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In this article, Pomerleau compares two methods used to border-adjust a carbon price, arguing that border adjustments present unique challenges but, if designed well, would be an important part of a domestic carbon price in the United States.

I. Introduction

Proposals to enact a carbon border adjustment have gained tremendous momentum globally over the past few years. In 2023 the European Union began implementing the world's first carbon border adjustment mechanism (CBAM).[1] Lawmakers in the United States have introduced several legislative proposals that would tax imported goods based on their associated carbon emissions.[2] Meanwhile, some countries, including the United Kingdom, Canada, and Australia are considering a carbon border levy.[3]

Those proposals are motivated by a desire to protect the competitiveness of domestic industry and address meaningful differences in climate regulations across jurisdictions. Climate change is a global issue that affects all countries, but climate policy is enacted at the country or state level, which inevitably leads to differences in the stringency and variety of policies. That creates an incentive to enact relatively lax climate policies to attract economic activity from countries with stricter policies.

There are several types of common climate policies that countries implement to encourage emissions reduction. They include explicit carbon pricing (a carbon tax or a cap-and-trade system), command-and-control climate regulations, and clean energy subsidies.

Carbon taxes and cap-and-trade systems are both explicit carbon prices that price the negative externalities of greenhouse gas emissions, but they have differences. A carbon tax is a consumption tax that is levied per tonne of carbon equivalent emissions (CO_{2e}). A cap-and-trade system sets the total allowed amount of emissions, then sells or assigns a specified number of emissions permits to businesses, enabling them to buy or sell the permits.[4]

A carbon border adjustment, in principle, is a component of domestic carbon tax.[5] Thirty-nine

[1] Shuting Pomerleau, "The EU Unveiled a Carbon Tariff. How Should the U.S. Respond?" Niskanen Center (July 20, 2021).

[2] Pomerleau, "Carbon Border Adjustment Bills: How Do the U.S. Proposals Compare to the EU One?" Niskanen Center (Mar. 21, 2024).

[3] International Emissions Trading Association, "IETA Publishes Overview of International Reaction to EU's Carbon Border Levy" (Apr. 18, 2024).

[4] Pomerleau, "Carbon Pricing and Regulations Compared," Niskanen Center (Sept. 21, 2021).

[5] Pomerleau, "Border Adjustments in a Carbon Tax," Niskanen Center (July 2020).

countries have implemented national carbon tax policies.[6] The border adjustment applies to the domestic carbon tax on imported goods and can provide a rebate for exports. A border adjustment is meant to limit the incentive to shift production to low-tax jurisdictions and, sometimes, encourage foreign jurisdictions to increase the stringency of their carbon pricing policies. In practice, carbon border adjustments are also enacted as a component of a cap-and-trade system like the EU emissions trading system (ETS), discussed below.

Border adjustments are widely used in other types of taxes, such as VAT and excise taxes on fuel. Unlike other taxes, however, the bases of a carbon border adjustment are not readily observable. That creates administrative and design challenges. Those challenges include determining emissions in both imports and exports; the coverage threshold for which goods to include; and whether or how to account for climate policies, for example, carbon pricing or climate regulations.

This article reviews two methods used to border adjust a carbon price: the EU CBAM and a proposed method developed by two U.S.-based experts called the greenhouse gas index (GGI). It compares the two frameworks and discusses significant similarities and differences regarding covered goods, covered emissions, level and method of allocating emissions, and the treatment of imports and exports. It concludes by arguing that border adjustments present unique challenges but, if designed well, would be an important part of a domestic carbon price in the United States.

II. Challenges in Designing a Carbon Border Adjustment

Domestic carbon taxes are typically designed as a levy on upstream facilities and operations to produce fossil fuels. Although a tax like this would apply to only roughly 3,000 companies,[7] it would cover most of the carbon content in the U.S. economy. While collected by these 3,000 producers, the tax burden would be passed along the supply chain to downstream producers in the form of higher costs and lower profits, ultimately increasing prices on goods and services based on their carbon content.

A border adjustment, in principle, would apply the equivalent levy on imported goods and services based on their carbon content. Also, it would provide a rebate for any carbon tax embedded in the price of exports. That would shift the base of the carbon tax from the carbon content in domestic production to the carbon content in domestic consumption. The goal is to maintain the competitiveness of domestic producers and eliminate location production decisions.

