RESOURCES *for the* FUTURE

Border Carbon Adjustments without Full (or Any) Carbon Pricing

William A. Pizer and Erin J. Campbell

Working Paper 21-21
July 2021

About the Author/Authors

Billy Pizer is a senior fellow at RFF. Previously, he was the Susan B. King Professor at the Sanford School of Public Policy, Duke University. He is also a Research Associate at the National Bureau of Economic Research. His past and current research examines how we value the future benefits of climate change mitigation, how environmental regulation and climate policy can affect production costs and competitiveness, and how the design of market-based environmental policies can address the needs of different stakeholders. He has recently begun work examining the potential role of solar radiation management (injection of aerosols in the stratosphere) in climate change policy, in addition to mitigation and adaptation. He is currently a member of the NASEM Committee on Accelerating Decarbonization in the United States.

Pizer was actively involved in creation of an environmental program at Duke Kunshan University in China, a collaborative venture between Duke University, Wuhan University, and the city of Kunshan. He recently served as Associate Dean for Academic Programs and Senior Associate Dean for Faculty and Research at the Sanford School. From 2008 to 2011, he was Deputy Assistant Secretary for Environment and Energy at the U.S. Department of the Treasury, overseeing Treasury's role in the domestic and international environment and energy agenda of the United States. Prior to that, he was a researcher at Resources for the Future for more than a decade. He has written more than sixty peer-reviewed publications, books, and articles, and holds a PhD and MA in economics from Harvard University and BS in physics from the University of North Carolina at Chapel Hill.

Erin Campbell is a research analyst at RFF. Originally from Bethlehem, Pennsylvania, she graduated from the University of Rochester in May 2021 with a BS in Environmental Health, BA in Economics, and a minor in statistics. Her primary research interests are environmental justice related, but she has a knack for finding just about anything fascinating if she reads enough about it. Throughout her time in Rochester, Campbell was involved in both independent and mentored research in the department of economics where she discovered her passion for applying the tools of econometrics to today's most pressing issues. Erin is a proud AmeriCorps alum, and prior to RFF she experienced many avenues of research at the USDA, Bipartisan Policy Center, and the Health and Environmental Economics Lab at the University of Rochester.

Acknowledgements

The authors would like to thank Joe Aldy, Carolyn Fischer, Michael Mehling, James Roaf, and Catherine Wolfram for helpful comments on an earlier draft, as well as participants in a workshop organized by the Global Climate Policy Partnership for the initial impetus on this topic.

About RFF

Resources for the Future (RFF) is an independent, nonprofit research institution in Washington, DC. Its mission is to improve environmental, energy, and natural resource decisions through impartial economic research and policy engagement. RFF is committed to being the most widely trusted source of research insights and policy solutions leading to a healthy environment and a thriving economy.

Working papers are research materials circulated by their authors for purposes of information and discussion. They have not necessarily undergone formal peer review. The views expressed here are those of the individual authors and may differ from those of other RFF experts, its officers, or its directors.

Sharing Our Work

Contents

1. Introduction

Border carbon adjustments (BCAs) are national or possibly multicountry trade measures—typically taxes on imports (and sometimes rebates on exports)—intended to support ambitious national climate mitigation policies. They are meant to address part of the problem that ambitious mitigation policies in one jurisdiction can lead to increased emissions in jurisdictions with less ambitious policies ("leakage"). In particular, they address the portion of leakage associated with energy-intensive production moving from areas with more ambitious policies to those with weaker policies ("competitiveness"). BCAs are being discussed as part of broader carbon pricing policies, like the European Union's Emissions Trading Scheme (EU ETS), which recently put forward a concrete BCA proposal; they have also been described and modeled alongside a domestic carbon tax. Much has been written about the design of a BCA in this world with what we might call "full" carbon pricing.

Yet, nations' climate mitigation policies may or may not include carbon pricing, and when they do, the carbon pricing is often not comprehensive. In the United States, for example, carbon pricing has been implemented at the state level (California, Washington State, and the northeastern states' Regional Greenhouse Gas Initiative) but is currently a lower priority in national policy than incentives and regulatory standards. China has implemented an ETS that allocates free allowances based on performance benchmarks like a firm's production level of electricity or (in the future) other industrial products. That is, the policy might regulate tons of CO_2 per megawatt of electricity, per ton of steel produced, or per ton of cement. This is frequently referred to as a tradable performance standard (TPS; see Pizer and Zhang 2018). Even the EU ETS gives significant free allocation to energy-intensive, trade-exposed industries, thereby blunting some of the ETS effects. This raises the question of how a BCA might work with a "partial-price" or "nonprice" policy.

