, much of the unilateral climate legislation that has been proposed also includes some type of border measure, popularly termed "carbon tariffs" (Paul Krugman, *New York Times*, November 14, 2014), to be targeted at energy-intensive imports.

The inclusion of border measures in climate change legislation is predicated on two connected concerns: first, there will be *carbon leakage*, i.e., production by firms in energy-intensive industries will be shifted to countries with less restrictive climate policies; second, there will be a reduction in *competitiveness* of firms in industries most affected by domestic climate policies, firms losing market share and incurring reduced profits.

Despite the obvious appeal of using "carbon tariffs" to take care of carbon leakage and loss of competitiveness, there is a practical concern that they could be used for protectionist ends and would therefore be constrained by current WTO rules. It turns out, that if such trade policy instruments are treated as *border tax adjustments* (BTAs) rather than border tariffs, the basis for their use is captured in the WTO rules: WTO/GATT Article II: 2(a) allows members of the WTO to place on the imports of any good, a BTA equivalent to an internal tax on the like good. However, under

WTO/GATT Article III: 2, the BTA cannot be applied *in excess* of that applied directly or indirectly to the like domestic good, i.e., they have to be *neutral* in terms of their impact on trade, their objective being to preserve *competitive equality* between domestic and imported goods. Therefore, if climate policy is to ensure that the price consumers pay for an energy-intensive product such as aluminum reflects the true cost of producing aluminum, then a BTA on imported aluminum may be permitted as long as it does not distort trade

Ultimately, whether or not BTAs are in compliance with WTO rules will be determined by an actual ruling from Geneva in any dispute between WTO members. Assuming they are legal though, it is interesting to consider the possible effect of the US unilaterally placing a price on carbon, and at the same time utilizing a BTA on imports of an energy-intensive good such as aluminum.

The North American Aluminum Industry

The US aluminum industry has already been identified as one that might be vulnerable to the issues of competitiveness and carbon leakage, due to the fact that it is both energy-intensive and also highly exposed to international competition (Houser *et al*. 2009).

Aluminum production is part of a vertical production process that initially requires the raw materials bauxite and alumina. Bauxite is processed into alumina, which is subsequently used to produce aluminum. Unwrought aluminum is then cast into various shapes depending on its end use: large flat ingots are intended for hot-rolling to produce aluminum plate and sheet, while cylindrical ingots are for extrusion through a die to produce tubing and other hollow shapes.

Aluminum is extracted from alumina using an electrolytic reduction method known as the Hall-Héroult process. It takes place in a series of steel-shelled cells, or "pots", which are lined with refractory bricks and carbon blocks, alumina being dissolved in the pot using a molten electrolyte. An electrical current is passed through the electrolyte via a carbon anode hung over the pots, the latter acting as a cathode, reducing the alumina to aluminum and oxygen. The oxygen is released on the carbon anode where it forms carbon monoxide and carbon dioxide, while the aluminum settles to the bottom of the pots. This process is very energy-intensive, with anywhere from 14 to 17 megawatts of electricity required per tonne of aluminum, the amount depending on the type of anode-technology used. Production costs for primary aluminum are dominated by raw materials (35%), electricity (25%), and anodes (16%) respectively, the remainder being due to labor and other input costs (24%), (USITC 2010).

In terms of environmental impact, the production process has two key sources for carbon and other greenhouse gas (GHG) emissions: first, there are direct carbon dioxide emissions due to anode degradation and perfluorocarbon (PFC) emissions from the electrolyte, amounting to emissions of 2-3 tCO_2/t of aluminum produced (Carbon Trust 2011); second, there are indirect carbon emissions associated with upstream electricity production, where the amount of carbon dioxide produced depends on the method of electricity generation, ranging from 3 tCO_2/t of aluminum for hydro-electric production to 20 tCO_2/t of aluminum for coal-powered production (Carbon Trust).

US aluminum production is concentrated in the hands of a few firms, Alcoa and Century Aluminum alone accounting for 73% of production capacity. However, there is significant import competition in the US market. For example, in 2008, US production of aluminum was 2.66 million tonnes, which was almost exclusively for domestic consumption. Total imports of aluminum were 2.81 million tonnes, of which over 71% was accounted for by Canada, the other major suppliers being Russia and Venezuela with 10% and 4% shares of US imports respectively (USITC).

