A European carbon border tax: much pain, little gain

Georg Zachman and Ben McWilliams argue that the EC should not make the implementation of a carbon border adjustment mechanism into a must-have element of its climate policy

Introduction

The European Union is preparing the world's most ambitious climate goal: to reduce emissions by about 40 percent over the next decade[1] and to become the world's first carbon neutral economy by 2050. To do this in an efficient way, the outline European Green Deal would increase the price all polluters in the EU must pay for their greenhouse-gas emissions.

One major element of the proposals would be the introduction of a carbon border adjustment mechanism. According to the European Green Deal plan, such a mechanism will be proposed *"for selected sectors, to reduce the risk of carbon leakage"*[2] if differences persist in levels of climate ambition worldwide (European Commission, 2019). The European Commission plans to make a proposal for a border adjustment mechanism in 2021.

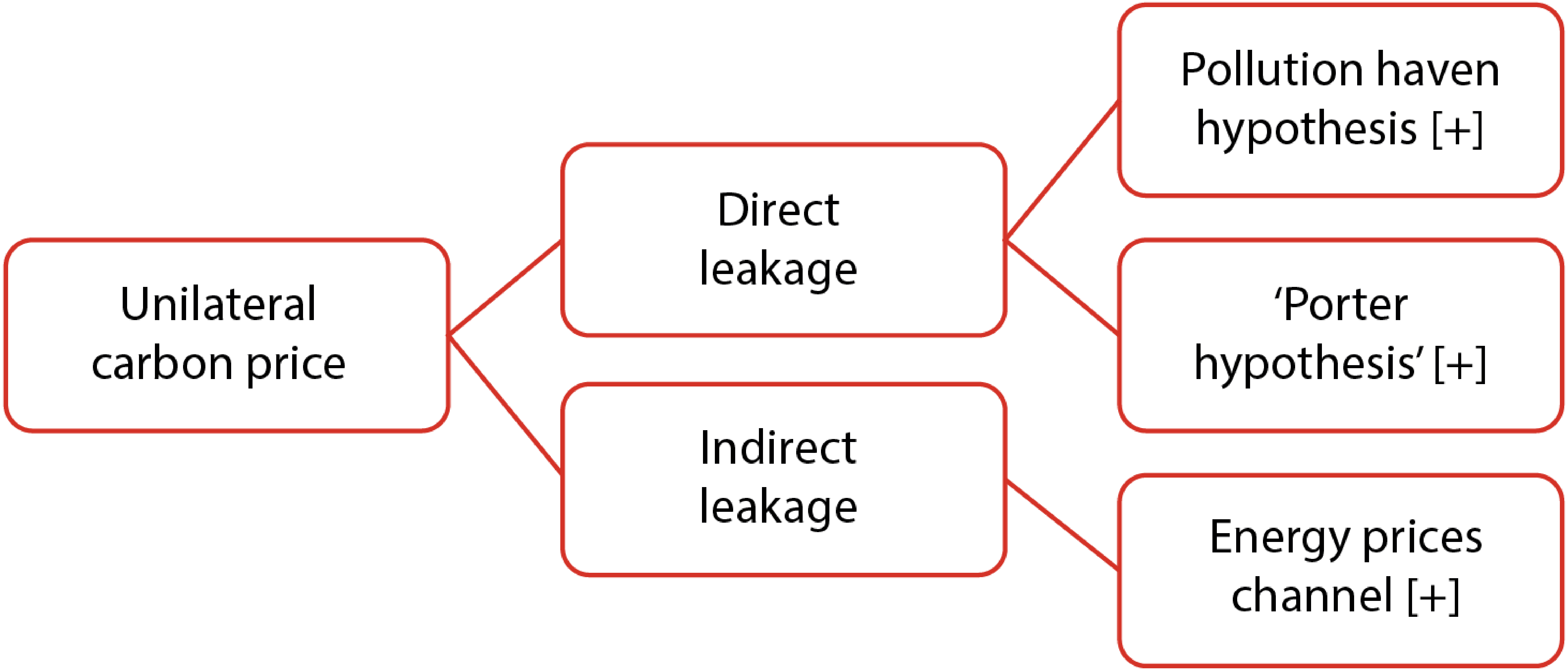
The EU should not make the introduction of a carbon border tax (CBT) that would tax the carbon embedded in imported products[3] into a must-have element of its climate policy. The existence of significant direct carbon leakage – which is the problem a CBT is designed to address – is mixed, and it would not be straightforward to design a CBT that is both politically/legally feasible and economically/environmentally meaningful.

Alternatives to CBTs should be considered (as we discuss later). The introduction of a CBT would be riskier, and would bring lower benefits, than alternative approaches to encourage global decarbonisation and preserve the competitiveness of EU industry during the transition to a zero-carbon economy.

Deconstructing the evidence for carbon leakage

Carbon leakage describes the relocation by companies of their carbon-intensive production activities from regions with tight emission regulations (for example, high carbon prices) to regions with less stringent standards (for

Figure 1. Theoretical channels of carbon leakage (+/- indicates positive or negative rates of leakage)



Source: Bruegel.

example, lower carbon prices or no price on carbon). In such a scenario, stricter rules on emissions in one place fail to reduce overall emissions.

Carbon leakage deriving from more stringent unilateral climate policy should be differentiated from changes in trade patterns for other reasons – particularly the growth of imports from emerging economies, which increased the amount of embedded carbon irrespective of climate policy[4].

It is feared that, because of carbon leakage, stricter climate policies in the EU could lead to: (1) a loss of market share to foreign, more polluting, competitors, and (2) increasing emissions in other regions. This assumed leakage is at the core of arguments in favour of carbon border taxation (CBT).

Ex-post studies of the ETS and other carbon pricing policies, have not yet found any significant evidence of carbon leakage

What makes the analysis so complicated?

An extensive literature has never been able to agree on the magnitude of carbon leakage for a certain environmental policy (for example, a €50/tonne CO_2 price).

Two extremes illustrate the uncertainty: in a worst-case scenario, an EU emission standard would kill a more-or-less carbon-efficient industry in the EU, leading that industry's products to be imported from countries with less carbon-efficient industries (and possibly also causing substantial trans- port emissions). The EU environmental standard would lead global emissions to increase under what is known as the pollution haven hypothesis.

In a best-case scenario, however, an EU environmental standard would stimulate the development of new, more efficient production processes in a sector, giving the EU a competitive edge and eventually replacing inefficient foreign production by cleaner EU production – known as the Porter hypothesis[5].

In addition, carbon leakage can operate through two channels:

- Direct leakage: in the short run, domestic carbon-intensive installations might reduce output, as output from equivalent foreign installations increases (operational leakage). In the long run, new capacities might primarily develop in countries with lower carbon prices (investment leakage). Both effects would lead to higher shares of carbon-intensive goods in imports.

- Indirect leakage, referred to in the literature as the international energy prices channel. In this situation, as EU climate policy leads to lower EU consumption of fossil fuels, global demand for fossil fuels would decline. As a result, fossil fuels prices fall. Lower prices encourage countries without climate policies to increase fossil-fuel consumption[6].