In this paper, we talk about "partial" price policy as implementing an explicit carbon price that is paid on some, but not all of a firm's actual emissions. Perhaps there is a free allocation tied, one way or another, to production of a given product. This might be explicit, through a tradable performance standard or output-based allocation, or implicit, through a free allocation that helps address competitiveness effects.

We talk about a "nonprice" policy as regulating emissions through some type of non-tradable technical or performance-based standard; there is no observed price. Although it is possible to estimate an *implicit* price or marginal cost associated with the most recent (most expensive) ton of carbon dioxide reduced, it is not observed *explicitly*.

In this short paper we outline basic principles of how such partial-price or nonprice policies might equivalently be applied to imports as a BCA. Full carbon-pricing policies (auctioned ETS credits or a carbon tax) typically put an equivalent price on the carbon content of imports, usually with an adjustment for any carbon pricing in the country of origin. In contrast, partial-price or nonprice policies exempt a portion of the carbon content of imported goods before applying any price. Moreover, the price paid on emissions above the exemption should be based on some notion of *marginal cost* if a market price or tax is not observed. That is, it should be based on the cost of the last ton abated domestically, not the average cost.

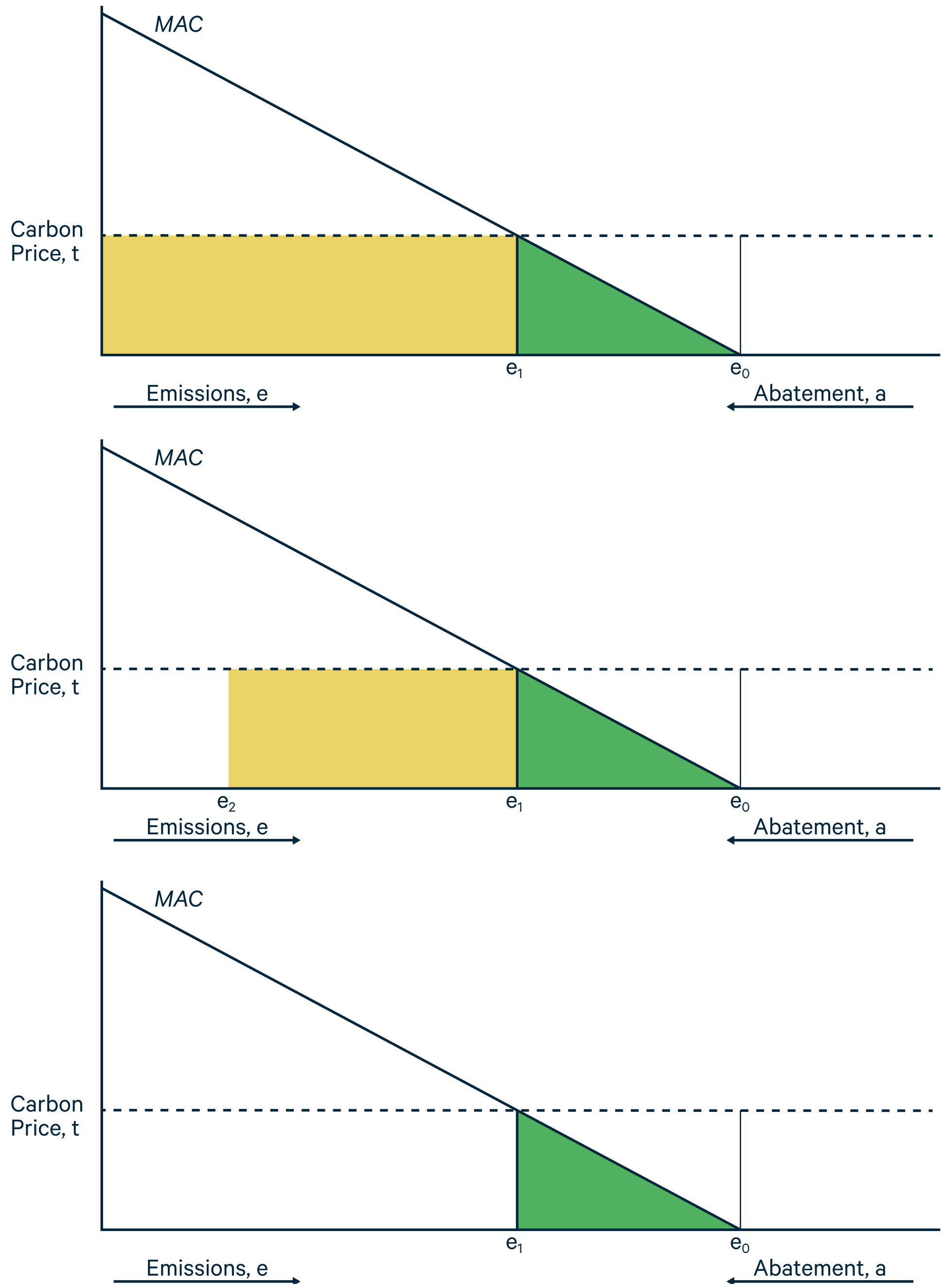
Our lens on this issue is an economic notion of roughly equivalent treatment. That is, are exporters to a regulated market facing the same incentives and charges, on average, as a domestic producer? “On average” is a critical term. Unless there is a transparent, fully national climate policy that is easily replicated on imports, the existence of state- (or even local-) level regulation means different producers will likely face different incentives and costs. Even with national regulation under the Clean Air Act, states may have some discretion in their implementation. Or a national regulation may give some deference to the starting point of individual firms in the application of benchmarks. The choice of how to match a range of observed domestic incentives and charges to BCA parameters has consequences that might motivate matching the high or low end of observed values instead of the average.