Although a carbon tax on domestic production is straightforward, adjusting the tax so it applies to domestic consumption is challenging. Taxes that are typically border adjusted, such as VAT or excise taxes, are levied either on the market price of goods and services or on a per-unit basis at the border. Market prices and physical goods are observable, so the tax base is known. In contrast, a good imported from a jurisdiction like Europe or China has unobservable carbon content that is a function of potentially unknown inputs and production processes. U.S.-produced goods for export face similar challenges. Because carbon taxes are often levied upstream at the point of extraction, it is not immediately known what the carbon content is or what the embedded tax associated with the imported and exported goods will be at the border. Content could be tracked through the supply chain like a VAT, but existing emissions data that would make this possible are available mostly at the industry and facility level, but not at the product level.

Given those challenges, border adjustment proposals typically vary in design. The design choices often represent trade-offs between efficiency (applying the carbon tax as broadly and equally as possible) and simplicity (a tax that can easily be administered by tax authorities and complied with by taxpayers). Designs vary regarding which goods are eligible, what type of emissions are covered, the level of emissions to use, how product-level emissions are estimated, how to treat exported and imported goods, and

[6] World Bank Group, "State and Trends of Carbon Pricing Dashboard."

[7] Pomerleau, "Administrative Costs of a Carbon Tax," Niskanen Center (Feb. 2021).

whether to account for foreign countries' carbon pricing policies.

III. Two Methods to Administer a Carbon Border Adjustment

Two main methods have been developed. The first is the EU CBAM, a border adjustment mechanism for the EU's ETS. The second method is a proposal by two U.S.-based researchers to administer a border adjustment for a hypothetical domestic carbon tax.

A. The EU Carbon Border Adjustment Mechanism

The EU started implementing the world's first carbon border fee, the EU CBAM, in 2023, and will start collecting emission certificates from importers of covered products imported into the EU based on their associated carbon emissions.

The border adjustment is meant to work with the EU ETS. The EU ETS was launched in 2005 and covers about 40 percent of total greenhouse gas emissions in the EU. It works by setting the limit of the total allowable greenhouse gas emissions for the covered businesses in the form of emissions allowances. Businesses can purchase the emissions allowances in an auction or trade them.[8] The EU ETS covers emissions from sectors such as energy, manufacturing, aviation within the EU and departing to the United Kingdom and Switzerland, and maritime transport.[9] Some industries are eligible for free allowances, which permit the manufacturers in these industries to be exempted from the ETS up to a specified threshold.[10]

The goal of the EU CBAM is to gradually replace the ETS free allowances and ensure domestic EU producers and foreign producers compete on a level field in the EU market.

The EU CBAM's transitional phase started in October 2023, and it will end in December 2025. During the transitional phase, importers of the covered goods must submit reports on the imported goods. In January 2026 the EU will start collecting import taxes.

B. The Flannery-Mares GGI for a Border-Adjusted Carbon Tax

Brian Flannery and Jan Mares proposed a method by which to administer a border adjustment for a domestic carbon price. Their proposal, called the GGI, allows for the measurement and reporting associated with product-level emissions under an upstream carbon tax. The goal is to estimate the carbon content of imports and exports at the border to administer taxes and rebates.[11]

The GGI follows the framework of a VAT to track the cumulative emissions at different production stages along the supply chain. A VAT is economically equivalent to a retail sales tax, but instead of being collected once when a good or service is purchased by a consumer, it is collected in stages along the value chain.

To illustrate how a VAT works, consider a VAT of 20 percent and how it would apply to the manufacture and sale of a car. First, the producer of steel would collect $200 of VAT on $1,000 of steel products sold to an auto parts manufacturer. The auto parts producer uses the steel products to manufacture auto parts, then sells the parts for $5,000 and charges $1,000 in VAT. However, the auto parts producer gets a credit for the VAT already charged on its inputs ($200 on the steel) for a new liability of $800. Finally, the car manufacturer assembles auto parts into a vehicle and sells it to a consumer for $20,000 and charges $4,000 in VAT. The car manufacturer, however, gets a credit for the VAT charged on its inputs and ultimately pays $3,000. The total tax along the supply chain is $4,000 ($200 + $800 + $3,000), or 20 percent on the pretax sales price of $20,000.