Canada's share of US aluminum imports increased substantially after 2004, such that by 2008, Canadian exports to the US accounted for 64% of its total production (USITC), suggesting that the US and Canada constitute a well-defined North American market where Canadian-based firms essentially compete in the US. The Canadian aluminum industry is also concentrated, Rio Tinto Alcan and Alcoa, accounting for 82% of production capacity in 2008 (Natural Resources Canada 2009). It should also be noted that both the US and Canadian industries are characterized by the operations of multinational firms, Alcoa and Rio Tinto Alcan, who between them account for 24% of global aluminum production (Carbon Trust).

A key difference between the US and Canadian aluminum industries is that while geographic location of smelting plants in both countries is tied directly to the availability and cost of electricity, the Canadian industry is located predominantly in the province of Québec, where electricity is produced entirely from hydro-electric sources (Natural Resources Canada). By contrast, US smelting plants are located in the southeastern region (South Carolina, Kentucky, and Virginia), the Midwest (Indiana, Missouri, and Ohio), New York, and the Pacific Northwest (Washington, and Montana), where the lion's share of electricity generation is fossil fuel-based (USITC; USEIA 2012). This of course has important implications for carbon emissions from aluminum production in the US as compared to Canada, where the former generates an estimated 7.4 tCO_2/t of aluminum (Carbon Trust), while the latter generates an estimated 2.5 tCO_2/t of aluminum (CIEEDAC 2013).

US Carbon Pricing and Carbon Tariffs

In recent research, Sheldon and McCorriston (2015) have analyzed the impact of US carbon pricing on the North American aluminum industry. Specifically, they evaluate the potential economic effects of the US and Canada implementing differential carbon prices, followed by the US targeting a BTA at imports of aluminum from Canada.

Their analysis assumes that the US carbon price is set at \$25/t CO_2, based on Tol's (2005) mean CO_2 damage estimate. This implies a total increase in the costs facing US aluminum firms of \$282/t of aluminum produced. Importantly, the US carbon price is assumed to be set higher than that recently introduced in Canada.

Starting January 1, 2013, Québec has implemented a cap-and-trade system for carbon emission permits as part of the Western Climate Initiative. The program covers electricity generation and industrial sectors with annual GHG emissions of over 25,000 tonnes, which includes aluminum production. From the start of the program, distribution of emissions permits to electricity generation has been set at 100% via auction, but due to concerns about competitiveness and carbon leakage, industries such as aluminum received 80-100% of their required emissions permits free of charge up to 2014, after which the number of free emissions permits they receive declines by 1-2% per year.

The Québec Ministry of Sustainable Development, Environment, Wildlife and Parks (MDDEFP) held permit auctions on December 3, 2013 and March 4, 2014, where the final auction prices averaged \$10.2/t CO_2 (MDDEFP 2013; 2014). This translates into an increase in Canadian aluminum production costs of \$84/t of aluminum produced. The initial free allocation of emissions permits, to aluminum firms in Québec means that there is no direct increase in Canadian aluminum production costs.

In the absence of BTAs, Sheldon and McCorriston find that US carbon pricing causes a 16% decline in profits of US aluminum firms, and US aluminum users are negatively affected by higher aluminum prices, although this is partially offset by the tax revenue raised from carbon pricing and the reduction in the damage due to carbon emissions. In terms of competitiveness and carbon leakage, US aluminum firms lose market share and there is carbon leakage, although total North American GHG emissions do decline by 6%. This is due to the fact that even though Canadian firms gain market share, their rate of carbon emissions is lower than that of US firms.

Since the WTO rules on BTAs are not specific in defining 'competitive equality', McCorriston and Sheldon allow for the US implementing one of two possible "carbon tariffs": *either* a BTA that keeps the *volume* of imports of Canadian aluminum constant given the US carbon price, *or* a BTA that keeps the US *market share* of imports of Canadian aluminum constant given the US carbon price. It can be argued that both of these rules fit into a broader rationale, on how stricter climate policy can be accommodated in a manner consistent with key principles of the WTO concerning market access. In the absence of BTAs, the US would have little incentive to unilaterally implement carbon pricing due to the competitiveness effect. However, if the competitiveness effect is thought of in terms of Canadian firms gaining additional market access to the US aluminum market beyond levels previously negotiated in the WTO, using a BTA to restore the level of market access to its negotiated level, after implementation of carbon pricing, it might not elicit a complaint to the WTO from Canada.

In their results, Sheldon and McCorriston find that a BTA designed to ensure that the volume of Canadian aluminum imports does not change after implementation of the US carbon price, should be set at $141/t of aluminum imported, less than the US carbon price. In contrast, a BTA designed to ensure that the market share of Canadian imports does not change after implementation of the US carbon price, should be set at $469/t of aluminum imported, greater than the US carbon price. The latter result follows from the fact that if US firms lose market share due to carbon pricing, Canadian firms' exports to the US will have to be taxed heavily at the border in order to restore market shares to their original level.