We note at the outset that we are also ignoring issues of WTO compatibility. This has been discussed elsewhere at length for full-price policies (Hillman 2013; Howse 2021). Partial-price and especially nonprice policies raise even more issues as the treatment of imports, while attempting to mimic domestic policy incentives and costs, is not the same. There may be no explicit domestic charges even as BCAs are implemented as a charge. We leave this for future work.

BCAs raise myriad other design questions, including treatment of exports, measurement of emissions, scope (e.g., are indirect emissions targeted?), types of imports covered, and use of revenue. There is also the question of BCAs’ fairness with respect to developing and emerging economies. We believe these questions apply regardless of whether there are full-, partial-, or non-price domestic policies and we do not attempt to tackle them here (see, e.g., Marcu, Mehling, and Cosbey 2020). Rather, our plan is, first, to review the costs imposed by full-, partial-, and nonprice policies and the application of BCAs in the context of full-price domestic policies. This frames our economic notion of trying to apply equivalent treatment to imports. We then discuss how BCAs could seek equivalent treatment with a partial-price or nonprice policy similar to the notion applied with full-price policies. Finally, we consider how domestic policies intersect with one other, and how BCAs might account for a trade partner’s similar or different policies.

2. The Costs of Price and Nonprice Policies

Figure 1. Emissions and Costs under Carbon Pricing



The figure diagrams policy costs for a firm where e_0 is the baseline emissions rate per unit of output and e_1 is the chosen level of emission in response to a particular policy. Panel a shows a full-price policy, e.g., a carbon tax or ETS with auctioned permits. Panel b shows a partial-price policy (e.g., a tradable performance standard equal to e_2 or an ETS benchmark allocation e_2). Panel c shows a nonprice policy with emissions rate e_1. Green indicates abatement cost, and yellow indicates payments for embodied emissions.

We start by looking at the unit-level costs created by different types of domestic climate policies for a particular firm. Figure 1 plots emissions along the horizontal axis, indicating a particular baseline emissions rate e_0 per unit of production.[1] This is the amount of carbon dioxide emitted, for example, per ton of steel produced, before any efforts are made to reduce emissions under a climate policy (whether carbon pricing or regulation). We also indicate the marginal abatement cost (MAC) along the vertical axis. The MAC schedule indicates, at each level of emissions on the horizontal axis, the cost of reducing one more ton along the vertical. Intuitively, as the firm reduces more and emits less, the cost of an additional ton becomes higher: the first ton is cheap, the last ton is expensive. For that reason, it rises from right to left as we move from the baseline emissions level, e_0, toward zero emissions. If we had plotted abatement rather than emissions along the horizontal axis, the MAC would rise from left to right.

We highlight three cases that lead to the same level of emissions, e_1, and abatement, $e_1 - e_0$, in this example, representing (a) full carbon pricing (an auctioned ETS or carbon tax); (b) partial carbon pricing (an ETS with free allocation or a TPS); and (c) nonprice regulations. Because we assume all three cases lead to the same level of abatement for the firm, all three have the same total cost of abatement, indicated by the green area. That is, if we add up the cost (the vertical distance) of each ton abated (a horizontal increment) from the baseline emissions level e_0 to the final emissions level e_1, it equals the green area.