This distinction between direct and indirect leakage is important in the discussion of CBTs. A CBT might be effective in theory in mitigating direct leakage, but might have close to no impact on indirect leakage (Figure 1).

A multitude of studies have attempted to tackle these complexities and estimate the magnitude of leakage. Methodologies used range from ex-post econometric assessments of leakage in individual sectors, to ex-ante simulation of expected leakage based on large global equilibrium models.

Ex-post empirical studies show no clear evidence for leakage

Ex-post empirical studies of the EU emissions trading system (ETS) and other sub-global carbon pricing policies, have not yet found any significant evidence of carbon leakage (Branger and Quirion, 2014).

For example, Naegele and Zaklan (2019) used data from the Global Trade Analysis Project and found no evidence that the EU ETS caused carbon leakage between 2004 and 2011 in European manufacturing sectors. Dechezlepretre *et al* (2019) used empirical evidence covering 2007-2014 from the Carbon Disclosure Project, which tracks the declared emissions of multinational businesses by geographical region.

Theoretically, multinational firms should be the most affected by carbon leakage. However, Dechezleprêtre *et al* (2019) found no evidence that the EU ETS has led to a displacement of carbon emissions from Europe to the rest of the world. World Bank (2019) concurred with these findings and concluded that there is little evidence that carbon pricing has resulted in the relocation to other regions of the production of carbon-intensive goods or of investment in such products. Competitiveness may remain a major concern for policymakers but *"these concerns should not be overstated"* (World Bank, 2019).

Costantini and Mazzanti (2012) used a gravity model to show evidence empirically for a strong Porter hypothesis – that innovation and productivity gains arise as a result of energy and environmental policies – in Europe from 1996 to 2007. They found that evidence for the Porter hypothesis varies depending on the sector and policy considered. Overall, environmental policies appear to have made EU exports more competitive.

Aichele and Felbermayr (2015) provided some empirical evidence for carbon leakage arising from countries' ratifications of the Kyoto Protocol. Their comparison of pre- and post-Kyoto periods (1997-2000 and 2004-2007) found that the imports of a Kyoto-committed country from an uncommitted exporter were about 8 percent higher than they would have been had the country not committed to the Kyoto Protocol. The carbon intensity of these imports was about 3 percent higher.

Ellis *et al* (2019) reviewed the empirical literature and concluded that limited competitiveness[7] effects had been found – any positive or negative effects have been small. The authors found that the only conclusive empirical evidence relates to innovation, where carbon pricing appears to have had a positive effect.

Thus, based on evidence from ex-post, empirical literature, there is no clear conclusion pointing to the existence of carbon leakage at the aggregate level. There might be several reasons for this, including that carbon pricing differentials have been relatively low so far, and that existing programmes have often included generous compensation schemes for exposed industries. At higher carbon pricing differentials, direct leakage might become more pronounced, either via the pollution-haven hypothesis or via the Porter hypothesis.

Ex-ante modelling analysis shows the existence of limited carbon leakage, which is mainly indirect leakage

Researchers have also tried to understand ex-ante what the effects might be of a hypothetical future carbon price. Usually, they have used models[8] built on a wide base of socioeconomic, technological and other economic assumptions, and have then looked to better understand the effects of altering a specific driver within an economy, such as the carbon price.

To analyse CBTs, global models have been used that offer insights into the interactions between sectors and countries through trade and fossil-fuel price channels. Such models have so far tended to find limited carbon leakage at the aggregate level.

For example, Böhringer *et al* (2012) summarised the findings of 12 advanced models. In a reference scenario in which a range of countries (Annex 1 of the Kyoto Agreement) agree a collective 20 percent emissions reduction, the mean average leakage effects are found to be 12 percent, falling to 8 percent with implementation of a CBT. This means that 12 percent of the emissions reductions achieved domestically by Annex 1 countries would be offset by an increase in emissions from non-Annex 1 countries – without implementation of a CBT[9].

The results suggest that a CBT could reduce the competitiveness disadvantages faced by the emissions-intensive and trade-exposed sectors. However, the global cost savings from a CBT would be small, with the burden of emissions abatement simply shifted to developing countries, exacerbating existing income differentials.

An Organisation for Economic Co-operation and Development literature review concluded that ex-ante studies find economy-wide leakage typically ranging from 5 percent to 20 percent[10] (Condon and Ignaciuk, 2013). Branger and Quirion (2014) performed a meta-analysis on 25 studies using 310 estimates of carbon leakage. They found a mean leakage of 14 percent without a CBT and 6 percent with a CBT[11].

A range of modelling studies have found that the indirect energy-price channel exceeds direct leakage (Fischer and Fox, 2012; Böhringer *et al* 2010; Kuik and Hofkes, 2010). Modelling results show that while some carbon leakage can be combatted by a CBT, a CBT will never be completely effective in eliminating leakage, which will always persist to some extent via the indirect channel.

Bao *et al* (2012) provided a concrete example. They estimated the hypothetical impacts of a joint US and EU carbon tax on China's emissions. They noted the presence of indirect leakage and found that the emission reduction impacts of a hypothetical CBT in the US and the EU would be *"relatively small in China."* Increased emissions in China are driven by lower fossil-fuel prices, and therefore policies such as innovation and technology-transfer agreements would be more globally beneficial.

Furthermore, McKibben *et al* (2018) analysed the effects of a hypothetical carbon tax (starting at $27 in 2020 and rising until 2050) in the US. They found no evidence of carbon leakage. If anything, the slight slowing of the US economy appeared to result in lower emissions abroad (negative leakage). Interestingly, in one scenario, carbon taxation revenues were returned to households by lump-sum transfer, as advocated by 3,000 US economists (2018).

In this scenario, the addition of a CBT actually reduced domestic output, contrary to its objective. This happened because the CBT (a tariff) raised the price of imports for American citizens, leading to weaker demand for imports and hence foreign currency. This caused an appreciation of the dollar, reducing American exports. The effect of the CBT on net exports was thus negligible, but noticeable in terms of reducing the overall volume of trade.

Overall, ex-ante models have tended to predict the existence of positive but limited carbon leakage at the aggregate level. Typically, the indirect energy prices channel dominates.

Evidence of leakage in carbon-intensive sectors

Carbon leakage, if it exists, will be dominated by relatively few industries. Carbon intensive and trade exposed (CITE) sectors are the most likely to be at risk of losing out, given the high carbon content of their products and their exposure to international markets.

High trade volumes increase competition and make firms less able to pass price increases through to consumers. The three main industrial sectors considered to be vulnerable to carbon leakage because of their participation in the ETS are steel, mineral products/cement and aluminium production.

Similarly to aggregate findings, ex-post empirical literature has tended to find little to no leakage in these sectors as a result of the ETS. For example, Branger *et al* (2017) estimated empirical regressions for cement and steel under the ETS and found no evidence that the ETS led to carbon leakage between 2005 and 2012. Healy *et al* (2018) found no leakage in the clinker and cement sectors. This is not surprising given the low emission prices and free allowances given to companies during the second phase of the ETS (2005-2012).