The GGI applies a similar framework as the VAT to track cumulative emissions at various stages along the supply chain that are ultimately associated with a product. In essence, it evaluates emissions from "cradle to gate," meaning that it covers the part of the product's life cycle from the

[8] European Commission, "What Is the EU ETS?"

[9] European Commission, "Scope of the EU ETS."

[10] *Id.*

[11] Brian Flannery et al., "Framework Proposal for a US Upstream GHG Tax With WTO-Compliant Border Adjustments: 2020 Update," Resources for the Future Report 20-14 (Oct. 2019).

cradle (resource extraction) to the factory gate (before the product is distributed to consumers).[12]

Consider the same example of a car. First, the producer of steel generates 300 tons of CO_2 emissions. The steel is then made into auto parts, which generates an additional 200 tons of CO_2. Finally, the car manufacturer assembles the car and, in the process, emits another 100 tons of CO_2. The car has a total of 600 tons of CO_2 associated with its production.

GGI is a metric that measures a product's carbon intensity. Intensity is equal to the tons of emissions per the product's weight in tons. Once a product's GGI is determined, it is straightforward to calculate the export rebate associated with the product by multiplying the GGI and the product's weight.

IV. Comparing Major Features of the Border Adjustment Methods

Although both proposals seek to apply a border adjustment to an existing or hypothetical domestic carbon price, their designs sometimes vary significantly. These design choices have important implications for the administrability and efficiency of each proposal.

A. Covered Goods

Carbon border adjustments should ideally cover all the goods and services across the entire economy to account for their associated carbon emissions. But that may not be feasible because it could be costly for the regulator and producers to collect, validate, and process all the product emissions data. To make the administrative costs manageable, border adjustment proposals typically cover a short list of goods by either adopting a threshold or enumerating specific goods. That could be a list of carbon-intensive industrial products that are commonly used for producing final consumer goods.

The GGI is designed for an economywide border-adjusted carbon tax. It can be applied to a select list of carbon-intensive and trade-exposed goods, or to a broad base of goods across the entire economy. By design, it would be the same goods produced in facilities that are subject to the domestic carbon tax that would be eligible for the border adjustment. Flannery and Mares set a carbon intensity threshold of 0.5 tonnes CO_2 equivalent (CO_{2e}) per tonne of product to determine the carbon-intensive goods to be border-adjusted. For electricity, the threshold is 0.25 tonnes CO_{2e}/megawatt-hour.[13]

The EU CBAM will initially cover six sectors of products: iron and steel, aluminum, cement, fertilizers, hydrogen, and electricity. The European Commission has signaled its interest in expanding the scope of the covered sectors.[14] The narrow base of border adjustment means that there are goods that are effectively priced by the ETS but are not subject to the border adjustment. Also, it's less clear how the European Commission determines the covered goods. It enumerates all the covered products in the CBAM legislation across the covered sectors.[15]

Neither framework would apply to either the import or export of services. Although services tend to be ignored in border adjustment proposals, theoretically they should be covered for the same reason as physical goods. That is especially true for trade in U.S. services.[16] Differential taxation of the production of services can also distort their location. That said, administering a border adjustment on services may be more complex because most of the emissions are associated with suppliers in the value chain (emissions in inputs).

B. Covered Emissions

A carbon tax and its border adjustment should ideally cover all types of greenhouse gas emissions, including carbon dioxide, methane, and nitrous oxide.

[12] C. Cao, "Sustainability and Life Assessment of High Strength Natural Fibre Composites in Construction," in *Advanced High Strength Natural Fibre Composites in Construction* (2017).

[13] Flannery and Mares, "Determining the Greenhouse Gas Index for Covered Products of Specific Manufacturers," Resources for the Future Working Paper 21-31 (Oct. 2021).

[14] Ashish Sinha, Kasia Klaczynska Lewis, and Richard Albert, "Carbon Border Adjustment Mechanism (CBAM) Update and Its Impact on the EU Cross-Border Imports," EY (Mar. 4, 2022).