Although the green triangle indicates the direct abatement costs of the tons *avoided*, it does not reflect any price that firms may pay for the tons that *occur* (sometimes referred to as "embodied carbon"). Firms facing full carbon pricing at price *t* in Figure 1a, through either an ETS or a tax, pay that price *t* on the full amount of emissions that occur, e_1. This is indicated by the yellow rectangle in panel (a). Note that in facing the carbon price *t*, they are exactly abating all the tons whose abatement is cheaper than the tax. Note also that although the abatement cost could be larger than the embodied emissions cost—in particular, at high levels of abatement—we have drawn it such that the embodied emissions cost with full pricing is much larger than the abatement cost.

Firms facing partial-price or nonprice policies pay the price *t* on only a smaller volume of emissions, as in panel (b), or not at all, as in panel (c). Consider, for example, a regulation that requires firms to limit their emissions to e_1—without exception—but then allows those emissions e_1 to occur without any further charge. We might think of this as a maximum emissions standard. Firms face the costs associated with the green area. However, there is no payment equivalent to the yellow area, as indicated in Figure 1c.

Alternatively, consider a tradable performance standard that limits emissions per unit of production, on average, for all firms in the sector to the standard e_2, indicated in Figure 1b. Emissions per unit produced up to e_2 are unpriced. Firms that beat the standard earn allowances that can be sold to firms that miss the standard; here we assume the market price is *t*. In our example e_1, the actual emissions level for our example firm is *larger* than the emissions standard for the sector e_2, so the firm will

1 We thank Carolyn Fischer and Keen et al. (forthcoming) for suggesting a similar figure.

face the added cost of the yellow rectangle in Figure 1b as it buys ($e_1 - e_2$) allowances in the market. Note that, on average, firms in the market have to hit the standard—the only allowances bought by a firm above the standard come from sales by firms that earned them by beating the standard.

Now suppose there is free allocation up to a benchmark of e_2. Firms still face no price up to the allocation e_2. Indeed, they can sell excess allowances in the market. But missing the standard, they have to buy allowances—for the example firm, $e_1 - e_2$.[2]

Finally, while we have not drawn this case, imagine reductions to e_1 arise because of government policies that provide financial incentives to reduce emissions. The benchmark e_2 might lie to the *right* of e_1. This would also be the case if free allocations were in excess of the observed emission level.

The preceding discussion highlights similarities and distinctions between partial-price and nonprice policies. Partial-price policies can face nonabatement costs, the yellow rectangle in Figure 1b; nonprice policies do not. Partial-price policies have an observable price; nonprice policies do not. Under partial-price policies, beating a particular emissions level leads to a rebate—if firms beat the standard or allocation, they can earn money by selling allowances; nonprice policies do not create such benefits.

In contrast, a full-price policy, such as an auctioned ETS or carbon tax, puts a price on *all* embodied emissions. Both nonprice and partial-price policies exempt *some* amount of emissions from such pricing. Moreover, both nonprice and partial-price policies may involve additional heterogeneity in this exemption: firms in different regions or with different historical emissions could face different levels of allowed emissions, different benchmarks, or different free allocation.

2 Here and throughout, we somewhat loosely talk about a partial-price policy having a benchmark, exemption, or standard. All of these refer to the same notion—a level of emissions below which there is effectively no charge on the emissions of carbon dioxide and above which there is a charge (or above which emissions may not be allowed).

3. BCAs with Full-Price Policies

Absent foreign regulation, a BCA that charges an identical import levy *t* on the actual embodied carbon dioxide emissions of foreign production will roughly mimic both the costs and the incentives of the domestic policy. Suppose a trade partner has no climate policy. Like domestic firms, foreign firms will have an incentive—on their exports to this market—to abate up to the point where their MAC equals *t*. Like domestic firms, these foreign firms will then pay the levy on all their remaining emissions associated with their exports to this market. If the foreign MAC were the same as the domestic MAC in Figure 1, unit costs would equal the yellow and green areas in Figure 1a.

This basic BCA concept glosses over many detailed design questions that need to be answered, ranging from how to measure the embodied carbon of imported goods and how to handle exports (versus imports), to whether the policy complies with WTO rules and whether it treats trade partners at different levels of development equitably. The question we consider here is how a BCA might adjust for comparable action among trade partners. We consider full-price policies first.