Dechezleprêtre and Sato (2017) reviewed ex-post studies on environmental regulations and their impact on particularly polluting and energy intensive sectors. They concluded that *"ambitious environmental policies can lead to small … adverse effects on trade, employment"* and that *"the effects tend to be concentrated on a subset of sectors for which environmental and energy regulatory costs are significant."* They also found strong evidence for environmental regulations promoting innovation in cleaner technologies, highlighting the uneven effects of carbon pricing by sector.

Ex-ante modelling tends to estimate more significant rates of leakage for CITE sectors. Kuik and Hofkes (2010) found a total leakage rate of 10.8 percent arising from the ETS. Of this, the steel and mineral products sectors were responsible for 5 percentage points.

More generally, leakage rates of between 8 percent and 90 percent were found for cement, aluminium, and steel and iron production when no measures are taken to address leakage (Cosbey *et al* 2019). Such a large range highlights the high degree of sensitivity of modelling results to complex underlying assumptions, and makes the interpretation of results difficult.

A literature review provided to the European Commission for the identification of sectors exposed to a significant risk of carbon leakage found sectoral estimates from ex-ante studies ranging from 2 percent to 73 percent of carbon leakage (Öko-Institut and Ecofys, 2013).

This range again highlights the complexities associated with modelling real-world policies. Öko-Institut and Ecofys (2013) attributed lower estimates to the assumption of continued measures aimed at protecting exposed sectors, while the higher rates seemed to be associated with rather simple modelling assumptions relating to underlying elasticities (eg. homogenous products), leading to over-estimation of leakage.

At higher carbon prices, especially higher global carbon pricing differentials, any leakage would likely be in CITE sectors. This is certainly one reason why the European Commission plans to focus any eventual CBT on selected sectors.

Zachmann and Cipollone (2013) showed that on average, energy-intensive sectors generate fewer jobs and less value added than other sectors, representing only slightly more than 10 percent of EU value added and employment.

The literature also highlights in particular that there are many factors beyond carbon pricing that determine how competitive a sector is. By reviewing ex-post results, Dechezleprêtre and Sato (2017) showed that aggregate competitiveness effects arising from environmental regulation are small relative to the other determinants of trade (infrastructure, geography, availability of raw materials and skilled labour).

Depending on the type of leakage (operational vs investment), factors such as transportation, non-tariff costs, political risk, exchange rate concern, product differentiation, quality of capital, labour and energy available in an economy can all be expected to outweigh any leakage effects.

Substantial energy price differentials had surprisingly small effects on the location of downstream sectors

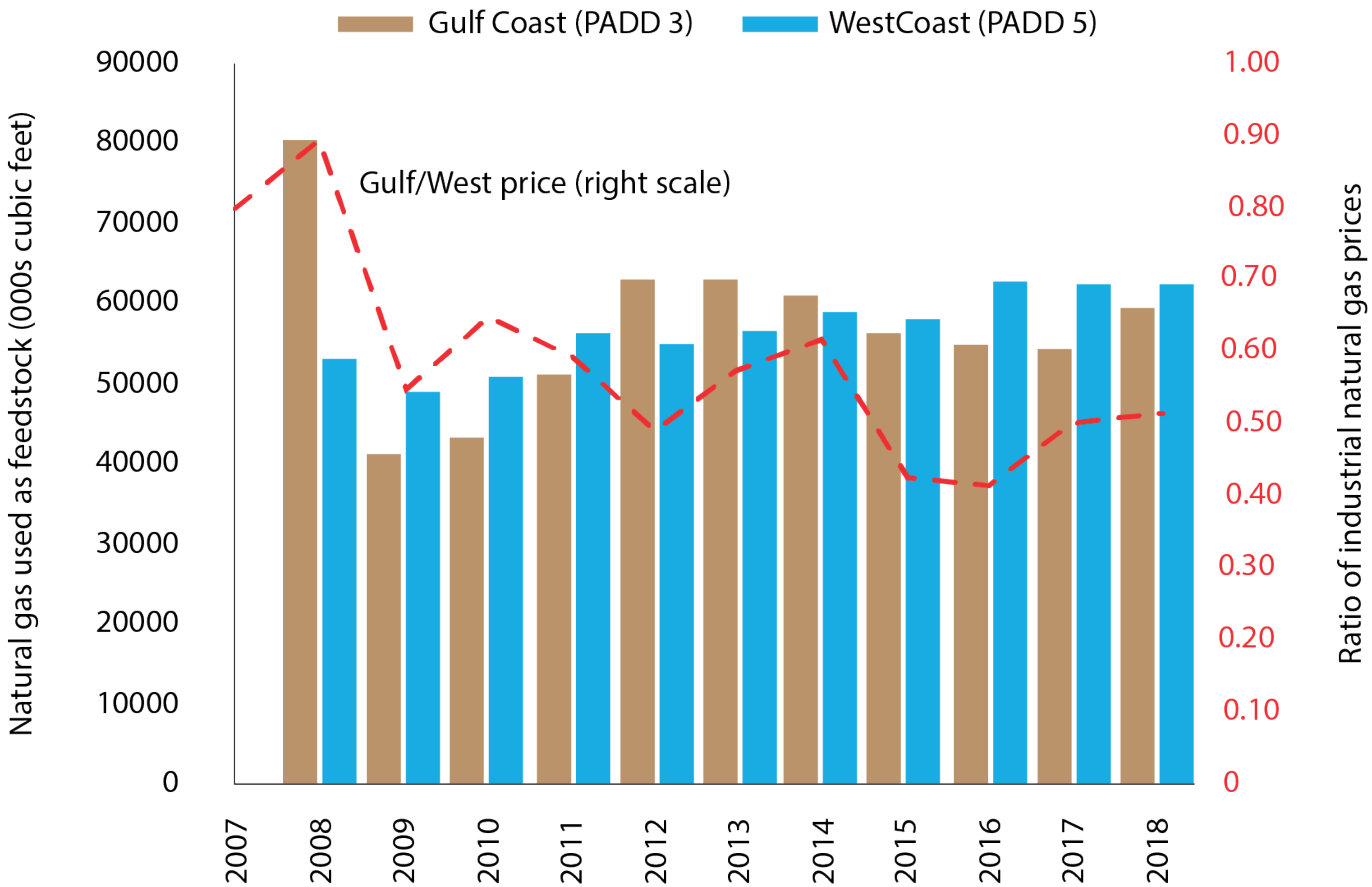
Given that carbon pricing differentials might not yet have been large enough to significantly influence competitiveness, energy price differentials could be used as a proxy for the expected effects of hypothetical carbon pricing.

Aldy and Pizer (2015) used US manufacturing industry data from 1974 to 2009, covering 450 sectors and sub-sectors. They estimated the effects of changing energy prices on domestic production and net imports for each of these sectors, with changes to net imports considered as the 'competitiveness effect'.

They found that for the most energy-intensive sectors (such as iron and steel, aluminium and cement), of the reduction in domestic production attributed to a rise in energy prices, only about one-sixth could be attributed to 'competitiveness effects'. Meanwhile, for sectors with median energy intensity there is no statistically significant effect of changing energy prices on net imports.