[15] European Commission, Regulation (EU) 2023/956 of the European Parliament and of the Council of 10 May 2023 establishing a CBAM.

[16] U.S. exports of services are an important part of the U.S. economy. In 2023 U.S. exports of services were nearly $1.03 trillion, and U.S. imports of services were $748.2 billion. Bureau of Economic Analysis, "International Services."

Full coverage of emissions from all sources across the supply chain would create proper incentives to reduce emissions. However, it could be significantly burdensome to account for all potential emissions. Thus, carbon border adjustments typically cover the emissions related to the production stage in the value chain, including emissions generated onsite at the manufacturing facility from both production and any electricity generation, emissions embedded in the input materials purchased from the facility's suppliers (including fuels purchased to create thermal energy for industrial processes), and emissions associated with the purchased electricity. Emissions related to other activities in the supply chain are not covered in border adjustments. For example, emissions embedded in upstream activities such as mining and transport of fossil fuels are ignored, as are emissions embedded in downstream sales and consumption activities like distribution, storage, use, recycling, and waste disposal.

Both the GGI and the EU CBAM only cover emissions related to the production stage. The GGI covers three sources of emissions:

- carbon content in fossil fuels;
- carbon emissions generated in a facility's production process that is through a chemical or physical process; and
- supply chain emissions, which include purchased electricity and emissions embedded in the input products (fuels and raw materials) purchased from suppliers.

The EU CBAM covers similar sources of emissions as the GGI, including carbon content in fuels, production process noncombusted emissions, emissions embedded in input materials, and purchased electricity.[17] Also the EU CBAM, like the GGI, follows the concept of tracking cumulative emissions along the value chain like a VAT.[18]

C. Level of Emissions Measurement (Product, Facility, Industry, Country)

To price carbon emissions in imports and exports and create proper incentives to reduce emissions, a carbon tax should apply to the greenhouse gas emissions of each product. In that way, the tax can properly distinguish between two competing products that may have different production processes that produce different levels of emissions. Although that aligns incentives properly, it is not an easy task because it requires detailed information on the emissions related to specific production processes involved in producing a specific good.

To ease the compliance and administrative burden, carbon border adjustments and carbon taxes more generally can measure emissions for goods at different levels of aggregation besides the product level. Those include measuring emissions intensity at the facility, industry, and country level. For example, a carbon border adjustment could assume that all goods produced in an industry have roughly the same carbon intensity and apply the tax uniformly to its goods. When industry-level data is unavailable, regulators could assume all the goods across the economy have the same level of carbon intensity

[17] The EU CBAM recommends two broad approaches for importers to measure emissions data at the facility level: a calculation-based approach and a measurement-based approach. The calculation-based approach includes a bottom-up method, in which importers work with their suppliers in foreign markets to conduct a detailed analysis of all the sources of emissions and their emissions levels and aggregate them. It also includes an alternative "mass balance" method, which can be viewed as equivalent to a black-box calculation method. It calculates the difference between the total emissions embedded in the output and input products to determine the amount of emissions generated from the production process. The black box here is a specific production process with complicated industrial processes, technologies, and various input materials. This method allows facilities to calculate total emissions without having to assess every detailed component of the production process. The measurement-based approach monitors the greenhouse gas concentration in a facility's smokestacks and the flue gas flow, which is the amount of mixed composition gases emitted through the stacks. This approach is applicable to facilities that have all their emissions emitted through smokestacks. European Commission, "Guidance Document on CBAM Implementation for Importers of Goods Into the EU" (May 2024).

[18] European Commission, "Guidance Document on CBAM Implementation for Installation Operators Outside the EU" (Dec. 2023).

and assign a country-specific value to the goods produced in that country.

Choosing emissions at a higher level (industry or country) is simpler, but it reduces the efficiency of the carbon tax. That might reduce incentives for businesses or individuals to decarbonize.

