What does an EU Carbon Border Adjustment Mechanism mean for the UK?

Josh Burke, Misato Sato, Charlotte Taylor and Fangmin Li

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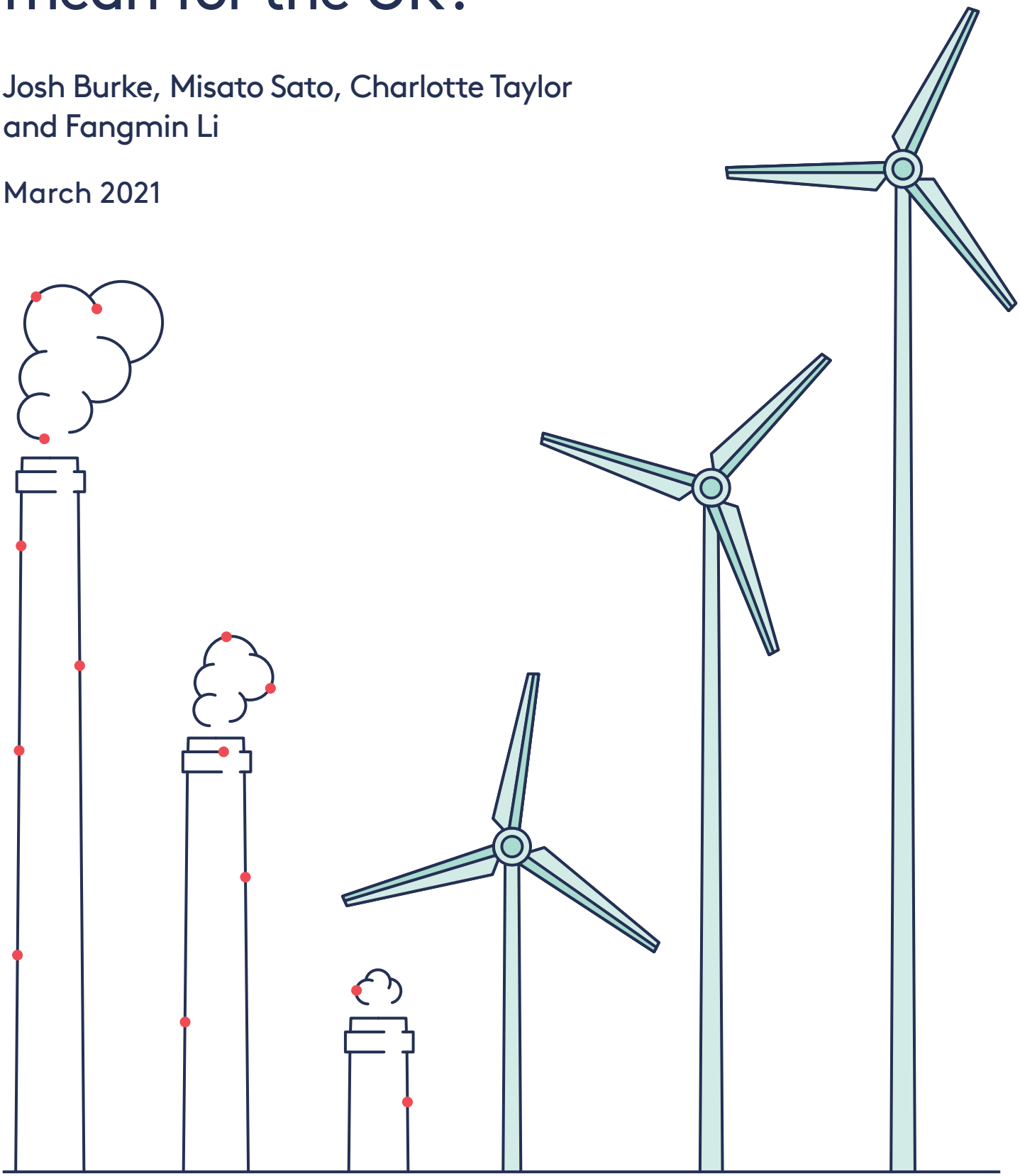

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About the authors

Josh Burke is a Senior Policy Fellow at the Grantham Research Institute on Climate Change and the Environment.

Misato Sato is an Assistant Professorial Research Fellow at the Grantham Research Institute on Climate Change and the Environment and Deputy Director of CCCEP.

Charlotte Taylor is a Policy Analyst the Grantham Research Institute on Climate Change and the Environment and Research Advisor to Professor Stern.

Fangmin Li an Assistant Professor in the School of Economics at Zhejiang University of Technology.

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Contents

Summary

Key messages

- A robust carbon pricing framework with anti-carbon-leakage measures is needed to support deep decarbonisation of industry on the pathway to net-zero greenhouse gas emissions.
- The EU has announced that a Carbon Border Adjustment Mechanism (CBAM) will be operational by the end of 2022. A failure by the UK to coordinate or keep pace with the EU's level of policy stringency for industrial sectors could risk important UK exports being penalised by the CBAM.
- This could entail large financial transfers from the UK to the EU, potentially amounting to €1 billion or more, with exporters of steel hit particularly hard.
- The product coverage of the CBAM has significant implications for the expected carbon leakage and competitiveness impacts, as well as for paid/collected fiscal revenue. It matters particularly for steel, where semi-finished products account for a significant share of sectoral trade-embodied carbon.
- As the EU is the UK's main trading partner in carbon-intensive goods, regardless of whether the CBAM considers only basic materials or broader products, the potential impact is significant. Around one-third of the total value of all UK goods exported to the EU could be affected.
- Joint implementation by the EU and UK of a CBAM covering imports but not exports would be more compatible with environmental objectives and trade law. However, it would disadvantage UK raw material exporters as they would not be able to pass on carbon costs in foreign markets. This would particularly affect exporters in steel and aluminium because they have a stronger trading relationship with non-EU countries.

High-level recommendations

- To decarbonise industry there needs to be a strong policy framework that includes a high carbon price and complementary leakage measures. The carbon price should rise to £75/tonne in 2030.
- Given strong trade linkages and integrated supply chains with the EU, uncertainty around UK's post-Brexit climate policy and particularly around anti-carbon-leakage measures further reduces the long-term investment security for carbon-neutral production processes for UK industry. As a priority, measures should be put in place to address this uncertainty and enable investors to recover the incremental costs of carbon-neutral investments.
- To reduce investment uncertainty, the UK should consider close multilateral cooperation with the EU on a robust policy package to support industrial decarbonisation, including linking of emissions trading systems, equitable CBAM design, the gradual phase-out of free allocation of permits, support for innovation, and carbon contracts for difference.
- Policies to address carbon leakage and prevent export sectors from losing global market share should focus on specific sub-sectors and may be differentiated. For example, leakage provisions that are tailored to steel and aluminium would be needed if the UK has a broad, import-only CBAM in conjunction with the EU CBAM. This could include different boundaries for product coverage.

Why the UK needs to address carbon leakage in some industrial sectors

There is a long-standing concern that unilateral and ambitious climate policies may lead to carbon leakage in some industries. The risk of carbon leakage – where production shifts offshore to countries with less stringent climate policy – is typically focused on energy-, carbon- and trade-intensive industrial sectors. These are sectors exposed to international competition and considered to produce emissions that are 'hard to abate', where breakthrough low-carbon technologies have not yet been found or are too expensive.

So far, carbon leakage concerns have been addressed in the UK by shielding industry from the full impact of the carbon price. Policymakers increasingly recognise that free allocation of emissions permits does not support low-carbon transformation, nor will it provide sufficient leakage protection. A robust plan and carbon price framework to support the low-carbon transformation of these energy-intensive sectors is therefore vital to meeting the UK 2050 net-zero carbon target. This may include a Carbon Border Adjustment Mechanism (CBAM) and the phase-out of free allocation of permits, but additional measures such as the introduction of carbon contracts for difference for hydrogen production may be needed.

Carbon Border Adjustment Mechanisms are gaining traction

A Carbon Border Adjustment Mechanism works by imposing a fee on carbon-intensive goods from countries with less stringent climate policy. As more and more countries raise climate ambition and commit to much stronger nationally determined contributions (NDCs), we have seen a resurgence in the debate around CBAMs and their possible role. In particular, the announcement made by the European Union that a CBAM will be adopted by the end of 2022 has galvanised debates internationally.

Two scenarios for the UK

It is not yet clear what the EU will do in terms of implementing its announced CBAM. We have hypothesised two emblematic scenarios for the UK:

- ***High convergence with the EU*:** Here, we hypothesise that the UK coordinates with the EU on all policies supporting industrial decarbonisation, and a CBAM is applied to UK imports from the rest of the world.
- ***High divergence with the EU*:** Here, UK ambition falls and the EU charges a CBAM on UK exports to the EU.

While the likelihood that the UK's exports are penalised by an EU CBAM is small given that the UK and EU share the net-zero by 2050 ambition, our analysis reinforces the need for continued high ambition and convergence with EU policies on carbon pricing and CBAMs.