Results therefore suggest that buyers of products such as steel and aluminium respond to changing prices, but appear to do so not by shifting consumption to foreign substitutes, but in other ways, including by switching to other, less energy-intensive materials or by using less of the good in the manufacture of their final product.

Figure 2. Natural gas used as feedstock for hydrogen production in US regions



Source: Bruegel based on US Energy Information Administration, available at: https://www.eia.gov/dnav/pet/pet_pnp_feedng_k_a.htm and https://www.eia.gov/outlooks/steo/data/browser.

Note: Petroleum Administration for Defense Districts (PADDs) are used for natural gas volumes. We match these to natural gas prices from the US Energy Information Administration. PADD 3 corresponds to New Mexico, Texas, Arkansas, Louisiana, Mississippi and Alabama with the corresponding price data from Texas, Oklahoma, Arkansas and Louisiana. PADD5 corresponds to Washington, Oregon, California, Nevada, Arizona, Alaska and Hawaii. The corresponding natural gas price is for the same states without Nevada and Arizona.

The authors suggest this might be because imports are imperfect substitutes for domestically produced products, or that other trade determinants limit substitution possibilities.

The response of industry to changing energy prices can be illustrated with another example from the US, showing how industrial prices for natural gas vary significantly.

One would expect that industries are more able to relocate within a country than between countries in response to changing energy prices. A major use for natural gas is as a feedstock for production of hydrogen, which is then combined with nitrogen to produce ammonia. This is done at facilities across the US.

Figure 2 shows that in spite of an almost 50 percent decrease over ten years in the price of natural gas along the Gulf Coast relative to the West coast price, the levels of natural gas consumed as feedstock in each region have not changed.

In conclusion, while CITE sectors might experience some carbon leakage as a result of strongly diverging carbon prices, the evidence indicates that the effects are likely to be smaller than certain economic models would suggest.

A carbon border tax would be very difficult to implement

We have argued that there is little solid evidence for a risk of dramatic carbon leakage. The benefits of a carbon border tax as a means of addressing direct leakage would therefore be limited.

Furthermore, the implementation of a carbon border tax would be exceptionally difficult and potentially costly. Implementation could be done in two ways: (i) comprehensive coverage with all goods priced according to their carbon content, or (ii) limited implementation with only some carbon-intensive goods covered.

The European Commission currently favours the second approach, but it will be difficult to defend a strict division between selected and initially not-selected sectors, and a gradual expansion of coverage would be likely, once an effective sectoral CBT is implemented.

A comprehensive carbon border adjustment

For a full-scale carbon border adjustment, it would in principle be necessary to establish the carbon emissions linked to each product. Ideally, all direct and indirect emissions along the entire value chain would need to be calculated. This raises a number of practical issues:

1. Companies might object to disclosing details of their supply chains which are often considered to be trade secrets;

2. For some inputs including electricity or transportation there are big differences between marginal and average emissions[12] and it is very difficult to make distinctions. For example, all aluminium smelters in a country where 95 percent of electricity is produced from coal might claim when exporting aluminium to the EU that they only use the 5 percent green electricity share;

3. A CBT will imply some trade deviation. Exporters can to some extent re-route their products from countries that levy carbon tariffs to unregulated markets. For example, steel exports from Ukraine to the EU might drop, but then Ukraine might export steel to the US, which in turn stops using its domestically produced relatively low-carbon steel and sells it to the EU[13];

4. A CBT can be a substantial non-tariff barrier. For small companies from less-developed countries

in particular, it will be very difficult to comply with complex rules of origin, leading to further sector concentration and discrimination against less-developed countries[14].

The complexity for importers could be reduced by setting default carbon values for each product and calculating the border adjustment based on these, while allowing importers to pay less if they can prove their imports are greener. In our view this will not prevent objections (i) to (iii), as listed above.

It would reduce concern about non-tariff barriers but would still discriminate against smaller/less-developed players. The incentives for more polluting firms to decarbonise will also be reduced. A firm will receive no economic benefit unless they are able to reduce carbon content below the benchmark, taking into account the economic cost of self-reporting.

Moreover, the setting of default carbon values will imply judgement calls similar to the benchmarks used for distributing free allowances in the ETS, which became a major lobbying battleground in Brussels.

One possibility would be to use the EU ETS benchmarks. Under the ETS, free emissions allowances are given to companies based on how well they perform against product-related benchmarks, with only the best 10 percent of performers receiving all allowances for free. Benchmarks (for example, 1.62 tonnes of CO_2 generated per tonne of ammonia produced) have been determined for more than 50 products[15].

Using such a well-established methodology, which has not so far been challenged at the World Trade Organization, could resolve some complicated technical questions at the beginning. But over time the question will arise whether the benchmarks should evolve in step with EU decarbonisation[16] or if the benchmark should be kept at its initial level[17].

A carbon border adjustment covering selected sectors

Previous discussions about a CBT within the EU have focused only on CITE industries (Mehling *et al* 2019), in line with the general conclusion in the literature that a limited CBT is the most politically and legally feasible option, whilst also capturing the majority of any leakage benefits (Cosbey *et al* 2019).

This is because most industrial emissions stem from very few traded sectors[18]. Twelve sectors highlighted by the ETS as particularly polluting accounted for approximately 55 percent of EU industrial process and product-use emissions in 2018[19]. Logistically, applying a CBT only to these products would be significantly easier, as it would not require investigating complex value chains, and would avoid placing an additional administrative burden on all other products, which currently account for 98 percent of the EU's imports in terms of value[20].

The main problem with such an approach is that it could have a more damaging impact on EU competitiveness effects compared to no CBT at all. Putting a border-tax on specific carbon-intensive inputs (such as steel) could imply trade distortions for other parts of the value chain.

So if leakage is an issue, a selective carbon-border tax could result in a situation in which instead of importing steel from less-regulated countries, the EU will instead import downstream products from the steel value chain (such as nails) from those countries. This would lead to a higher loss in terms of value added and jobs. The Trump Administration's steel and aluminium tariffs have shown the potential impact. A White House report found that domestic steel capacity did not increase after the 25 percent tariff was introduced on 23 March 2018. At the same time, a 10 percent tariff was introduced on aluminium.

The reason for the lack of change in US production is that although imports of steel decreased after the imposition of the tariff, imports of certain steel products significantly increased. From June 2018 to May 2019, imports of steel nails, tacks, drawing pins, corrugated nails, staples and similar articles increased by 33 percent, while imports of aluminium wire, cables, plaited bands and similar increased by 152 percent[21].

The result was detrimental to domestic demand for US-produced steel and aluminium[22]. The Trump Administration has now decided to extend tariffs further down the value chain, illustrating nicely the theory of 'cascading protectionism'[23]. Given the complexities of a more comprehensive CBT, it is not clear how easy it would be for the EU to engage in this game of chasing carbon down the value chain.

The closest to an explicit analysis of the magnitude of this effect we have been able to find comes from Burniaux *et al* (2012). The authors modelled unilateral climate policy by groups of countries (EU, Annex 1 Kyoto) with and without a CBT. They found that a CBT would have no effect on reducing the output losses associated with energy-intensive industries as a result of carbon taxation.