So now suppose that instead of no climate policy, a trade partner has its own carbon price, *t'*, less than *t*. Absent some BCA, foreign firms will not face as high an incentive or pay as much for their embodied carbon as domestic firms. But charging the full domestic price *t* on the carbon content of imported goods would be too much. Foreign firms would face an incentive and total per ton charge of $t + t'$ on their exports to this market. Instead, it would make sense to set the BCA levy for this partner equal to $t - t'$. Added to the exporter's own domestic price, *t'*, the full burden is *t* on its exports to this market.

This is the basic goal of BCAs in a world with an ETS or a carbon tax: seek to have imported products face the same incentives and charges as domestic producers. Absent a foreign policy, apply the full domestic price; with a nonzero foreign price lower than the domestic price, apply the difference. This remains the guiding principle as we turn to partial-price and nonprice policies.

4. BCAs with Partial-Price and Nonprice Policies

Here we consider the incentives and costs created domestically by a partial-price or nonprice climate policy and then design a BCA to create similar incentives and costs for foreign firms exporting to this country. Based on the preceding discussion and examples in Figure 1b and 1c, the basic idea is (1) to exempt a certain level of emissions per unit of production and (2) to charge a price for emissions over that exemption level.

In the partial-price policy, diagramed in Figure 1b, with a well-defined benchmark or exemption level e_2 per unit of production and an observed price *t*, this approach is straightforward. Charge a price *t* on the carbon content of imports that is above the benchmark level e_2 per unit. The only complication is if the exemption level or price varies across domestic firms. One could then use the average price and average benchmark across domestic firms to define the exemption and price to be applied to imports.

Conceptually, we imagine imports facing the US market collectively and therefore want to treat imported goods the same based on the average domestic market effect. Put another way, we might imagine trying to come up with a common exemption level and carbon price that, if applied equally to all domestic firms in place of current regulation, would have the same effect on carbon emissions. Or, we might look for the common exemption and carbon price that would match the total cost of current regulation. Or have the same effect on product prices. Ultimately, there are a number of alternative concepts of "equivalence" that could be used to select an exemption and carbon price when treatment of domestic firms varies. Moreover, applying this derived, common exemption level and price to imports will be more favorable than the treatment of some domestic firms, and less favorable than that of others. Depending on actual structure of import competition within the sector and how one weights the outcomes for different firms and importers, one could make the case for exemptions and prices almost anywhere within the range of observed domestic firm-level values.

Larger questions loom with nonprice policies, depicted in Figure 1c. In particular, should a country ban or tax imports that have higher embodied carbon than domestic products? If a domestic regulation clearly establishes a maximum domestic emissions rate, a ban would seem plausible if not reasonable. The solution is less obvious if, instead, there is a distribution of emissions rates because of domestic regulation. Is there really a maximum allowable rate (for example, the maximum observed) and should imports above said rate really be banned?

Analogous to the conceptual approach with partial-price policies when prices or benchmarks vary, a logical solution would be to treat domestic production collectively. Apply the average or some other value in the range of observed domestic emissions rate as an exempted emissions level (e_2 in Figure 1b). Then price the excess emissions at an average or some other value in range of observed marginal costs faced by domestic producers (t in Figure 1b). For example, one might determine these parameters based on the common exemption e_2 and price t that, when applied across firms in place of current domestic regulations, are estimated to create the same domestic aggregate costs as the regulations they would replace.

Here, we bump into the particularly tricky issue with nonprice policies: prices are not observed. Nonetheless, there are several alternative solutions. The import charge could be based on modeled estimates of marginal cost, typically conducted in a regulatory impact analysis of domestic regulation. Statistical techniques might be used to estimate marginal costs. Some regulations may have fines or other consequences of noncompliance that could be used to assess the incentive faced on the last ton of abatement. Finally, one could turn to the government's social cost of carbon, the benefit measure applied to emissions reductions in regulatory impact analyses. The important point is this: BCAs for partial-price and nonprice policies should be designed around (1) an exempted level of embodied content based on domestic emissions that do not face carbon pricing; and (2) a per ton charge on emissions above that exempted level based on the marginal cost associated with domestic above-exemption emissions.

5. How can BCAs adjust for foreign climate policies with partial- and non-price policies?

Above, we discussed the case of a foreign carbon price that was equally comprehensive but lower than the domestic price. We now want to consider the more general case of intersecting foreign and domestic policies.