Potential economic impacts for the UK under a high convergence scenario

We explore the potential impacts of a CBAM using two possible scopes:

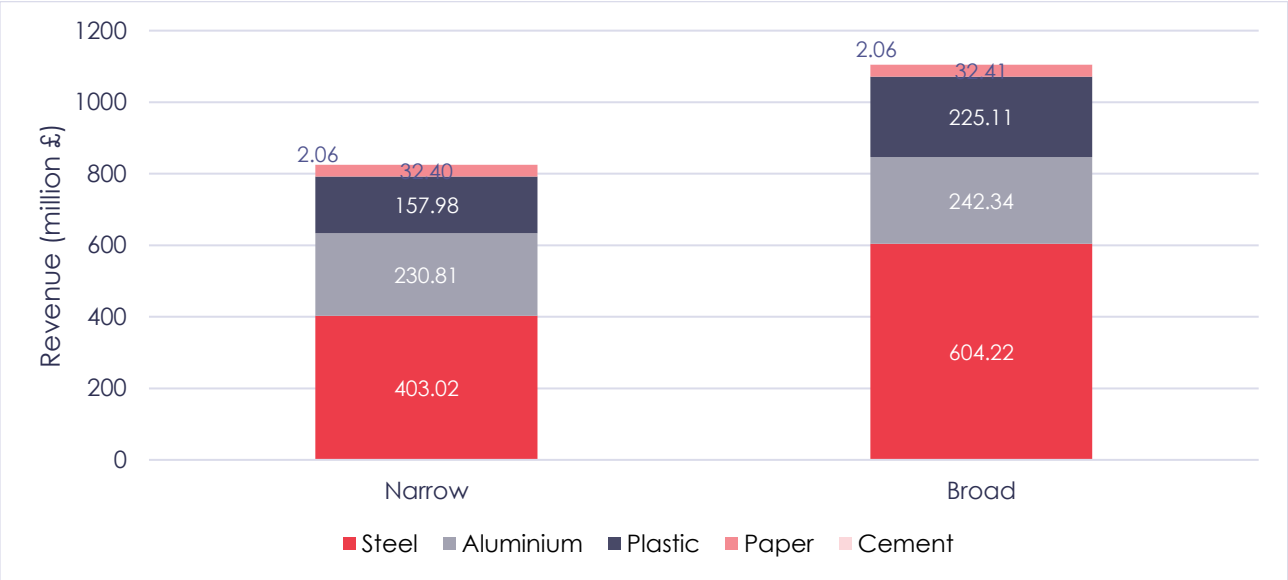
- ***The 'narrow' CBAM*** covers only raw material products, defined as those with content of at least one raw material greater than or equal to 90%.
- ***The 'broad' CBAM*** covers both raw material and semi-finished products with content of at least one raw material greater than or equal to 50%.

The impacts of the UK implementing and enforcing a CBAM (alongside the EU) on imports from non-EU countries is measured in terms of potential revenue to the UK exchequer.

The estimated economic impact is not trivial, even if only a narrow set of basic products are covered by the CBAM. Figure S1 below illustrates that if the UK enforced a CBAM on imports from non-EU countries on only raw materials of steel, cement, plastic, paper and cement, the tax revenues would be close to £800m per annum, assuming an adjustment

rate of €50/tonne of CO_2. If the scope were broadened to include semi-finished products, the tax revenue would increase to approximately £1.1bn. These are upper bound estimates, and these impacts are likely to be moderated with some import substitution resulting from the price rise of imported raw materials. The biggest contributors are steel and aluminium, which account for almost 50% and 20% respectively of total revenue from raw materials and raw materials and semi-finished products.

Figure S1. Potential annual CBAM revenue from UK imports from non-EU countries



Notes: Raw material content of 'Narrow' >=90% and of 'Broad' >=50%. Revenues are 2010–2018 mean. The CBAM adjustment assumes €50/t carbon price in the EU and UK, full adjustment to all trading partner countries.

A CBAM should not be considered a revenue-raising instrument. The measure should be viewed as environmentally motivated – a way to reduce emissions and preserve climate ambition, rather than fiscally motivated – a way to raise government revenue. To increase the international acceptability of the CBAM policy, the proceeds should be hypothecated towards low-carbon innovation and channelled towards climate change mitigation and adaptation investments in Least Developed Countries (LDCs).

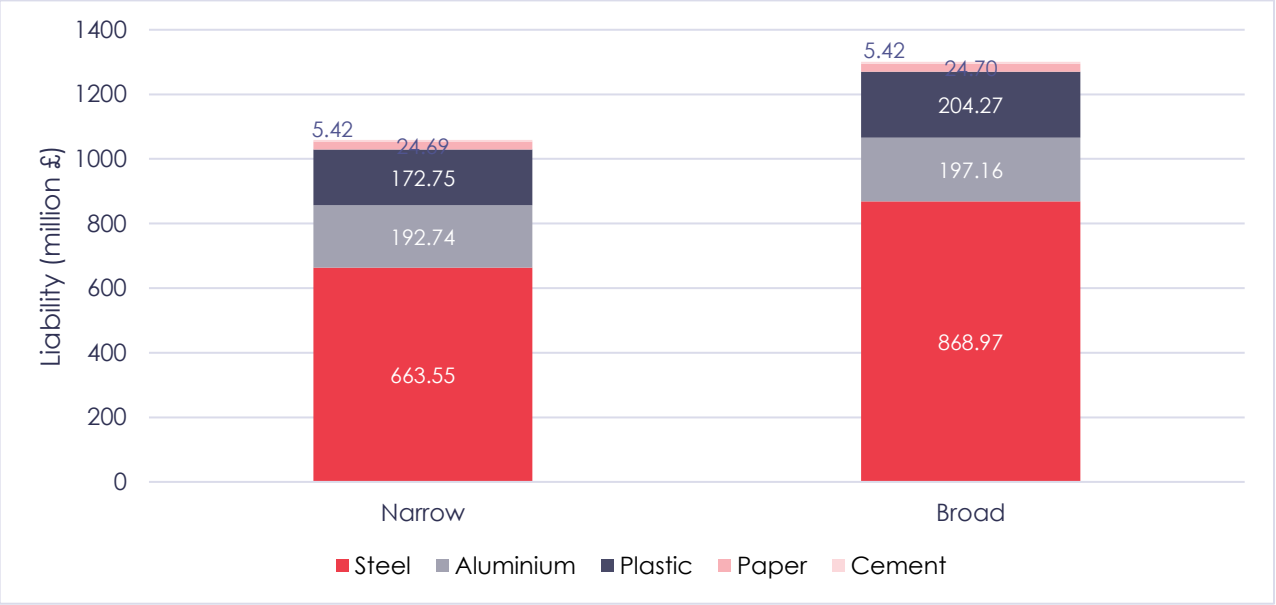
Implications for the UK under a high divergence scenario

The EU trading block is the main destination for UK raw material exports. Between 2010 and 2018 the average annual value of UK exports of raw materials and semi-finished products to the EU was €58.9bn, which equates to 13.5% of the average annual value of UK production over the period. If these exports were affected by an EU CBAM this would account for approximately 34% of the total value of all UK goods exported to the EU. This would suggest that it is important for the UK to retain its alignment on climate policy ambition with the EU, to avoid being charged a CBAM on UK exports.

Economic impacts on sectors, industries and products

In the unlikely event that the UK is fully subject to an EU CBAM, the potential liabilities would be large. Here, the economic vulnerability of a sector to a CBAM is largely driven by the carbon intensity of the traded materials. We examine the actual/relative impact of the CBAM in two ways: first, we look at the liability as a percentage of the monetary value of the trade flow; second, to put into context the importance of the EU market for each UK industry, we look at the liability against the export share of production.

Figure S3. Annual potential tax liabilities on UK exports to EU



Notes: Raw material content of 'Narrow' >=90% and of 'Broad' >=50%. Liabilities are 2010–2018 mean. The CBAM adjustment assumes a €50/t carbon price in the EU, full adjustment to all trading partner countries. The Appendix to this report contains an additional scenario where the EU credits a UK carbon price of £22/t.

Our results are likely to reflect upper bound estimates. Nevertheless, across both scenarios, the largest tax liability is faced by the steel sector, followed by the aluminium then plastic sectors. Under the narrow CBAM scenario, the UK's raw-material steel, aluminium and plastic sectors would face £663.55m, £192.74m and £172.75m tax liabilities, respectively. When broadening the scope to include semi-finished products, tax liabilities across steel, aluminium and plastic are higher but remain the same for paper and cement. The larger increases for steel and plastic suggest that a CBAM on raw materials only does not significantly address leakage risk. In contrast, there is either a small or no change in liability for cement, paper and aluminium when the scope is enlarged. This shows that a narrow CBAM will capture almost all materials at risk of leakage in those sectors. A broad CBAM that covers only imports can result in the cumulation of charges for materials that are part of integrated value chains and cross the UK–EU border multiple times during the production process. To avoid being subject to the adjustment multiple times, a mechanism is necessary to account for the charge paid at earlier stages.