This is because any international competitiveness benefit is outweighed by the increased production costs that such firms face (because of the increased price of imported intermediate goods). Their results suggest that energy-intensive industries might not actually benefit from a limited CBT[24].

Legal issues

The European Commission under Ursula von der Leyen has made it clear it wants a carbon border adjustment that is compatible with the rules of the WTO. The political reason for this is that the EU sees itself as a main beneficiary of the multilateral trade architecture (European Commission, 2015) and does not want to be seen to be undermining it. A CBT that is WTO-compliant is in principle possible, but rests on complex preconditions that will imply a trade-off between political feasibility and effectiveness[25].

Jennifer Hillman (2013) provided an overview of the challenges a CBT would face at the WTO. Article II.2 of the General Agreement on Tariffs and Trade requires any border tax to be implemented on 'like' products to those taxed domestically, and that the border tax cannot exceed the domestic tax rate (Article III.2). Determining whether products are the same creates a trade-off between ease of implementation and environmental effectiveness – for example, is steel the same product if produced by a blast furnace or an electric mill.

The carbon emissions for 'like' products can thus be drastically different, and to be effective, benchmarks would have to be determined for a whole host of products and variations of those products. Until now, the WTO has determined whether products are 'like' one another by *"examining their end use, consumer tastes and habits, and their physical characteristics, along with whether they compete with each other"* (Hillman, 2013).

There would arise a legal debate over how alike products produced via different methods are. Trachtman (2016) suggests that the best option for WTO compatibility would be a *"product-based tax that does not vary by reference to carbon intensity of production but is set at a fixed rate for specified categories of products"*[26].

In the event that a CBT was legally challenged and found to violate Articles II.2 or III.2, General Agreement on Tariffs and Trade exemptions can be applied for tariffs that *"protect human, animal, or plant life or health"* or when they are related *"to the conservation of exhaustible natural resources."* A CBT would likely meet these criteria, but explicit measures would have to be taken in the design of the tariff to highlight that it is implemented for global environmental purposes rather than to protect the economic competitiveness of EU firms (Hillman, 2013).

Furthermore, the United Nations Framework Convention on Climate Change (UNFCCC) rests on the principle of *"common but differentiated responsibilities and respective capabilities."* This implies that less-developed countries (and possibly countries that contributed less to the current stock of greenhouse gases in the atmosphere) should not face the same mitigation burden as richer, developed countries.

A CBT which gives preferential treatment to clean domestic and foreign producers might unduly affect developing countries. Tensions between developed and developing countries in international climate negotiations have long existed and there is concern a CBT might significantly exacerbate this. The EU might therefore wish to design a CBT which to some extent excludes developing countries. This would again raise the trade-off between overall effectiveness and addressing the concerns of developing countries.

Böhringer *et al* (2016) showed that carbon border tariffs would exacerbate pre-existing income inequalities as richer countries shift the burden of emissions abatement to poorer countries. In a scenario in which OECD countries take action to reduce emissions and implement CBTs on all embodied carbon within imports, OECD countries would end up free riding on their own climate policies at the expense of the developing world, because of shifts in the global terms of trade.

Böhringer *et al* (2016) concluded that the *"main effect of carbon tariffs is to shift the economic burden of developed-world climate policies to the developing world",* while reducing the global cost-effectiveness of climate mitigation, based on numerous welfare estimations.

Foreign political issues

The impact of a CBT on exporter countries will depend on whether the CBT is comprehensive or limited, and on the sectoral structure of the country. There might be a windfall profit for countries such as Costa Rica and Switzerland with clean fuel mixes, while India, South Africa and other countries with particularly carbon-intensive industries would be disadvantaged (Figure 3). The latter countries would be negatively affected by a CBT and would likely strongly oppose such a measure.

The administrative costs of a CBT – especially if comprehensive, requiring the disclosure of value chain information – will be opposed by all of the EU's trading partners. The implementation cost of such non-tariff barriers has been estimated at up to $70,000 for the certification of one product with a complex supply chain (Persson, 2010)[27]. Calculating embedded carbon is an expensive process, which will favour larger producers in developed countries with more resources, benefiting from economies of scale.

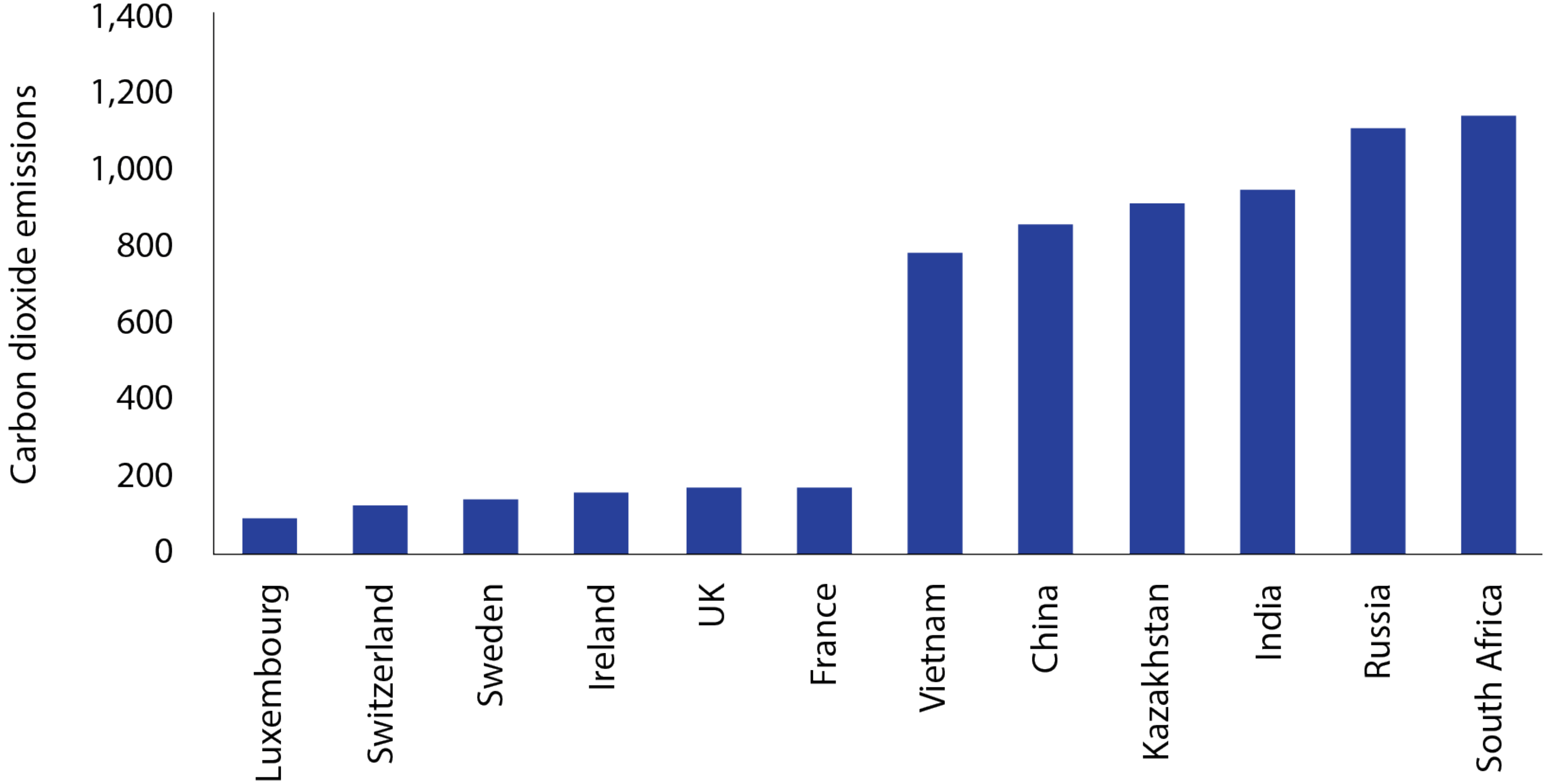
Moreover, a CBT might be seen as extraterritorial regulatory overreach by powerful countries that care a lot about their sovereignty. The narrative that the EU is introducing a CBT to trigger decarbonisation in other countries[28] is unlikely to help.