There are datasets with carbon intensity data at the country, industry, and facility level. Country-level emissions intensity measures CO_{2e} generated per unit of output. For example, the World Bank has data on kilograms of CO_{2e} per dollar of GDP for all economies.[19] Industry-level emissions intensity data is a high-level benchmark for all the goods within that industry. For example, the OECD provides carbon intensity data for manufacturing industries across different countries.[20] Facility-level emissions refer to the level and types of emissions for a specific manufacturing facility. A company could own multiple facilities that manufacture the same or different goods. For example, in the United States, the Environmental Protection Agency's greenhouse gas reporting program requires facilities that emit more than 25,000 tonnes of CO_{2e} to report their greenhouse gas emissions data.[21]

However, product-level emissions data is scarce compared with country, industry, or facility-level data. It is important to leverage existing emissions data and convert it into product-level emissions data.

Both the GGI and EU CBAM propose similar methods to calculate product-level emissions through allocating facility-level emissions to the products manufactured from the specific facility.

The GGI proposes two approaches to apportion a facility's total emissions to products, including allocation by carbon content or a "core product." An example of a core product is raw steel that is in many steel products. For fossil fuel products, the GGI allocates emissions based on the mass of carbon for all the products manufactured at a facility. For products made using energy sources and materials (for example, steel, aluminum, or cement), the GGI allocates emissions based on the weight of the core product as a component of a product.[22] The idea is that most carbon emissions associated with manufacturing of the product are embedded in the core product.

The EU CBAM allocation method is more complex because it allocates facility-level emissions to products using granular data on the actual production processes and technologies. It requires facilities to report detailed information on the emissions generated from each major component of the production process. Because the EU CBAM is still in a transitional phase of collecting emissions data from its importers, it remains to be seen whether the EU regulator will update or simplify the reporting method requirements.

D. Treatment of Exports

Carbon border adjustments in principle should include export rebates. Export rebates allow exporters to compete with foreign producers in foreign markets on a level playing field. Without export rebates, companies have incentives to move their production to a jurisdiction that has less stringent emissions regulations.

However, many existing carbon border adjustment proposals do not include export rebates. They focus on leveling the playing field between foreign and domestic producers in the domestic market, subjecting imported goods to the same domestic carbon price levied on domestically produced goods.

The decision not to provide rebates for exporters increases the amount of tax collected, but it also increases incentives to shift production overseas. Further, excluding export rebates makes it more likely that a border-adjusted carbon tax runs afoul of WTO rules.[23]

Flannery and Mares believe an export rebate is important for a carbon tax to comply with the

[19] World Bank Group DataBank, "Metadata Glossary."

[20] OECD, "Data Explorer."

[21] Flannery and Mares, *supra* note 13. EPA, "Greenhouse Gas Reporting Program."

[22] Flannery and Mares, "The Greenhouse Gas Index for Products in 39 Industrial Sectors" (Sept. 2022).

[23] The WTO rules allow member countries to border-adjust a tax on products, or an indirect tax that is not levied directly on producers or their income. A common example of a tax that is border-adjusted is the VAT. A carbon tax, a type of broad-based consumption tax, is an indirect tax. So a carbon tax is eligible for border adjustments under the WTO rules. Pomerleau, *supra* note 5.

WTO rules, so it should include both imported taxes and export rebates. Under the GGI framework, exports would be provided with a rebate at the border. The rebate would be equal to the good's weight multiplied by the GGI carbon intensity of the given product.

The EU CBAM, however, does not include export rebates — for two main reasons. First, there is uncertainty as to how an ETS would be treated under the WTO rules. If border-adjusting the ETS is impermissible under the WTO rules, EU lawmakers worry that including export rebates would be treated as illegal subsidies. Second, the EU CBAM is considered largely an environmental policy to incentivize emissions reduction. Opponents of export rebates worry that those rebates would encourage EU producers to export carbon-intensive goods.

EU manufacturers are not subject to the emissions measuring and reporting requirement under the EU CBAM because the policy does not provide export rebates. The regulation also does not mandate domestic EU producers to provide information on product-level emissions.

E. Treatment of Imports

Imports present a unique challenge for carbon border adjustments. The carbon content of goods imported from foreign countries is unknown. Further, foreign producers are outside the jurisdiction of the taxing country's reporting requirements. Thus, taxing countries need to either rely on reporting from importers or domestic data that can be applied to foreign products.