Assuming the liability is paid, the relative price change[1] for each sector can be calculated as the percentage of the monetary value of the trade flow that the tax liability represents. Though the tax liability is greatest for steel in absolute terms under a narrow and broad CBAM, the relative price change is instead greatest for aluminium under a narrow CBAM and cement under a broad CBAM. This is because UK exports to the EU of aluminium and cement have a much lower total value than steel and so the tax liability represents a relatively larger percentage of the value of the trade flow.

Industry-level analysis for the high divergence scenario

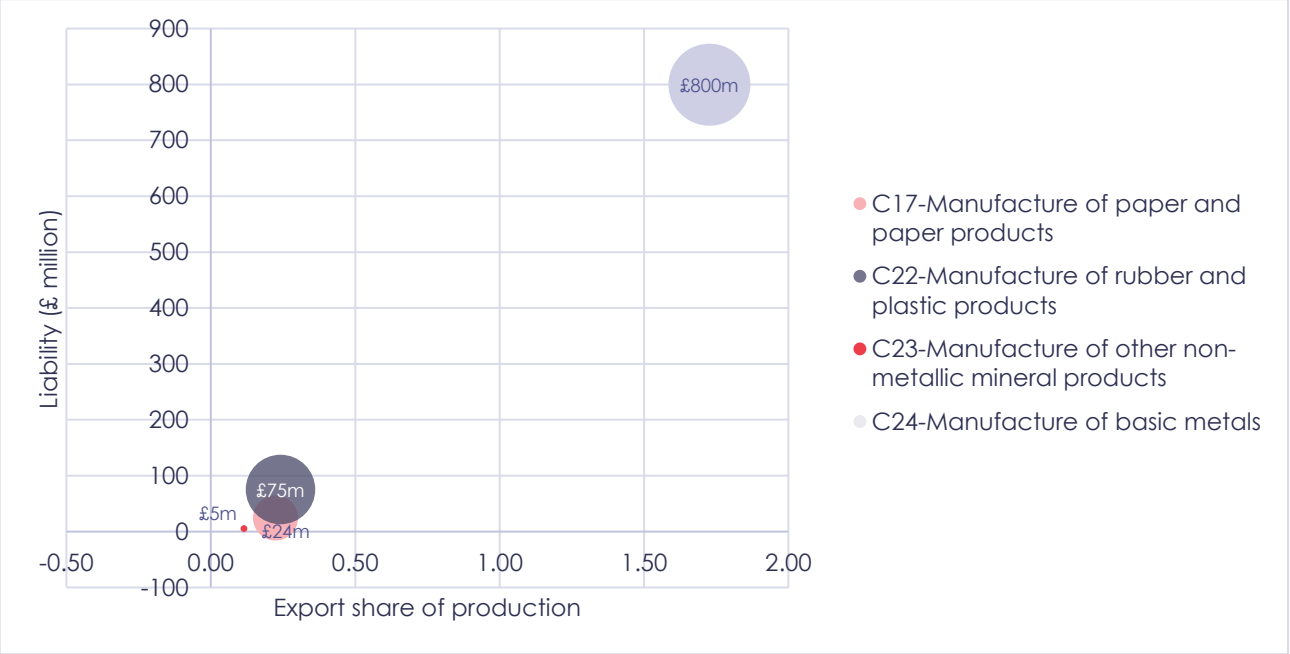
The extent of the impact on industrial sectors is largely influenced by two factors: economic liabilities caused by an EU CBAM and the strength of the trading relationship between the

[1] 100% cost pass-through provides an upper-bound cost estimate.

UK and the EU, which is indicated by the export share of production. We have combined these metrics in the charts below to aid understanding of the potential impact of an EU CBAM on UK exports.

In Figure S4 the value of industry exports is indicated by the size of circle. On the basis of these two factors, the industry most directly hit by the CBAM would be manufacturing of basic metals. This industry is an outlier in terms of both its export share of production and its tax liability. An export share of production of 1.73 conveys that the value of UK exports of raw material products to the EU in this industry exceeds the value of UK production, indicating that the UK re-exports products. This industry is also faced with a high tax liability of £800m and contributes most significantly to the total value of UK exports of raw material products to the EU.

Figure S4. Potential impact of a narrow EU CBAM on UK exports from industrial sectors



Notes: 'Narrow' includes products with raw material content >=90%. Liabilities are 2010–2018 mean. The numbers are from the European Community's NACE code for classifying economic activities.

The UK should prioritise alignment with the EU on anti-carbon-leakage measures

A robust carbon pricing framework with anti-leakage measures is needed to support the deep decarbonisation of industry in the UK. This includes higher carbon prices than those currently in place. However, carbon pricing needs to be part of a broader framework to support the low-carbon transformation of these energy-intensive sectors. This includes high convergence, collaboration and market linkage with the EU, which would provide a common platform on which to collaborate with the EU on anti-leakage measures. Failure to sufficiently align with the EU risks undermining the role of UK carbon pricing in supporting deep decarbonisation in sectors that would otherwise be at risk of carbon leakage.

Conclusions

This analysis reinforces the need to reduce uncertainty around the UK's post-Brexit climate policy and particularly around anti-carbon-leakage measures, while prioritising high decarbonisation ambition, carbon market linkage to nullify the impacts of an EU CBAM, and collaboration with the EU on anti-leakage measures.

1. Introduction

As more and more countries raise their ambition on climate action and commit to much stronger nationally determined contributions (NDCs) to achieving the Paris Agreement targets, there has been a resurgence in the debate around Carbon Border Adjustment Mechanisms (CBAMs) and the role they may play in preserving the effectiveness of climate action in high ambition countries. This report explores how the European Union's CBAM, announced to come into force by the end of 2022, might affect the UK.

Addressing carbon leakage

There is a long-standing concern among policymakers that unilateral and ambitious climate policies may lead to carbon leakage in some industries (Dissou and Eyland, 2011; Dechezleprêtre and Sato, 2017). Concerns around carbon leakage – where production shifts offshore to countries with less stringent climate policy – is typically focused on energy- and carbon-intensive industrial sectors. These sectors are exposed to international competition and their emissions are considered 'hard to abate', where breakthrough low-carbon technologies either have not yet been found or are too expensive.

To mobilise large-scale investments towards carbon neutrality or net-zero in these sectors, it is well recognised that a high enough carbon price alongside standards and investment support is needed to incentivise companies to develop and adopt low-carbon technologies and produce carbon-neutral goods and services. It is less often acknowledged that companies and investors need a guarantee that they can recover parts of the incremental costs, by achieving a higher sales price for carbon-neutral products. In other words, a robust carbon price framework that achieves full carbon cost pass-through throughout the value chain is needed to transform industrial sectors and enable them to direct investments towards carbon neutrality.

In the UK, industrial sectors accounted for 21% of total greenhouse gas emissions in 2019 (BEIS 2021), which includes basic materials such as steel, cement, aluminium, plastic and paper. These sectors are characterised by capital-intensive processes with long investment timeframes. They are also currently trapped in carbon-intensive processes and often suffer high excess capacity and low cash flow because of factors including globalisation, Brexit and now COVID-19. A robust plan and carbon price framework to support the low-carbon transformation of these energy-intensive sectors is therefore vital to meeting the UK's 2050 net-zero carbon target.

While the levels of climate ambition in the UK and the EU are unlikely to diverge – indeed the UK's 2030 target is currently more stringent than the EU's – the precise policy pathways to support and achieve the low-carbon transition of industrial sectors could differ. For example, the EU may impose a Carbon Border Adjustment Mechanism (CBAM) and phase out free allocation of emissions permits (despite the EU Parliament recently voting against an amendment to gradually phase out free allocation of permits), or it could introduce carbon contracts for difference for hydrogen production or a carbon consumption charge (Marcu et al., 2020).

So far, carbon leakage concerns have been addressed in the UK by largely shielding industry from the impact of the carbon price. Empirical evidence suggests that current carbon policies have had little impact on leakage (Dechezleprêtre and Sato, 2017; Venmans et al., 2020). The current solution (free allocation to energy-intensive, trade-exposed [EITE] sectors) may have provided adequate protection against leakage while

carbon prices were low, but it does not support a long-term low-carbon investment framework, nor does it provide robust leakage protection going forward.

Carbon prices are rising, free allocation is set to decline, and countries are striving for increasingly stringent climate targets. Globally aligned carbon policies remain the first-best solution. But in reality, we live in a world of second-best solutions, where asymmetric carbon prices across jurisdictions, free allocation of permits and price exemptions exist. Therefore, until globally equivalent carbon policies are enacted, temporary but more robust policy measures may be needed to ensure the survival of these sectors in the UK's low-carbon future. CBAMs are often discussed as an alternative mechanism to address leakage while countries pursue climate action at differing speeds, and can act as a tax on the imports of energy-intensive goods from countries that do not have appropriate environmental policies.