A proposal for the EU to retain revenue from the CBT for redistribution to industry or the economy would be particularly damaging in terms of legal compliance and cooperation with foreign partners. Powerful voices have already begun to express such sentiments.

Poland's prime minister, Mateusz Morawiecki, has suggested that revenues from a CBT could be used to fill the hole in the EU's budget following Brexit[29] (Krukowska, 2020). Such an argument blurs the distinction between a CBT as a measure designed for global environmental purposes and green protectionism.

As an advocate of free trade, the EU must be careful to steer clear of the argument that a CBT is a disguised restriction on intentional trade. Rather than accruing to the general budget, any EU CBT revenues should be sent back to developing countries affected by the tax. Because of the negative impacts for carbon-intensive exporters,

Figure 3. Intensity of CO_2 emissions embodied in total gross exports of final products in 2015 (in tonnes per $ million for the six lowest and highest countries)



Source: OECD.

the cost of compliance and fears of extraterritorial overreach, many of the EU's trade partners will be firmly opposed to an EU CBT. Other countries have already shown their willingness to retaliate in similar circumstances.

When the EU tried in 2012 to introduce carbon pricing for the full distance of flights arriving from outside the European Economic Area, the US, China and other countries quickly resisted (Sapir and Zachmann, 2012). The EU was forced to bury the proposal, in particular after reported Chinese threats to cancel Airbus orders[30] (Lewis, 2013). It is highly likely a unilateral EU CBT would trigger similar reactions[31].

The US would certainly strongly oppose – US commerce secretary, Wilbur Ross, has already said as much[32] (Tett *et al* 2020). One possible area for retaliation would be tariffs on automobiles, which could have a similar effect on the EU as the Chinese threat to Airbus in 2012. Introducing a CBT would thus require strong commitment and a coherent position from each EU country, in order to overcome the inevitable foreign opposition.

A wide international alliance with other countries that might join an EU initiative to introduce domestic climate policies, together with a jointly-designed CBT might alleviate some of the concerns[33]. But some countries, including the US and China, might have structural reasons to dislike such an approach (Böhringer and Rutherford, 2017).

Therefore, at best, it would require time, political capital and compromise on essential design elements, such as the desired carbon price, to develop such a coalition. At worst, such coalition- building will fail and leave the EU with the option of abandoning the idea of a CBT or doing it unilaterally.

Domestic political issues

Different industries and different EU countries have different preferences with respect to a CBT. Export-oriented industries and countries fear a CBT might trigger retaliation[34] (Nienaber, 2019), while industries and countries that fear foreign competition from carbon-intensive foreign suppliers might be interested in very strict border adjustments.

The design of a CBT implies decisions about which products to cover and how to set the adjustment for different products from different suppliers/countries. There cannot be an objectively optimal set-up and the choices will impact different countries and industries differently.

Spain, for example, might want to use the marginal carbon intensity of a country's fuel mix to calculate the adjustment for electricity imports, to protect itself against imports from Morocco, while Germany might want upstream emissions in natural gas imports not to be covered to reduce its gas import prices from Russia.

On other design elements, positions will also vary widely. Particularly difficult questions include:

- Will CBT revenues be returned to trade partners, used in the EU budget, or given to EU countries?
- Will existing leakage protections such as free allowances and indirect cost compensation be immediately abolished, phased out, or kept indefinitely?
- How long will a limited CBT last? Will it be limited to CITE sectors indefinitely, or will revision clauses be inserted allowing for the gradual extension of the CBT along value chains, turning it into a more comprehensive measure?

This suggests that compromises will lead to either reduced environmental effectiveness or less international/legal acceptability. Complex internal discussions will expend significant time and effort and risk political stalemate.

Moreover, when final decisions are made on a CBT, so much domestic political capital will have been invested that it will be very difficult to change/undo the design of the CBT as the international situation evolves. Table 1 provides a broad overview of the complexities.

Alternatives are available

Putting a price on carbon contained in imports is not the only way to treat leakage concerns.

Compensating trade-exposed polluters

One alternative is to compensate carbon-intensive domestic industries at risk of carbon leakage for the domestic carbon cost they face. This has been practiced under the EU ETS in two forms.

First, many companies were eligible to receive free emission allowances. The complex design of the allocation rules was supposed to ensure that companies have an incentive to reduce emissions, while being largely compensated for the carbon cost, in order to remain internationally competitive. The system likely led to significant overcompensation of carbon-intensive companies, which passed the market price of free allowances through to consumers[35].

The system also caused a fight over allocation rules and reduced the incentives for a deep transformation of the corresponding sectors. The second compensation mechanism was that the EU allowed governments to return some national ETS revenues to certain electricity-intensive companies.

The rules differed widely between countries and led to distortions in the internal market, in addition to most of the aforementioned problems[36]. Thus, we would advise against continued large-scale compensation schemes for carbon intensive producers.

Table 1. Advantages/disadvantages for different elements of CBT

	Selected advantages	Selected disadvantages
	Justification for CBT	
Competitiveness argument	Important in the domestic debate: industry wants protection from higher carbon prices	Not WTO compatible
		Trade partners will be encouraged to retaliate
		Beggar-thy-neighbour sentiment
Environmental argument	WTO compatible	Implies extra territoriality (no increase in foreign emissions) which might be politically sensitive
		Carbon leakage evidence is not clear
Induce stricter climate policies abroad	Potential to reduce emissions abroad	Impede upon sovereignty concerns of other countries
		Violates UNFCCC principle of 'common but differentiated'
	Coverage of CBT	
Complete value chain	Fair	Logistically difficult
Selected sectors	Easier to manage	Trade deviation (steel nails); Incentive for 'cascading protectionism' with CBT moving up the value chain
	Maximise	

Table 1. Advantages/disadvantages for different elements of CBT cont.