Countries may have a combination of overlapping price and nonprice domestic policies in different sectors across different subnational regions. Ultimately, it should be possible to convert this landscape into (1) an average of observed emissions rates per unit of product across firms (value for e_1 in Figure 1); (2) an average marginal cost associated with observed emissions rates (value for *t* in Figure 1); and (3) an average exemption relative to pricing the full amount of average observed emissions e_1 at the full marginal cost emissions rate *t* (value for e_2 in Figure 1c). A zero exemption would indicate that firms are paying the full marginal cost *t* on all emissions e_1 in the sector—equivalent to the yellow rectangle in Figure 1a. This would likely be the case with a carbon tax or auctioned permit system but no other policies. Otherwise, the additional policies are likely to cause some discrepancy between the marginal cost (caused by the other policies) and any price paid on unavoided emissions. This exemption fraction, e_2/e_1, therefore could arise *either* because not all emissions face an emissions price *or* because the emissions price is less than the actual marginal cost. In any case, the actual cost of unavoided emissions is given by the (smaller than in Figure 1a) yellow rectangle in Figure 1b.

Table 1 shows various combinations of domestic and foreign climate policies intersecting with one another and possible BCA approaches. We have already considered the case where countries have either full-price policies or no policies. This is described in the upper left corner. The remainder of the table shows that consideration of nonprice policies actually adds four new “BCA cases” that we need to discuss. (When the domestic importer has no policy, we assume border measures are inappropriate.)

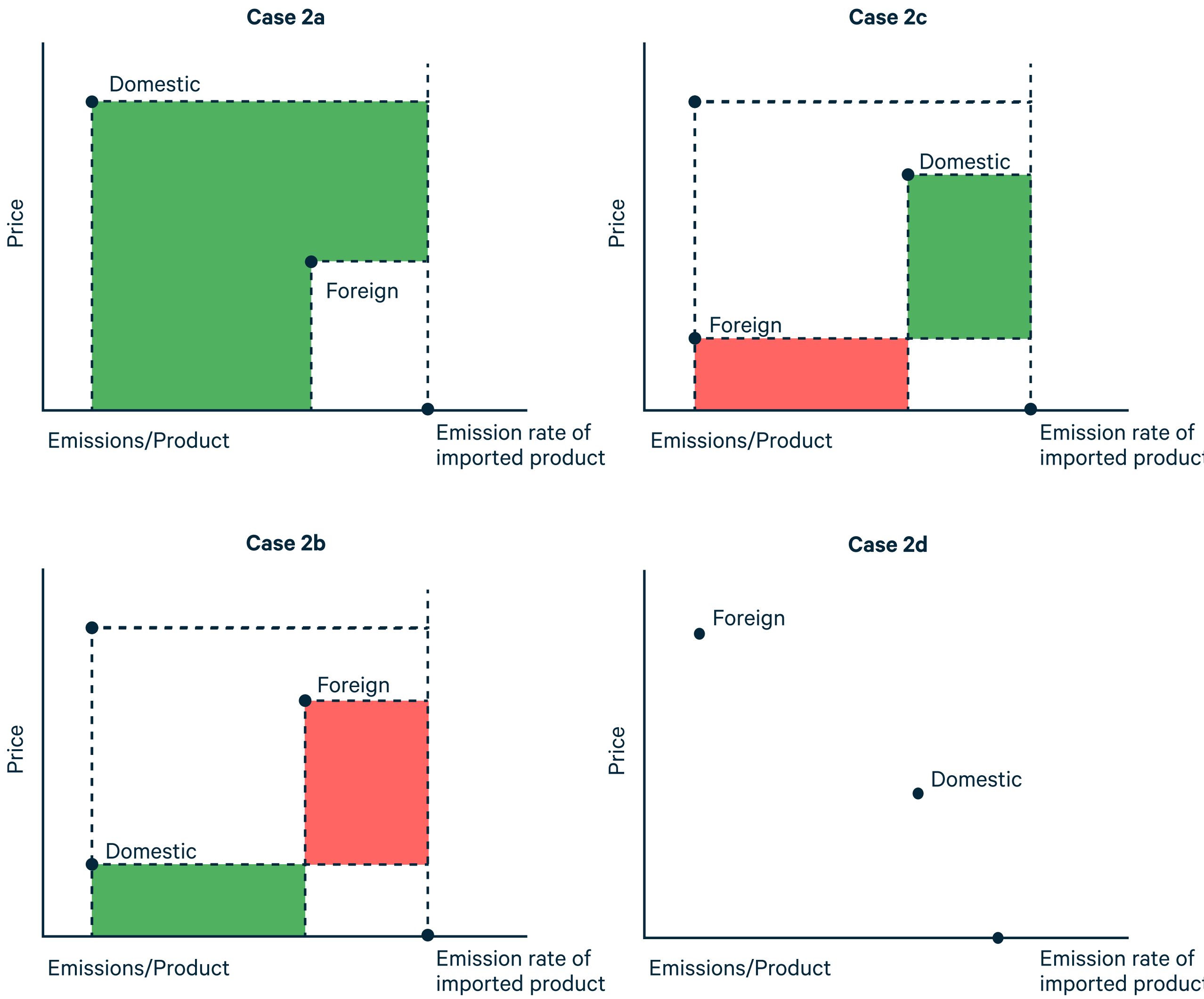
These four cases can be divided in two groups. What happens when the importer has a partial-price or nonprice policy and the trade partner has either no policy or a similar partial-price or nonprice policy (cases 1 and 2), and what happens when one country has a full-price policy and the other has a partial-price or nonprice policy (cases 3 and 4). Case 1 is described in the previous section. The domestic policy landscape can be used to define an emissions rate e_2 that serves as a benchmark for exempted emissions and a price *t* applied to emissions above the benchmark. In some cases, where a maximum emissions rate regulation exists, one might decide to simply ban imports that exceed that rate.