CBAMs have moved up the political agenda

A CBAM is designed to impose a fee on carbon-intensive goods from countries with less stringent climate policy. The announcement made by the EU that a CBAM will be adopted by the end of 2022 has galvanised debates internationally. The European Commission's President, Ursula von der Leyen, pledged before her election to introduce an EU CBAM to "ensure our companies can compete on a level playing field" and "avoid carbon leakage" (Von der Leyen, 2019). It was therefore no surprise that EU CBAMs were a key inclusion in her vision for the European Green Deal. In July 2020, the EU launched a consultation on a CBAM to elicit views from key stakeholders, signifying the first step in the policy design process.

In the UK, the EU Energy and Environment Sub-Committee took evidence in March 2020 from academics on the implications for the UK of the EU's proposed CBAM. More recently, the National Infrastructure Commission's policy report of November 2020 (which accompanied the Chancellor's 2020 Comprehensive Spending Review) stated that "government will consider what trade and diplomatic levers can be used to protect the competitiveness of UK industries as they decarbonise". This was echoed in the interim Net-Zero Review by Her Majesty's Treasury. CBAMs also featured prominently in the Climate Change Committee's Sixth Carbon Budget advice, which stated that such a measure "could enable carbon pricing to support deep decarbonisation in sectors that would otherwise be at risk of carbon leakage" (CCC, 2020).

It is questionable whether this intensifying interest in CBAMs will ultimately manifest in tangible policy development within the UK. It does, however, signify intent for global regime change where trade relations are affected by climate ambition. Furthermore, it reflects recognition that free allocation does not provide sufficient leakage protection. To tackle industrial sector emissions, complementary measures are likely needed to enhance the effectiveness of carbon pricing policies in driving forward investments in carbon-neutral technologies, and to create markets for low-carbon alternatives.

Discussions around CBAMs also reflect the increasing convergence of two key multilateral issues: trade and climate. These issues are even more pertinent to the UK as it begins the complex task of implementing new domestic carbon pricing policy while simultaneously upholding agreements made under the new free trade agreement with the EU and forging new free trade agreements with other countries.

This report

It is not yet clear how the EU will implement the CBAM. To explore how the EU CBAM might affect the UK, this report uses two extreme, emblematic scenarios – high convergence and high divergence with the EU. In a high convergence world, the UK coordinates with the EU on all policies supporting industrial decarbonisation, and the UK implements a CBAM with the EU, such that it is applied to UK imports from the rest of the world. In a scenario of high divergence, UK ambition falls and the EU charges a CBAM on UK exports to the EU. Of course, the likelihood that the UK's exports come under the auspices of an EU CBAM is unlikely in reality – at the national level, the UK and EU share the ambition for net-zero emissions by 2050.

We further discuss likely design features of the EU CBAM and the implications for the UK in terms of designing future carbon pricing policy. We also discuss and provide some indicative numbers on the parts of UK trade that will be directly affected by the CBAM, the importance of trade with the EU in relevant sectors relative to non-EU trade partners, the importance of these industries to the UK economy, and the economic impacts to sectors, industries and products in absolute terms and relative to export value.

2. Design of an EU CBAM

To understand the possible implications of the EU CBAM for the UK, it is important first to consider how its design is likely to look. A number of designs have been proposed and discussed (European Commission, 2020b; Mehling and Ritz, 2020; Marcu et al., 2020; Seyfarth et al., 2020) and the assumptions we present below are based on these proposals.

Trade flow coverage: EU imports only

The mechanisms under consideration in the European Commission's consultation (European Commission, 2020a) indicate that the EU CBAM would likely be imposed only on imports to the EU. Although modelling results indicate that adjustments on both imports and exports would reduce carbon leakage (Branger and Quirion, 2014), giving rebates to domestic exporters of carbon-intensive goods goes against using a CBAM as a climate measure and is more challenging in terms of adherence to World Trade Organisation rules (Marcu et al., 2020; Seyfarth et al., 2020). Specifically, an export rebate under the CBAM could be classified as a prohibited export subsidy under the Subsidies and Countervailing Measures (SCM) Agreement and/or could prevent application of the exemptions allowed under Article XX of the General Agreement on Trade and Tariffs (GATT), which would be needed to justify the CBAM on the import side, on environmental grounds (Seyfarth et al., 2020). From a UK perspective then, only UK exports to the EU would be subject to the EU CBAM and so its impacts would be tied to UK ambition and, thus, UK–EU regulatory alignment after Brexit.

Sectoral and product scope: cement, steel, aluminium, plastics, paper and copper[2]

Energy-intensive and trade-exposed (EITE) sectors are the sectors most vulnerable to carbon leakage. Ex-ante simulations of leakage rates under unilateral climate policy suggest that leakage for such sectors, including cement, steel, aluminium, chemicals, paper and pulp, and refining, would be significantly above average (Quirion and Demailly, 2008; Ponssard and Walker, 2008; Chen, 2009; Mehling et al., 2019). Within these sectors, emissions tend to be further concentrated in the production of basic products upstream in the value chain. The value of embodied carbon as a proportion of value-added tends to be high for these basic products compared with semi-finished or finished products.

Determining the embedded emissions in the basic or raw materials produced by EITE sectors is also much simpler than for more complex products further down the value chain (Marcu et al., 2020). The administrative cost and technical complexity of implementing an EU CBAM could, therefore, be greatly reduced by focusing on basic products from EITE sectors, while still delivering significant emissions reductions (Monjon and Quirion, 2011; Böhringer et al., 2012).

Here we assume that the EU CBAM covers the key carbon-intensive materials covered by the existing EU Emissions Trading System (ETS) Phase 4 (2021–2030) carbon leakage list: cement, steel, aluminium, plastic, paper and copper (European Commission, 2019). Product coverage within these sectors is likely to target the most carbon-intensive, basic raw material products that are most exposed to leakage risk, to minimise administrative burden. This may, on one hand, create incentives to import semi-finished products to avoid the CBAM charged on basic products. On the other hand, a broader CBAM that also covers semi-finished goods but is applied only to imports and not to exports could result in

[2] Electricity is also expected to be covered but is out of the scope of this report as the export trade volume is small at 2.4% of UK generation (see Drax, 2020).

the cumulation of charges for materials that are part of integrated value chains and cross the UK–EU border multiple times before reaching the final consumer. For example, steel used in parts to produce trucks can cross the English Channel five times (Campbell, 2016). To avoid being subject to the adjustment multiple times, a mechanism is necessary to account for the charge paid at earlier stages. (See Box 1 on p21 for a more detailed description of how this might affect integrated automotive value chains.)

Emissions scope: Scope 1 and 2

While expansion of the emissions scope of the EU CBAM increases both environmental and competitiveness benefits, it also increases the administrative cost and technical complexity of implementation (Marcu et al., 2020). It is generally accepted that Scope 1 and 2 emissions, as defined by the Greenhouse Gas Protocol,[3] are significant enough that both need to be included for an EU CBAM to be comprehensive. However, the data and methodological challenges involved in tracking emissions throughout a product's value chain (i.e. Scope 3 emissions) would likely be prohibitively complex (Prag, 2020).

Determination of embedded carbon using EU benchmarks

Given the additional complexity that determining carbon intensity individually at the product level would impose, the EU CBAM is likely to rely on sector-based carbon intensity benchmarks to calculate the embedded carbon emissions in EU imports (Mehling and Ritz, 2020). The benchmarks used in this analysis follow Pauliuk et al. (2016; see Table 1), who construct carbon emissions benchmarks for steel, aluminium, plastics, paper and cement by combining process inventory data from the Ecoinvent life cycle database (Ecoinvent Centre, 2014) with current process-specific EU ETS benchmarks for direct emissions (European Commission, 2011) and electricity use (ibid., 2012a, 2012b). The emissions benchmark values used for products under the existing EU ETS are calculated as the average greenhouse gas emissions of the best performing 10% of installations producing that product in the EU and EEA-EFTA states. These benchmarks are due to be updated for the upcoming Phase 4 (2021–2030) of the EU ETS, to reflect technological progress since they were established in 2008, but their release has been delayed, reflecting the difficulties faced in arriving at suitable benchmark values.

Crediting policies: explicit carbon pricing only

Crediting foreign countries for their carbon pricing policies can help to level the playing field and prevent leakage because then imported goods from trading partners with domestic carbon pricing are not unfairly penalised by double taxing. From an environmental perspective – and therefore a trade law perspective – crediting for carbon pricing is desirable as it encourages better climate policy abroad (Marcu et al., 2020). Administratively, it is simpler to credit for explicit carbon prices – a direct price on emissions, such as the UK's Carbon Price Support – than for implicit carbon prices, policies or instruments that effectively price carbon, such as fuel duty in the UK, renewable support schemes, fossil fuel subsidies, and compensation schemes for indirect carbon costs due to increased power prices (Mehling and Ritz, 2020; Fankhauser, 2013).