There are generally two approaches to measure emissions in imported goods. The first one is to apply the same method of tracking product-level emissions of exported goods to imported goods. That could lead to an onerous administrative burden for regulators to enforce the reporting requirements and validate the data quality if there are numerous covered products, suppliers, and markets of origins involved. Fraudulent data is a concern because foreign producers might manipulate their emissions data to pay a lower import tax. There may also be data availability issues.

A second approach is to assign benchmark values to imported products based on either an exporting country's average industry values or domestic products' carbon emissions value. The latter option, also called a "like" product approach, was proposed by Jennifer Hillman, a former member of the WTO's Appellate Body. Her proposal is to treat imported goods as if they were produced domestically and assume their carbon emissions are the same.[24] That would require matching imported goods with a domestically produced good based on the similarities in production technology. By doing so, the tax burden between imported goods and domestic goods are equalized.

The second approach is significantly simpler because regulators do not need to get to the granular level of product-level emissions specific to a producer and a market of origin. However, the second approach would inevitably overestimate or underestimate the actual carbon emissions with a product. That is a trade-off that lawmakers would have to consider when weighing the costs and benefits of implementing a precise carbon border adjustment.

Both the GGI and EU CBAM's emission calculation methods apply to imported goods. Under the GGI, all foreign exporters are expected to leverage the GGI framework to report their relevant emissions for the covered products. To encourage compliance and quality control, Flannery and Mares believe that it would be helpful to have companies publish their emissions data for transparency and method improvement.[25]

Under the EU CBAM, the emissions reporting burden is placed on importers. They are expected to work with their foreign suppliers to fill out the required emission reporting forms and purchase corresponding emissions certificates for the imported goods.

Calculating the emissions embedded in imported goods is more complex than exported goods because regulators need to collect information from numerous foreign producers across many different markets. Foreign producers might be unwilling to submit the required emissions data or falsify information. Also,

[24]Hillman, "Changing Climate for Carbon Taxes, Who's Afraid of the WTO," American Action Forum Climate & Energy Paper Series (2013).

[25]Flannery and Mares, *supra* note 13.

emissions data methods and measuring capabilities might be lacking in less developed markets. That is especially difficult for smaller companies that might not have the resources or capabilities to measure carbon emissions from their production processes.

F. Accounting for Foreign Carbon Pricing Policies

Lawmakers might offer exemptions or refunds when levying the import taxes in the carbon border adjustments to account for the carbon pricing policies in the market of origins. That works by reducing the import tax liability by the same amount that has already been paid under a foreign market's carbon pricing policy. The consideration here is to avoid double taxation of emissions and to encourage other trading partner countries to enact a carbon pricing policy. Calculating the refund for a carbon price paid in the origin market at the product level is a daunting task, especially if foreign carbon pricing policies have various tax bases or exemptions. It may also lead to unintended consequences because exporters might find loopholes to ship their products from an exempted market of origin.[26] Some proposals seek to determine and account for the effective prices of climate regulations in markets of origin, but that is a challenging task.[27]

On the other hand, lawmakers may choose not to provide any refunds or exemptions, regardless of whether exporters have paid for a carbon price for their products in the market of origin. That would significantly reduce the administrative burden and make the policy more likely to be in compliance with international trade rules such as the WTO's nondiscrimination rules, which prohibit its members from giving preferable treatment to some trading partners.

The border-adjusted carbon tax proposed by Flannery and Mares does not account for the climate policies in the markets of origin. It treats all imported goods the same regardless of whether they are subject to a carbon price in the export market. They believe that eases the administrative burden and makes the policy in compliance with the WTO rules. Though that may be geopolitically challenging because foreign countries that have enacted a carbon price on their domestic producers may request an exemption from the import tax.

In contrast, the EU CBAM gives a refund to the importers if the covered goods they import are already affected by an explicit carbon price in the country of origin, including a carbon tax or an ETS. The credit amount would be equal to the explicit carbon price paid at the product level. The motivation behind this policy design choice is to avoid "double taxation" of a product's carbon content and, more importantly, to encourage foreign countries to adopt carbon pricing policies that offer incentives for reducing emissions. But that might be an onerous administrative burden because it would be difficult to measure and validate the carbon price already paid in a foreign market on a good, especially because the carbon pricing policies in foreign markets have different tax bases or tax exemptions.