Table 1. Policy Matrix

		Trade partner (exporter)		
		Full-price policy	No policy	**Partial-price and nonprice policy**
Domestic market (importer)	Full-price policy	If domestic price is higher, border measure on imports can be instituted to make up difference.	Border measure on imports can be instituted to price those emissions at domestic carbon price level.	**Case 4: Domestic country can price emissions up to foreign standard and any price difference above standard.**
	No policy	N/A	N/A	**N/A**
	Partial-price and nonprice policy	**Case 3: Domestic country can apply difference between domestic and foreign price on emissions above domestic standard.**	**Case 1: Domestic country can institute price on imports similar to its domestic scheme.**	**Case 2: Domestic country can institute price on excess emissions depending on relatively stringency.**

Case 2 is more complex, with several subcases to highlight (see Figure 2). If a trade partner has a similar but weaker regulation, the additional stringency in domestic regulation could be applied to imports. *But* stringency has two dimensions—the benchmark rate and the price—and one may be more stringent domestically and the other more stringent under the trade partner's policies. In these cases, it would make sense to compute the charge under the domestic and foreign policies and include a BCA based on the difference, domestic minus foreign, if this net effect is positive. For example, suppose the domestic standard is more stringent *and* the domestic price is higher (case 2a). The domestic price can then be applied on emissions above the domestic standard and up to the foreign standard; the difference in prices is applied on all emissions above *both* domestic and foreign standards. This (green area) is an unambiguously positive charge.

Figure 2. Emissions under Differing Domestic and Foreign Carbon Policies



The figure diagrams versions of case 2, when both domestic and foreign jurisdictions have tradable performance standards but differ in terms of the level of standard and the price in the TPS, as indicated by the labeled dots, and the emissions rate of the imported product is above both foreign and domestic standards. The shaded area indicates the suggested BCA levied on an imported product with the indicated emissions rate.

Now consider a case where the domestic standard is more stringent but the price is lower (case 2b). The domestic price would be applied to the emissions above the domestic standard and up to the foreign standard (the green area). At that point, the foreign regulation would be applying an even higher price and we would want to apply a credit equal to the red area. Whether the difference—the green charge minus the red credit—is positive is unclear. If it were positive, we would suggest a charge on the product. If not, we would not automatically suggest a credit. Whether to rebate domestic carbon taxes or allowance costs on exports to countries with less stringent regulation is essentially the same question as whether to credit imports from countries with more stringent regulation. It is something to consider, but we do not delve into that question here.

A similar situation arises if the price is higher but the domestic standard is weaker (case 2c). The difference between the domestic and foreign prices could be applied to emissions above the domestic standard (the green area). But we would want to offer a credit for the price paid in the exporting jurisdiction for emissions above the foreign standard and below the domestic standard (the red area). Any positive difference (the green area minus the red area) would be the import charge on this product.

If the foreign standard is more stringent *and* the foreign price is higher (case 4c), no import charge is necessary. The foreign regulation is unambiguously stronger and we are pointed again toward the question of export rebates.