[3] See Greenhouse Gas Protocol for definitions of Scope 1, 2 and 3 emissions: https://ghgprotocol.org/calculationg-tools-faq

Implementation mechanism: agnostic

The European Commission's public consultation proposed four different forms for an EU CBAM (European Commission 2020). These include:

1) Extending the EU ETS to imports
2) Creating a separate pool of EU ETS permits for foreign producers
3) A border tax on imports, to be levied on selected carbon-intensive products produced in sectors at risk of carbon leakage
4) A carbon tax (VAT or excise duty) at the consumption level on products produced in sectors at risk of carbon leakage. (Latham and Watkins LLP, 2020)

From a UK perspective, this would mean either a tax on goods exported to the EU or that exporting companies would need to buy EU ETS permits at the border, both to bridge the differential between UK and EU carbon pricing. This analysis is agnostic about the EU CBAM's implementation mechanism.

3. Analysis – how an EU CBAM might impact the UK

We assess the potential impact of an EU CBAM on the UK using recent UK trade data and two illustrative scenarios. Under the 'high convergence' scenario, we hypothesise that the UK coordinates with the EU on policies supporting industrial decarbonisation, and the UK joins the EU in implementing a CBAM on imports from the rest of the world. Under the 'high divergence' scenario, the UK's climate ambition falls behind the EU's, and UK exports to the EU are subject to a full CBAM. Given the UK's target to reach net-zero emissions by 2050, the 'high divergence' scenario is unlikely.

Looking at recent data, we explore the following questions:

- Which parts of UK trade will be affected by a potential EU CBAM?
- How important is trade with the EU in relevant sectors, relative to non-EU trade partners?
- How important are these sectors in the UK economy, in terms of value-added and employment?
- What are the economic impacts to sectors, industries and products in absolute terms and relative to export value?

Our analysis uses recent data on relevant UK sectors' trade flows, employment, GVA and production to assess potential impacts. We are not forecasting using economic modelling based on assumptions.

Our results are likely to reflect upper bound estimates for a number of reasons:

1. Manufacturing output and trade are likely to be adversely affected by an economic shock such as Brexit.
2. Trade flows respond to prices and adjust over time in response to the policy.
3. The direct liability of an EU CBAM primarily falls on the EU importer, rather than the UK producer. While EU importers might absorb some of the charge, costs will inevitably be passed through the UK producers.
4. The EU CBAM design may incorporate exemptions for countries that are deemed to be taking equivalent climate action, whether that is assessed at the national or sectoral level. Exemptions may also be made on the basis of 'common but differentiated responsibilities', for example to the Least Developed Countries.

Imports that are made with lower carbon intensities may be able to reduce the CBAM through an appeals process. The EU may also credit the UK carbon price, which would reduce the carbon price differential between the UK and the EU and consequently reduce the economic impact of an EU CBAM on UK exports. However, the issue of determining equivalence and comparing relative policy stringency and rules for policy crediting is complex and under-discussed, even though it is an important part of CBAM design.

Data, methodological approach and assumptions – a summary overview

Our analysis combines trade data from Eurostat: 'EU Trade Since 1988' and 'ProdCom', with carbon intensity data from Pauliuk et al. (2016) and UK sectoral GVA, production and employment data from the Office for National Statistics (ONS). We estimate the embodied emissions in UK imports exports from this data (see Appendix). We compare two possible CBAM product coverages: the 'narrow' CBAM covers only raw material products, defined as those with content of at least one raw material greater than or equal to 90% (the

threshold used to define raw materials products), whereas the 'broad' CBAM covers both raw material and semi-finished products with content of at least one raw material greater than or equal to 50% (the threshold used to define raw materials and semi-finished products).

Our illustrative 'high convergence' and 'high divergence' scenarios are characterised by the following carbon price levels in the UK, EU and Rest of the World (RoW):

- *Scenario 1 – High convergence*
  UK and EU carbon price[4]: €50/tonne. RoW carbon price: €0/tonne
- *Scenario 2 – High divergence*
  UK carbon price: £0/tonne. EU carbon price: €50/tonne

As the EU may also credit the UK carbon price, we include in the Appendix an additional sensitivity scenario to examine a smaller carbon price differential between the UK and the EU.

If the EU and UK carbon markets remain unlinked, a scenario where the UK carbon price is equal to or higher than the EU carbon price is possible, in which case the EU is unlikely to subject imports from the UK to the CBAM. To show why a higher carbon price is needed we have a scenario where the UK price is lower.

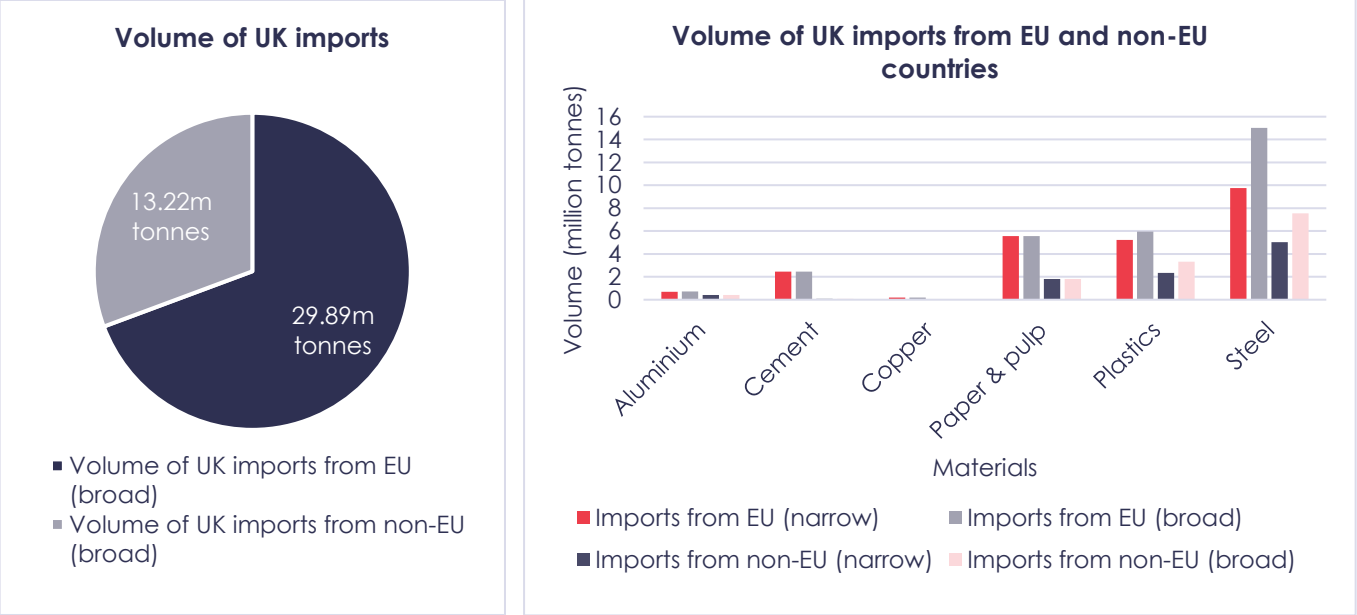
More details on the data and the methodology are provided in the Appendix.

Scenario 1 – High convergence

In this scenario, the UK and EU implements a CBAM jointly, against the rest of the world. Only UK imports from non-EU countries are subject to the CBAM in this scenario.

Which sectors are most affected?