In the case of the import volume BTA, Sheldon and McCorriston find that there is a 13% decline in profits of US aluminum firms, and while US aluminum users lose from higher aluminum prices, again this partially offset by the tax revenue raised from carbon pricing and the BTA, along with a reduction in the damage due to carbon emissions. In terms of competitiveness and carbon leakage, the results indicate US aluminum firms still lose some market share, but there is no carbon leakage, i.e., the competitiveness problem of US implementation of a differential carbon price relative to Canada cannot be wholly resolved with a volume BTA.

In the case of the import share BTA, the results indicate that profits of US aluminum firms fall by 6%, and once again the losses incurred by US aluminum users are partially offset by the tax revenue raised from carbon pricing and the BTA, along with the reduction in the damage from emissions. In terms of competitiveness, US aluminum firms no longer lose market share, a function of Canadian firms maintaining their market share. Interestingly, there is also negative carbon leakage, which follows from the combination of the US carbon tax and share BTA, reducing the output of both US and Canadian firms, but at the same time maintaining their pre-policy market shares. In other words, this particular policy combination actually "facilitates collusion" among US and Canadian aluminum firms, imposing the largest losses on aluminum users of any policy combination. This highlights an important issue: while pricing carbon reduces GHG emissions in the US, and use of a "carbon tariff" maintains competitiveness and prevents carbon leakage, exploitation of market power in the US aluminum industry may be exacerbated along with the associated costs imposed on aluminum users.

Concluding Observations

The discussion presented here is motivated by the fact that proposed climate legislation often includes some type of border measure to be targeted at energy-intensive imports such as aluminum. The argument for including such "carbon tariffs" is not only the possibility that import-competing firms will become less competitive following implementation of climate policy, but that there will be carbon leakage as market share shifts to foreign firms.

Results of recent research by Sheldon and McCorriston show that if WTO rules on BTAs are interpreted as maintaining the volume of aluminum imports, there will be no carbon leakage, US firms incurring a reduction in output and lost profits and hence their competitiveness. Alternatively, if WTO rules on BTAs are interpreted in terms of maintaining US market share of aluminum imports, global carbon emissions may actually be reduced due to there being negative carbon leakage, and the competitiveness of US firms is maintained.

It should also be noted that in both interpretations of WTO rules on BTAs, users of aluminum actually suffer a loss due to prices increasing by more than they would in a competitive setting. This highlights an important practical tension between targeting carbon emissions where there is a possibility that polluting firms may exploit their market power. This tension is greatest in the case of a BTA based on maintaining the US market share of imports, given that the BTA has to be set much higher than the US carbon price in order to maintain the competitiveness of US aluminum firms.

However, even if domestic political economy concerns favor the market share over the market volume interpretation of WTO rules, the former would seem much more likely to fall foul of the national treatment principle contained in Article III of GATT. Specifically, even if trade neutrality is maintained, Canadian exporters of aluminum might contest that they are being discriminated against via a "carbon tariff" that is higher than the effective carbon price faced by US aluminum firms.

Bibliography

Carbon Trust, *International Carbon Flows: Aluminum (CTC 790)* (2011).

Canadian Industrial Energy End-Use Data and Analysis Center (CIEEDAC), *Energy Use and Related Data: Canadian Aluminum Industries 1990 to 2011*, Simon Fraser University (2013).

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).

Natural Resources Canada, *Canadian Minerals Yearbook – 2009*, Government of Canada (2009).

Paul Krugman, "China, Coal Climate," New York Times, November 14, 2014.

MDDEFP, *Auction of Québec Greenhouse Gas Emission Units on December 3, 2013: Summary Report Results*, Government of Québec (2013)

MDDEFP, *Auction of Québec Greenhouse Gas Emission Units on March 4, 2014: Summary Report Results*, Government of Québec (2014).

Ian Sheldon and Steve McCorriston, "Climate Policy and Border Measures: The Case of the US Aluminum Industry," Working Paper, Ohio State University, (2015).

Richard Tol, "The Marginal Damage Costs of Carbon Dioxide Emissions: An Assessment of the Uncertainties," *Energy Policy* 2005(33): 2064-2074.

United States Energy Information Administration (USEIA), *Net Generation by State by Type of Producer by Energy Source* (2012).

United States International Trade Commission (USITC), "Unwrought Aluminum: Industry and Trade Summary," Publication ITS-06 (2010).

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