A few points are worth noting about the approach we have just described for case 2. First, cases 2a and 2d may be more likely in practice. Usually, a more ambitious allocation or standard will involve a higher marginal cost. Cases 2b and 2c assume that countries with stricter benchmarks have lower marginal costs. Second, if we end up using *national*-level estimates of embodied carbon (versus firm- or facility-level estimates) to determine BCAs *and* if the foreign country is using a tradable performance standard (rather than an ETS with free allocation or some other policy combination), our calculations simplify. Foreign emissions, averaged across all products, exactly equal the foreign standard (which has to be met on average under the foreign TPS policy). There are no foreign emissions above the foreign standard, and the BCA amounts to a payment of the difference in standards (in cases 2a and 2b) times the domestic price.

Returning to our other cases in Table 1 , cases 3 and 4 are similar to case 2. In case 3, with full carbon pricing in a foreign country but a domestic partial-price or nonprice regulation, imports are already being taxed on all their emissions. Domestic producers face a charge only when their emissions are above the domestic standard. However, if the foreign price is lower than the domestic price, it would seem reasonable to apply the price difference to foreign emissions above the domestic standard *while crediting* foreign carbon payments below the domestic standard (analogous to case 2c with the foreign standard equal to “zero”). If the difference is positive, it would be applied to those imports. This would be the case if the United States, say with a high-price tradable performance standard in each sector, were to apply a BCA to EU imports (*and* the EU eliminated free allocation).

In case 4, with a domestic full-price carbon policy and foreign partial-price or nonprice regulation, it would seem reasonable to apply the domestic price to emissions up to the foreign standard—emissions that are otherwise unpriced. And, similar to case 2b, we would then credit any excess price paid for emissions above the standard if the foreign price is higher than the domestic. Or if the domestic price is higher, the difference applied to emissions above the foreign standard would be *added* to the BCA charge (similar now to case 2a with a domestic exemption equal to “zero”).

6. Concluding Thoughts

Partial-price and nonprice policies have a different structure of costs than do price policies. Therefore, BCAs implemented alongside these policies need to adjust for different things. The underlying notion is really the idea of a standard or benchmark, and whether imports miss or meet that standard. Emissions charges are then tied to missing the standard, not the overall emissions level. Moreover, charges are tied to the *marginal* cost of the policy—the cost of that last, most expensive ton abated. In this way, the BCA is levying a charge on the carbon content of imports to (1) create incentives for the same mitigation action (and mitigation costs); and (2), if that outcome occurs, also generate the same additional charge on emissions by exempting a similar volume of emissions.

We have noted several challenges with BCAs in the context of partial-price and especially nonprice policies. Even if there is an observed carbon price, the presence of nonprice policies means that the marginal cost may not match the observed price if the nonprice policies create additional emission constraints. Although we have suggested alternative ways to construct marginal cost estimates, it is unclear how well any would work in practice. For both types of policies, it may be tricky to clearly establish a benchmark for exempting foreign emissions before charging the BCA price. Absent a domestic carbon price, the mean observed domestic emissions rate is a natural starting point. With a domestic carbon price, one needs to consider how free allocation may explicitly or implicitly define a benchmark rate where charges for embodied carbon emissions begin.

We have not generally addressed WTO compatibility or myriad other design questions. These necessarily need to be considered. We believe our effort to lay out the structure of domestic policy alternatives and how they could be equivalently applied to imports is nevertheless a useful starting point.

7. References

Hillman, Jennifer. 2013. "Changing Climate for Carbon Taxes: Who's Afraid of the WTO?" *Georgetown Law Faculty Publications and Other Works*, July. https://scholarship.law.georgetown.edu/facpub/2030.

Howse, Rob. 2021. "How to Begin to Think about the WTO Compatibility of the European Union CBAM." International Economic Law and Policy Blog. July 14, 2021. https://ielp.worldtradelaw.net/2021/07/how-to-begin-to-think-about-the-wto-compatibility-of-the-european-union-cbam.html.

Keen, Michael, Ian Parry, and James Roaf. forthcoming. "Border Carbon Adjustments -- Rationale and Design." IMF Working Paper.

Marcu, Andrei, Michael Mehling, and Aaron Cosbey. 2020. "Border Carbon Adjustments in the EU: Issues and Options." ERCST. https://ercst.org/border-carbon-adjustments-in-the-eu-issues-and-options/.

Pizer, William A., and Xiliang Zhang. 2018. "China's New National Carbon Market." *AEA Papers and Proceedings* 108: 463–67. https://doi.org/10.1257/pandp.20181029.