Figure 1. Volume of UK imports



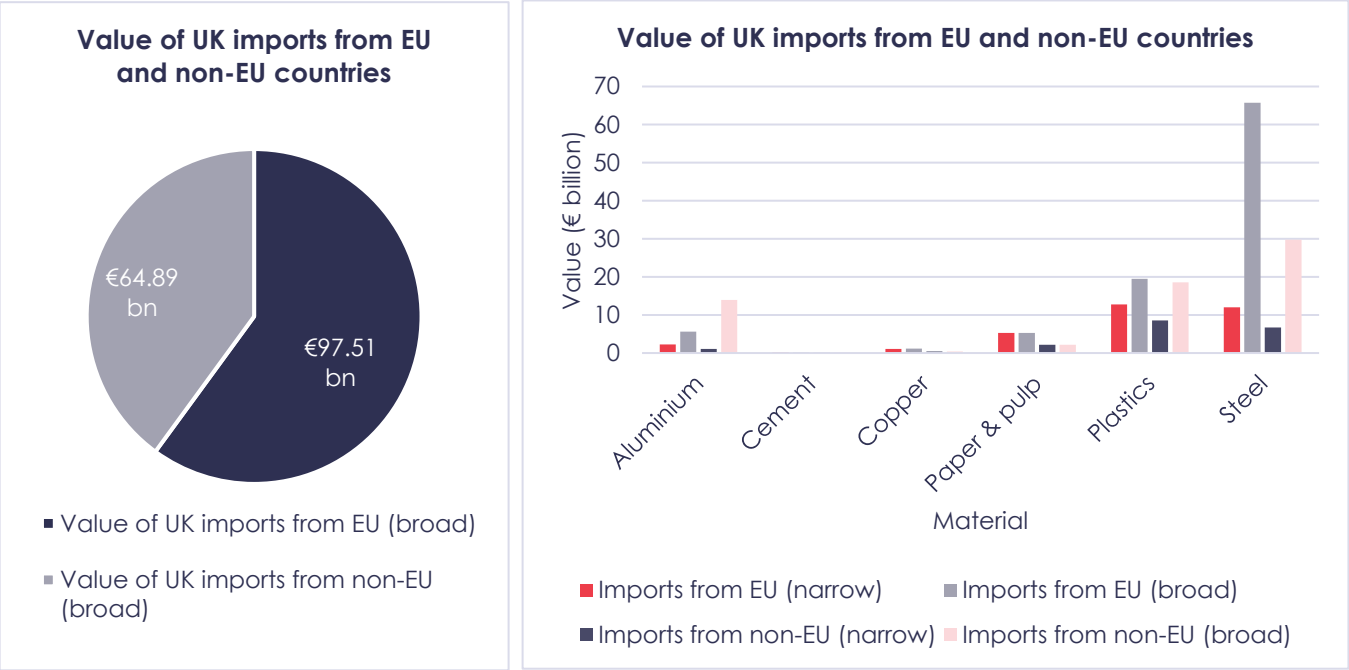
Notes: 'Narrow' includes products with raw material content >=90%. 'Broad' includes products with raw material content >=50%. Volumes are 2010–2018 mean.

[4] Price harmonisation achieved through linking carbon markets.

Between 2010 and 2018, annual average imports of the six basic materials studied here totalled €162.4bn (43.1 tonnes). Of these, around two-thirds were imported from the EU (€97.51bn and 29.9bn tonnes), and one-third from non-EU countries (€64.8bn and 13.22bn tonnes).

In this scenario, a CBAM particularly affects steel and plastic sector imports. Imports from non-EU countries are particularly high for steel (€29.75bn and 7.54bn tonnes). In plastics, non-EU imports account for 11.4% of total imports (in value terms) and in paper 1.3%. In aluminium, non-EU imports account for a high share (8.5%) in value terms if semi-finished products are covered. Non-EU imports are negligible in the cement and copper sectors.

Figure 2. Value of UK imports

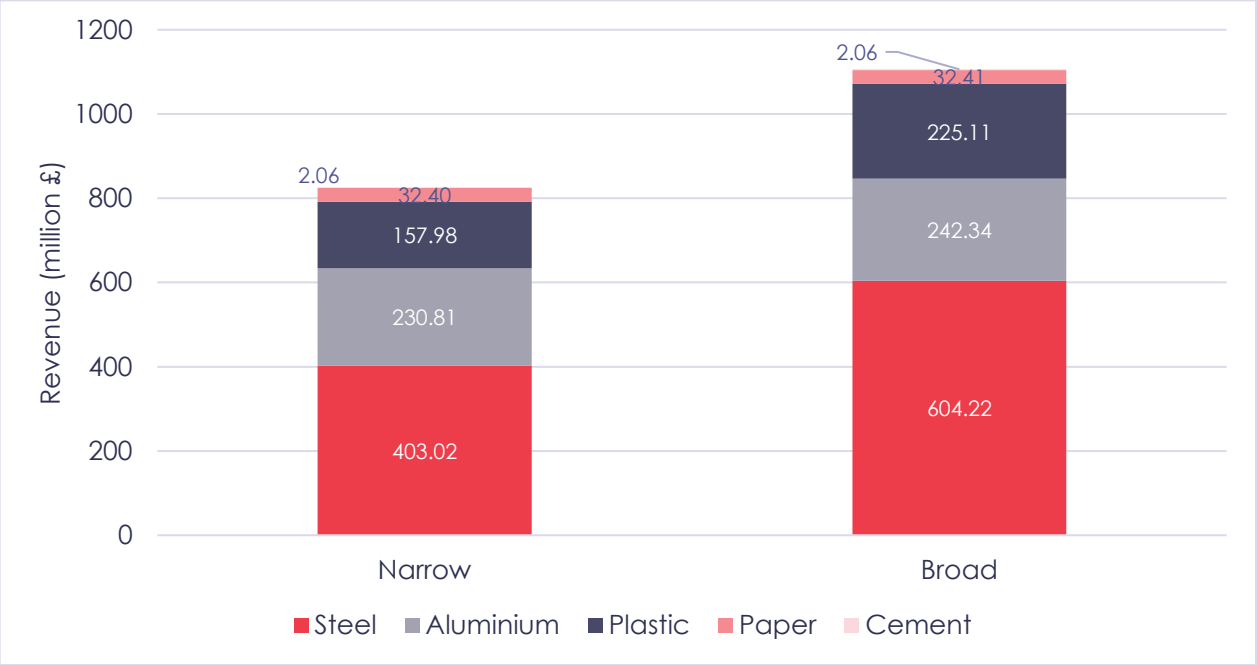


Notes: 'Narrow' includes products with raw material content >=90%. 'Broad' includes products with raw material content >=50%. Values are 2010–2018 mean.

What are the potential economic impacts?

The impacts of the UK implementing and enforcing a CBAM alongside the EU on imports from non-EU countries can be measured in terms of the potential revenue to the UK exchequer. Under these assumptions, the estimated economic impact from the narrow CBAM is close to £800m per year, or approximately 4% of the value of UK imports of these basic materials from non-EU countries (Figure 3). With the broad CBAM, the tax revenue would extend to approximately £1.1bn, or around 1.7% of the value of imports from non-EU countries.

Figure 3. Potential annual tax revenue on UK imports from non-EU countries



Notes: 'Narrow' includes products with raw material content >=90%. 'Broad' includes products with raw material content >=50%. Revenues are 2010–2018 mean. The CBAM adjustment assumes a €50/tonne carbon price in the EU and UK, full adjustment to all trading partner countries (no crediting of equivalent climate policies or exemptions for developing countries) and carbon intensities set to EU ETS allocation benchmarks (data from Pauliuk et al., 2016; see Table 1, Annex). Trade volumes are average annual imports from non-EU countries between 2010 and 2018.

Looking more closely at the sectors, the largest potential revenue comes from imports of non-EU steel, followed by the aluminium then plastic sectors. Under the narrow CBAM scenario, the UK's raw-material steel, aluminium and plastic sectors would face £403.02m, £230.81m and £157.98m tax liabilities, respectively. When broadening the scope to include semi-finished products, tax liabilities across steel, aluminium and plastic are higher but remain the same for paper and cement. For the UK steel sector, broadening the product coverage to increase semi-finished goods increases the potential revenue by 50% to £604.22m. For aluminium there is an increase of 5% to £242.34m and an increase for plastic by 42% to £242.34m.

Our analysis suggests that for steel and plastic, a narrow CBAM only partially addresses leakage risk. In contrast, there is either a small or no change in liability for cement, paper and aluminium when the scope is enlarged. This shows that a narrow CBAM will capture almost all materials at risk of leakage in the cement, paper and aluminium sectors.

It is important to stress that a CBAM is a climate instrument and to increase its political acceptability it should not be portrayed as a protectionist or a revenue-raising instrument. To be consistent with its environmental motivations, proceeds might be hypothecated towards low-carbon innovation or channelled towards mitigation and adaptation investments in Least Developed Countries (LDCs) (Kussi et al., 2020).

Scenario 2 – High divergence

In this scenario, the EU charges a CBAM on imports from all non-EU countries, including the UK; UK exports to the EU are therefore subject to the CBAM.

Which parts of UK trade would be directly affected?

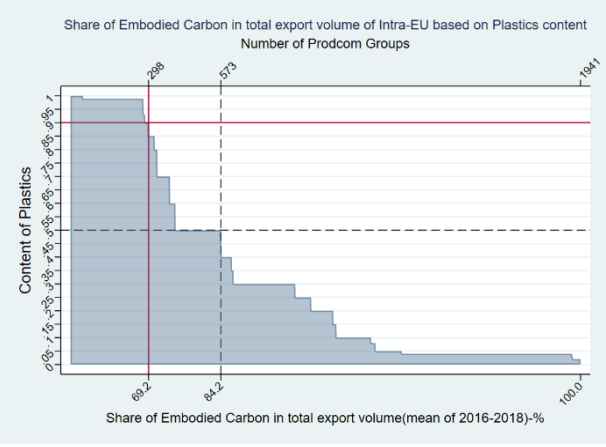
Our analysis shows that the potential impact of an EU CBAM on UK exports depends on the product scope covered by the policy. As noted, coverage is likely to be limited to a small number of basic products that embody a sufficient amount of primary materials, for reasons including administrative ease and compliance costs. However, how to define what is a basic product within each material sector is not always clear.