Design elements		
Compute exact carbon emissions	Largest and fairest effects	
EU product Benchmarks [1t steel = 0.8t of CO_2]	Logistically easier than computing exact carbon emissions	No incentive for excessive polluters
		Difficulties over how to adjust benchmarks over time
WTO Compliance	Defending the multilateral trade system is in the EU's interest	Reduced effectiveness
	Sine qua non for some member states	Will be challenged by trade partners regardless
Keeping the revenue	Adding to EU resources could help stabilize national macroeconomic shocks	Some EU member states oppose giving EU own resources
		Generating revenues makes it difficult to claim purely environmental reasons undermining political and legal arguments for CBT
Interaction with existing system		
CBT to replace free allowances	Free allowances were very distortive	As CBT will not be perfect, companies will lobby for allowances
	Maintaining two instruments will be difficult to defend legally and politically	Time-limited parallel scheme might be a solution
CBT to replace indirect cost compensation	ICC distorts internal market and international competition	As CBT will not be perfect, companies will lobby for allowances
	Maintaining two instruments will be difficult to defend legally and politically	CBT might not work further up the value chain -> argument for ICC

Source: Bruegel.

Supporting clean alternatives

A better alternative would be to support low-carbon production of products that are linked to high carbon emissions in their production. The EU would provide large-scale public support to the deployment of green steel, green cement or green aviation.

This would produce a double benefit. First, it would strengthen the long-term competitiveness of the EU in these currently high-carbon sectors.

Second, it could provide the world with the technologies needed for deep decarbonisation. The obvious blueprint is the renewable energy revolution that enabled unexpected cost reductions in wind and solar technology, and perhaps to a lesser extent the electric vehicle and batteries revolution that has also been supported by sizeable public programmes.

One approach to achieve such support is payments for low-carbon production. For steel, cement, pulp-and-paper, aluminium and other products, the EU could define emission benchmarks for disruptive low-carbon alternatives (for example, less than 0.75 tonnes of CO_2 per tonne of non-recycled steel, compared to an industry average of approximately 1.5 tonnes of CO_2).

Companies beating this benchmark would be given access to a fixed fund, potentially based on the auctioning of emission allowances that are currently distributed for free (at a carbon price of €40/tonne that would be €32.5 billion per year)[37]. Companies would receive a pro-rata allocation from the fund based on the amount of emissions they save compared to the benchmark.

he challenge would then be to define products and benchmarks in a way that would give companies flexibility in finding new solutions, such as new materials that meet the same demand, while closing loopholes that provide windfall profits to providers (for example, by recycling the same steel repeatedly and claiming the premium each time). The feed-in tariff system for renewables managed to deal with similar issues without being significantly derailed by WTO disputes[38].

If well designed, such a system could increase tenfold the incentive for emission reductions[39]. Such a competitive scheme to reduce emissions and develop new low-carbon technologies would be much more forward-looking than current schemes that compensate emission-intensive producers.

Measures to create markets for low-carbon alternatives can also be developed[40]. Similar to renewables support, a quota system for green products could be considered, in which the government sets the percentage of the product, such as steel, that must come from low-carbon sources and then allows the market to determine the cost.

Standards for products that can be used in the EU might be developed so that very carbon-intensive products are excluded. This might work best for products where the 'dirty' alternative can be clearly identified.

Contracts for difference are another support system for low-carbon alternatives[41]. These guarantee to investors in green projects a certain carbon price, which might be significantly above the market price. Contracts for difference are not linked to a measurable output, for example tonnes of green steel.

That makes the contracts easier to administer, but also results in only indirect incentives for the production of low-carbon products. So, an investor might benefit from the contract for difference initially obtained, irrespective of whether the green steel installation is fully used or not.

Public procurement represents a huge market in the EU for building materials and other products. Rules on public procurement should be designed in a way to better stimulate demand for low-carbon products.

If, as we argue, carbon leakage is not a massive problem for the majority of producers in currently carbon-intensive sectors, and over time alternative low-carbon products and production processes will become competitive, the best way to reconcile long-term competitiveness with decarbonisation becomes a question of timing.

While a CBT or allowances and compensation might buy time for incumbents, they will have political and financial costs and will delay the transition. Meanwhile, support for low-carbon alternatives might speed up the transformation and provide the EU with a lasting competitive edge in new sectors.

Supporting global decarbonisation efforts

Active climate diplomacy should complement the EU's decarbonisation efforts. Pushing for a price on carbon, for example, can be linked to preferential treatment for countries, such as allowing Ukraine to participate in the EU's Energy Union. Current work to provide technical and financial support to countries that implement carbon pricing should be continued and can have substantial returns.

Conclusion

Carbon leakage is real but limited and it should receive the political attention it merits but no more. All measures to address carbon leakage are imperfect, including carbon border taxes.

A CBT could be introduced in very different ways. The EU will have to choose between more efficient but highly complex and politically risky approaches, and almost ineffective but easily implementable mainly symbolic solutions.

Developing a CBT will however certainly expend significant amounts of human and political capital, whilst alienating and provoking international partners with whom cooperation is essential for successful decarbonisation.

Moreover, given the predominance of indirect leakage, and difficulties in measuring embedded carbon from foreign producers, it is not overwhelmingly clear that CBT would actually significantly address leakage.

The EU should therefore be careful not to fall into the trap of viewing a CBT as a carbon panacea, and should not put a CBT too high on its list of political priorities within the Green Deal. The EU must first begin to develop a series of more effective climate policies, such as a higher price on carbon, applied more widely, and broader support for low-carbon technologies.

Through such a strategy, Europe will be better placed to decarbonise internally and to spread this decarbonisation globally via the export of green technologies and know-how.

Whilst implementing such policies, the EU should closely monitor the risk of carbon leakage. If significant evidence arises that it is indeed becoming a substantial issue, the possibility and feasibility of a CBT could be further explored.

However, a focus on strengthening domestic policies, before resorting to a CBT, would hopefully offer solutions rather than problems to the EU's international partners. ■

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Endnotes

1. A 50 to 55 percent emissions reduction in 2030 compared to 1990, as proposed by European Commission president Ursula von der Leyen, would be a reduction of about 40 percent compared to 2018, as 2018 emissions were already about 23 percent below 1990 values.

2. The quote continues: "This would ensure that the price of imports reflect more accurately their carbon content. This measure will be designed to comply with World Trade Organization rules and other international obligations of the EU. It would be an alternative to the measures that address the risk of carbon leakage in the EU's Emissions Trading System."

3. So far the European Commission has talked about an "adjustment mechanism", which has no clearly defined meaning. We focus on a broader form of carbon border tax, which could also be a special import duty, the obligation to buy EU permits for imports or a domestic consumption tax on the carbon content of imports. Some of the arguments will, however, also apply to other conceivable mechanisms (including carbon standards for imports or no trade agreements with countries without proper emission pricing).

4. The EU's territorial emissions were 22 percent lower in 2016 than in 1990, while consumption-based emissions were 17 percent lower in 2014 than in 1990. From 1990 to 2014, consumption-based emissions were consistently higher than territorial emissions, on average by 19 percent (Kartensen et al, 2018).