Overview of the Flannery-Mares GGI Framework and the EU CBAM GGI for a Border-Adjusted Carbon Tax

	GGI for a Border-Adjusted Carbon Tax	EU CBAM
Covered goods	Applies to products with greenhouse gas intensity that exceeds specified thresholds	Enumerates products across the six covered sectors: iron and steel, cement, aluminum, hydrogen, fertilizer, electricity
Covered emissions	Cradle-to-gate emissions associated with a manufacturer's operations and products acquired through its supply chains (not including emissions of end users)	Emissions related to the production of the good (direct and indirect emissions)

[26] Pomerleau, *supra* note 5.

[27] Gabriel Weil, "The Carbon Price Equivalent: A Metric for Comparing Climate Change Mitigation Efforts Across Jurisdictions," 125 *Dick. L. Rev.* 475 (2021).

Overview of the Flannery-Mares GGI Framework and the EU CBAM GGI for a Border-Adjusted Carbon Tax *(Continued)*

	GGI for a Border-Adjusted Carbon Tax	EU CBAM
Level of emissions measurement	Emissions are measured at facility level and allocated to product level	Emissions are measured at facility level and allocated to product level
Treatment of exports	Export rebates are included; the GGI is applicable to calculating the carbon content in exported goods	Export rebates are not included; the emissions methods are not applicable to calculating the carbon content in exported goods
Calculating carbon content in imports	Requires the reported product-level emissions of the imported goods to be determined in the same way as emissions associated with domestic products	Requires the product-level emissions of the imported goods to be conducted by certified verifiers
Accounting for foreign carbon pricing policies	No	Yes, if an imported good is already affected by an explicit carbon price in market of origin

Source: Author's analysis.

V. Conclusion

Carbon taxation is an important policy to effectively address climate change. Because climate policy is enacted at the national or state level, it is inevitable that there are differences in the stringency and portfolios of countries' climate policies. To reduce the incentives for companies to relocate their production to a different country with a less stringent climate policy, carbon border adjustments are a critical component of a carbon tax. Carbon border adjustments include import taxes and export rebates, which equalize the tax burden between domestic and foreign producers. Under a border-adjusted carbon tax, companies would be indifferent to produce domestically or in a foreign market because they would be subject to the same tax burden when selling to domestic consumers.

While it is relatively straightforward to implement a domestic carbon tax by levying the tax upstream at a small number of facilities and producers, it is much more complicated to enact the carbon border adjustments. This is because the associated CO_{2e} of a product need to be determined to calculate the magnitude of the import taxes and export rebates. Even though companies and industries have measured carbon emissions of industrial production for a long time, this is conducted at the industry and facility levels.

There is scant research on how to measure, calculate, and determine CO_{2e} at a product level. The GGI, a leading U.S. research framework proposed by researchers Flannery and Mares, discusses a pioneer method to calculate the cumulative emissions along the supply chain following the framework under VAT, and allocate the facility-level emissions to different products.

The EU CBAM, the world's first import tax based on a product's associated carbon emissions, is scheduled to be fully effective in 2026. The policy includes detailed guidance on how to calculate facility-level emissions and allocate them to specific products.

Both the GGI framework and the EU CBAM have contributed significantly to the method development and research on measuring product-level emissions. This challenging undertaking requires both regulators and companies to have significant expertise in the technical aspects of production processes, technologies, materials, and supply chains.

Lawmakers must make important decisions on the design elements of carbon border adjustments. There is a trade-off between simplicity and efficiency. Ideally, it would be useful to measure and calculate the actual emissions associated with a good, but this may cause onerous administrative costs and burdens. Simpler design choices in areas such as covered goods, covered emissions, level and method of allocating emissions, and the treatment of imports and exports could significantly lower the

administrative burden but overestimate or underestimate the emissions level.

As demonstrated by this analysis, it is feasible to measure product-level emissions for implementing carbon border adjustments. Methods in this area need to be further improved and standardized as more countries start to implement carbon border adjustments, and eventually measuring product-level emissions won't be heavy lifting. ■