Here we assess for each material sector how embodied emissions are distributed across product categories by plotting the material content against share of embodied emissions – Figure 4. As shown in the figure, basic material products are easily identified in some but not all sectors. In aluminium, cement and steel, there are a relatively small number of products (ProdCom Groups) with raw material content exceeding 90% (shown by the red line on Figure 4): 35 aluminium products, four cement products and 20 copper products. These products are thus likely to be covered by the CBAM. In other sectors, there are many more product groups above the 90% threshold: 133 paper and pulp products, 298 plastic products and 427 steel products.

If the threshold is expanded to include semi-finished products (those above 50% raw material), these carbon-intensive products account for a high share of total embodied emissions in trade in the steel, plastic, paper and cement sectors. A broad CBAM would therefore address a large share of potential leakage. Taking steel as an example, at a 90% threshold, 70% of emissions embodied within steel exports to the EU would be covered. This would increase to 99% if the threshold were set at 50%. Aluminium, however, is an outlier, as a CBAM with a 90% threshold would cover only 43% of emissions embodied in exports to the EU.

Figure 4. No. of directly affected products and their share of trade-embodied emissions

Red lines show embodied emissions in products with raw material content >=90%
Dotted lines show embodied emissions in semi-finished products with raw material content >=50%



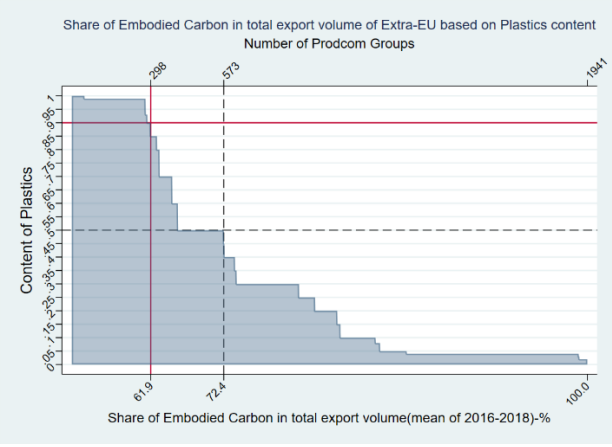


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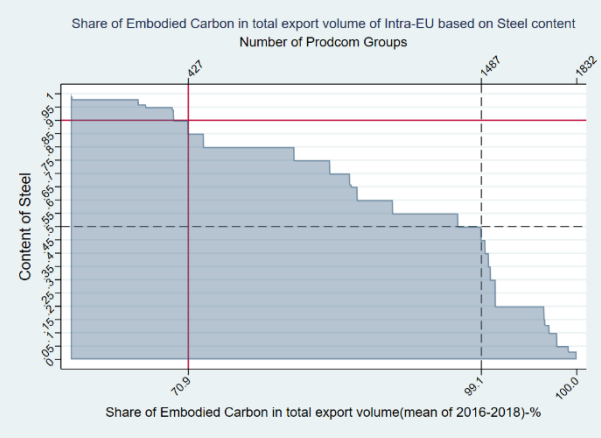
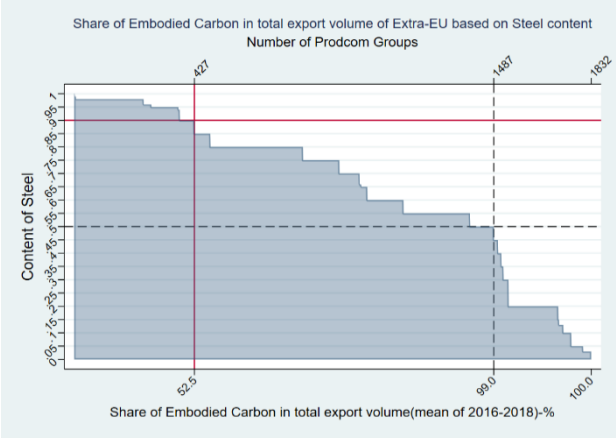
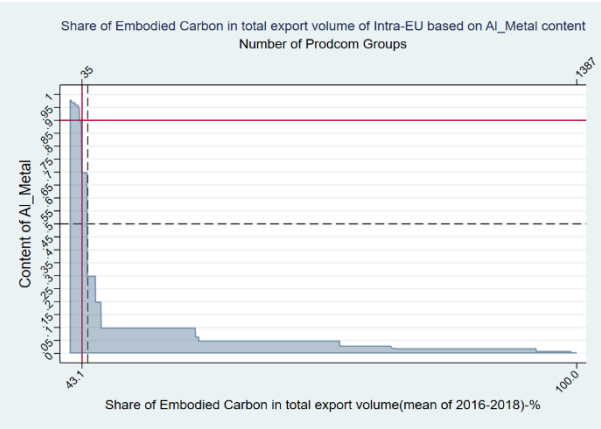
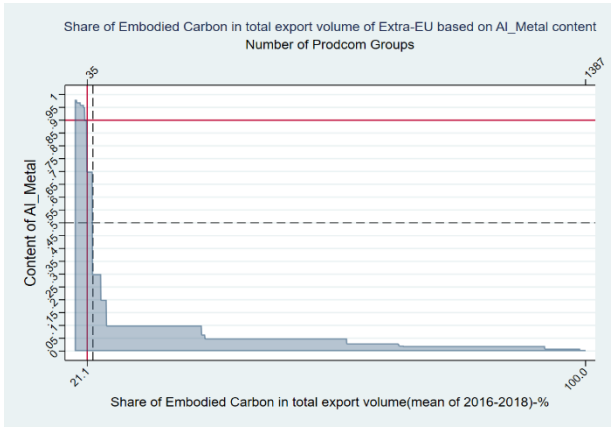
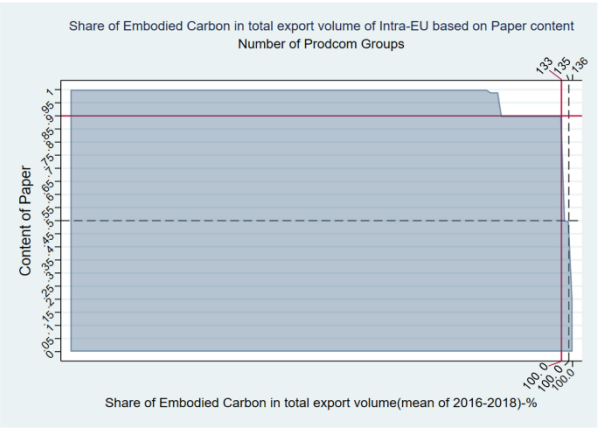
Figure 4 cont. Red lines show embodied emissions in products with raw material content >=90% Dotted lines show embodied emissions in semi-finished products with raw material content >=50%