5. The Porter hypothesis, from the work of Michael Porter, says that well-designed environmental regulation can increase the competitiveness of firms. Regulation forces a reduction in pollution which might lead to improvements in the efficiency of resource use. The result would be to trigger innovation because firms are forced to become more efficient (Porter and van de Linde, 1995).

6. This effect is not restricted to energy, but might also be present for other carbon-intensive products, such as beef.

7. The authors used a range of variables as proxies for competitiveness: net imports, FDI, turnover, employment, profits.

8. Underlying carbon leakage results are Armington elasticities, which specify the degrees of substitution in demand for similar products produced in different countries. The error bands in estimation of these elasticities are very wide (see Aspalter, 2015, p55, who estimated the 95 percent confidence interval for primary metals between -1.921 and 1.211 for

the UK), while most models only use point estimates to derive their results.
9. This definition of carbon leakage is the same for the rest of the literature estimates presented: if one economy implements a domestic climate policy, carbon leakage would be the ratio of the increase in emissions outside that economy to the decrease in emissions that occurs within the economy.
10. See footnote 9.
11. The intuition being that according to models, CBT can have some effect in combatting leakage. Burniaux et al (2013), among others, confirmed this result. Branger and Quirion (2014) noted that computable general equilibrium models dominate results, and that these models estimate statistically significant higher leakage rates than other models. The likely explanation for this is that in computable general equilibrium models, a large portion of leakage usually derives from the indirect, energy price channel (Kuik and Hofkes, 2010; Condon and Ignaciuk, 2013).
12. Average emissions depend upon total production whilst marginal emissions depend upon the production source that provides flexibility to accommodate an extra unit of demand. For example, an electricity grid might on average provide relatively clean electricity but with flexibility provided by natural gas plants. Additional demand will then result in an increase in supply from natural gas. The operations of an aluminium plant would have low average emissions but very high marginal emissions.
13. In 2018, the US produced 68 percent of its steel using electric arc furnaces (with a relatively clean fuel mix), while Ukraine produced 70 percent of its steel using oxygen furnaces and 8 percent using open hearth. Rough estimates of the emissions associated with each production type are 0.2 to 0.4 tonnes of carbon dioxide equivalent (tCO2e) per tonne of recycled steel for electric arc furnaces, and 1.8 to 3.0 tCO2e per tonne virgin steel for oxygen furnaces (World Steel, 2019, p10; Carbon Trust, 2011, p11).
14. Special provisions for developing countries may be implemented to attempt to solve this problem, but would in themselves lead to further complications in designing such exemptions. Most pertinently, such provisions would appear to violate the 'most-favoured nation' principle under the WTO.
15. See https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0331&from=EN

16. If the benchmark is regularly updated in line with the best 10 percent of EU installations, the benchmark will steeply decline when the EU decarbonises – undermining the instrument.
17. Then trade partners will complain that the gradual improvements in technology they make are not properly reflected.
18. According to a European Commission (Regulation (EU) 2019/331) definition, these are: hot metal, aluminium, grey cement clinker, white cement clinker, lime, dolime, sintered dolime, adipic acid, soda ash, carbon black, ammonia, hydrogen.
19. Industrial process emissions are only a small proportion of total emissions. However, our calculations do not consider indirect emissions. Including indirect emissions from these sectors would also account for a significant proportion of overall emissions: see Monjon and Qurion (2011), who estimated that steel, cement, aluminium, and electricity accounted for 75 percent of emissions covered by the ETS.
20. Trade data from UN Comtrade for codes: 2521, 2523, 2606, 2803, 280410, 2814, 283620, 291712, 72.
21. Both figures are compared to the figures from the previous year: June 2017 to May 2018.
22. Domestic steel price increases because of a tariff on imports are not the same as domestic steel price increases because of a domestic carbon price. Under imperfect competition, the former will increase the market power of domestic producers, leading to higher prices but not massively increased production. The latter will put more competitive pressure on domestic producers, causing some of the burden of the carbon tax to result in lower rents for capital owners.
23. Bown (2020) highlighted that even more cascading protectionism has occurred in the USA as a result of upstream steel and aluminium industries lobbying for antidumping measures. An estimated $5 billion of additional goods has faced antidumping measures since March 2018.
24. The industries they consider as emissions intensive are: chemicals, nonferrous metals, fabricated metal products, iron and steel, pulp and paper, non-metallic mineral products.
25. See Horn and Sapir (2013). Amon the issues they raise are principles of international allocation of jurisdiction, fears of evolution into protectionist measures, and providing evidence that any CBT would be internationally fair.
26. Such an approach would be difficult to reconcile with the WTO 'like products' Article II.2, as it is not the system

currently applied for EU production.

27. It should be noted that were the EU to pursue a more limited form of CBT only for particular heavy industries, costs may be lower.

28. Ursula von der Leyen's January 2020 speech at the World Economic Forum in Davos, which touched on a CBT, triggered media responses such as: M Khan and G Rachman 'Davos 2020: Ursula von der Leyen warns China to price carbon or face tax', 22 January 2020, Financial Times.

29. See E Krukowska, 'Carbon Border Tax in Europe Gets Backing From Polish Premier', 6 February 2020, Bloomberg.

30. See B Lewis, 'Exclusive-Airbus to China: We support you, please buy our jets', 13 May 2013, Reuters.

31. Zhao Yingmin, China's vice environment minister, said in 2019: "We need to prevent unilateralism and protectionism from hurting global growth expectations and the will of countries to combat climate change together." See C Cadell, 'China says CO_2 border tax will damage global climate change fight', 29 November 2019, Reuters.

32. See G Tett, C Giles and J Politi, 'US threatens retaliation against EU over carbon tax', 26 January 2020, Financial Times.

33. See Victor (2015) for the arguments for an alliance, or club. The proposal from Nordhaus (2015) was to raise uniform percentage tariffs on all imports from countries which are outside of the club, ie. tariffs not linked to carbon emissions. This may be even more difficult to reconcile with WTO rules than a CBT.

34. See M Nienaber, 'German industry sounds alarm over EU carbon border tax', 25 September 2019, Reuters.

35. Zachmann et al (2018, p84) calculated that between 2013 and 2017 this transfer amounted to €45 billion.

36. For example, Italy provided no such compensation, while Germany returned €202 million in 2017 (See Marcu et al 2019, p24).

37. The EU ETS Innovation Fund already builds on a similar logic, using a share of the revenues of the ETS to support low-carbon technologies in sectors covered by the ETS (Article 10bis, §8 of Directive (EU) 2018/410). However, available funding will only correspond to the market value of at least 450 million allowances for the period 2021 to 2030, amounting to approximately €10 billion over ten years.

38. Some provisions – such as local content provisions – were however ruled incompatible with WTO rules. See

https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds426_e.htm.
39. Initial implicit carbon prices of renewables support schemes were up to €1,250 per tonne in 2000.
40. See, for example, OECD (2019); Agora (2019); Neuhoff (2018).
41. See, for example, Sartor and Bataille (2019) or Zachmann (2015).

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