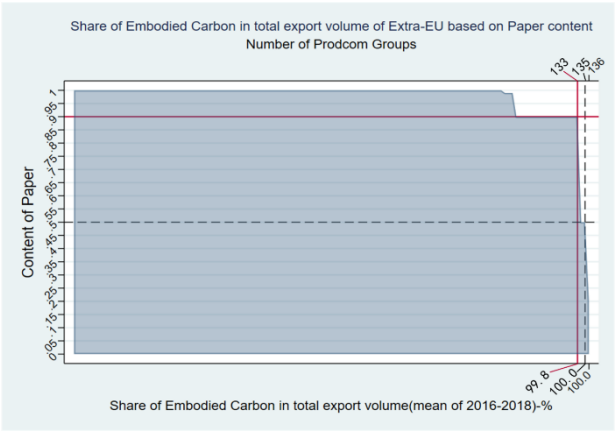


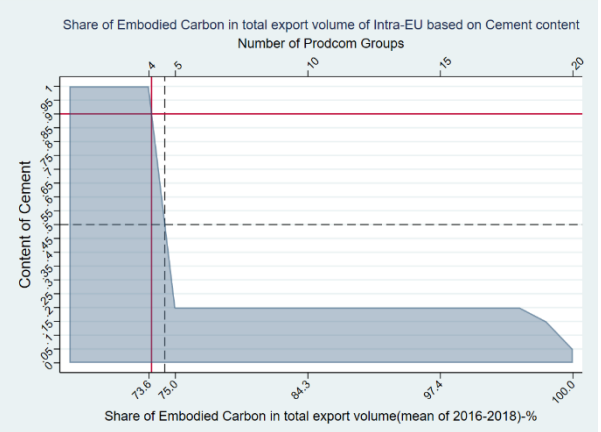


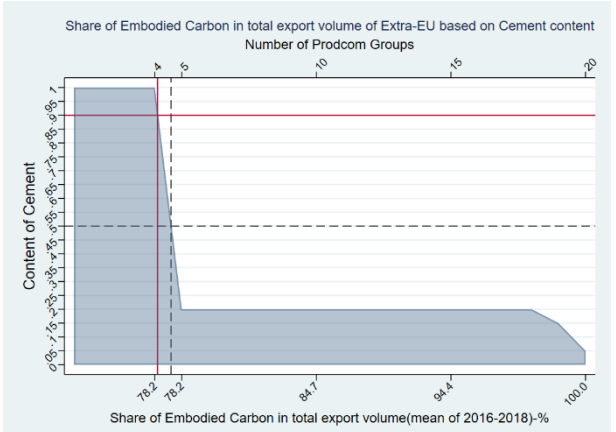








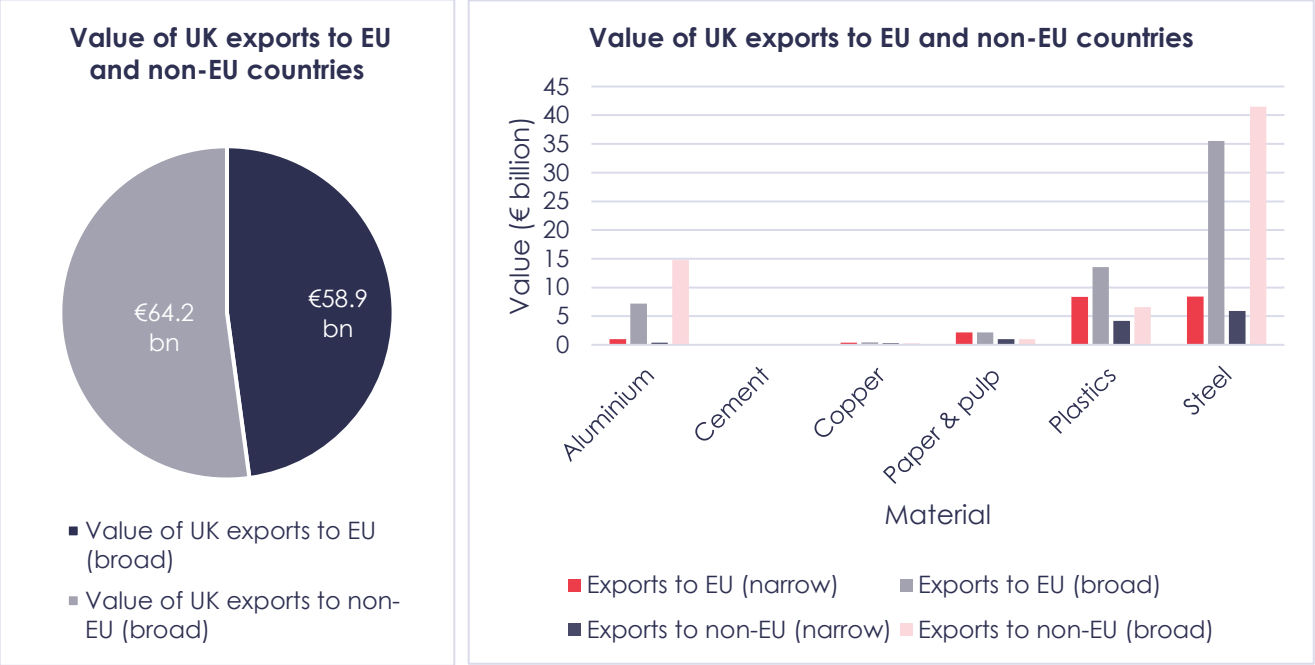




How important is trade with the EU in relevant sectors, relative to non-EU trade partners?

We separate the total UK exports of these products into UK exports to the EU and UK exports to non-EU countries, to understand how important trade is with the EU in relevant sectors, relative to non-EU trade partners. The values and volumes of directly affected products are shown in Figure 5.

Figure 5. Value of UK exports to EU and non-EU countries (2010–2018)

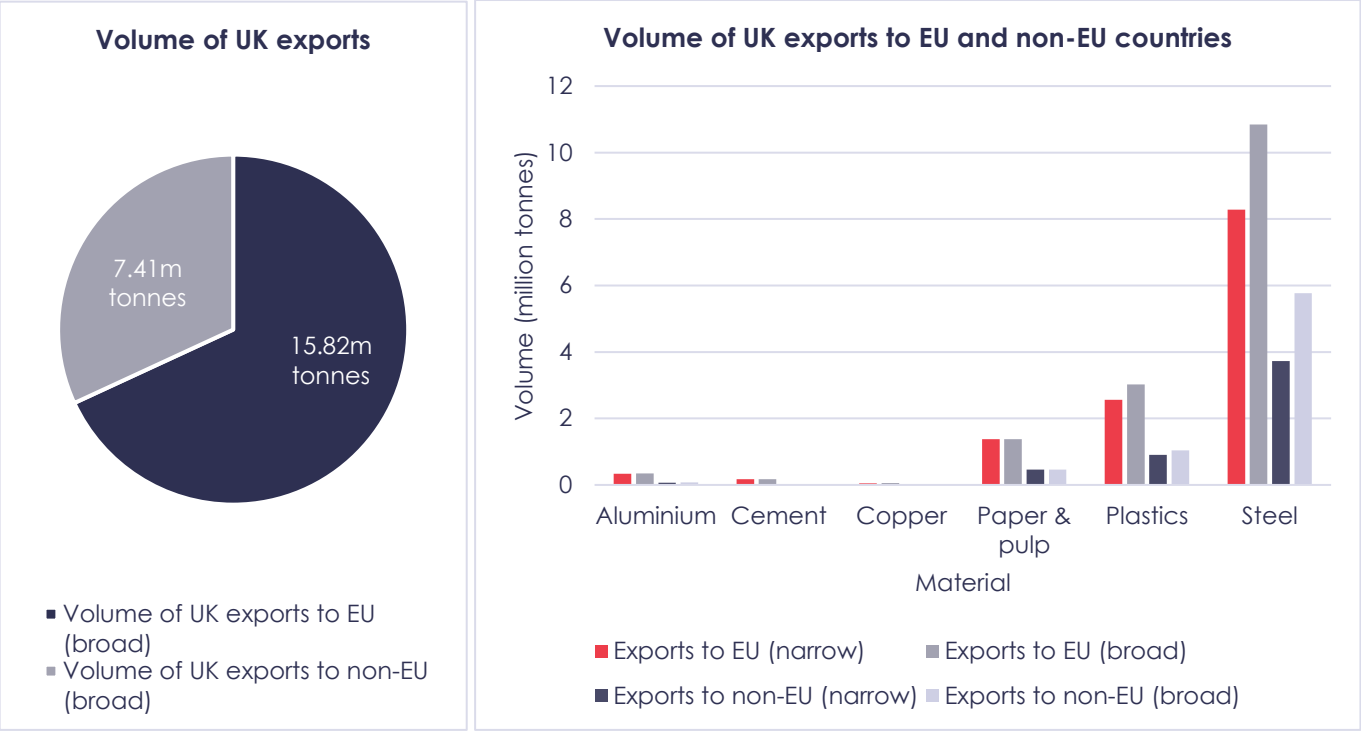


Notes: 'Narrow' includes products with raw material content >=90%. 'Broad' includes products with raw material content >=50%. Values are 2010–2018 mean.

Between 2010 and 2018, the annual average exports of the six basic materials studied here totalled €123.1bn (23.23 tonnes). Just under half the value (€58.5bn) and two-thirds of the volume (15.7bn tonnes) were exported to the EU.

In this scenario, a CBAM on UK exports particularly affects the steel, aluminium and plastic sectors. The value of exports to non-EU countries is particularly high, and indeed higher than to EU countries for steel (€41.46bn and 7.54bn tonnes) and aluminium (€14.79bn). In plastics, non-EU exports account for 5.3% of total exports (in value terms) and in paper, they represent 0.8%. EU and non-EU exports are negligible in the cement and copper sectors. The total value of raw material and semi-finished products affected by a broad EU CBAM accounts for approximately 34% of the total value of all UK goods exported to the EU.

Figure 6. Volume of UK exports to EU and non-EU countries (2010–2018)



Notes: 'Narrow' includes products with raw material content >=90%. 'Broad' includes products with raw material content >=50%. Volumes are 2010–2018 mean.

The strength of the trading relationship with the EU would suggest there is more to be won from linking with the EU ETS, jointly implementing an import-only CBAM and reducing free allocation accordingly. But this misses important heterogeneity within the aggregated trade data. For example, the value of exports of raw material and semi-finished products to the EU is lower than to non-EU countries for steel and aluminium, but more than double for plastics and paper and pulp. Policymakers need to be aware of these dynamics when designing provisions to limit leakage or a loss of global market share under a domestic UK ETS with an import-only CBAM. This may call for differentiated leakage measures such as different boundaries for product coverage under a CBAM and other policies to support sectoral decarbonisation like standards, consumption charges or R&D support.

How important are these industries to the UK economy?

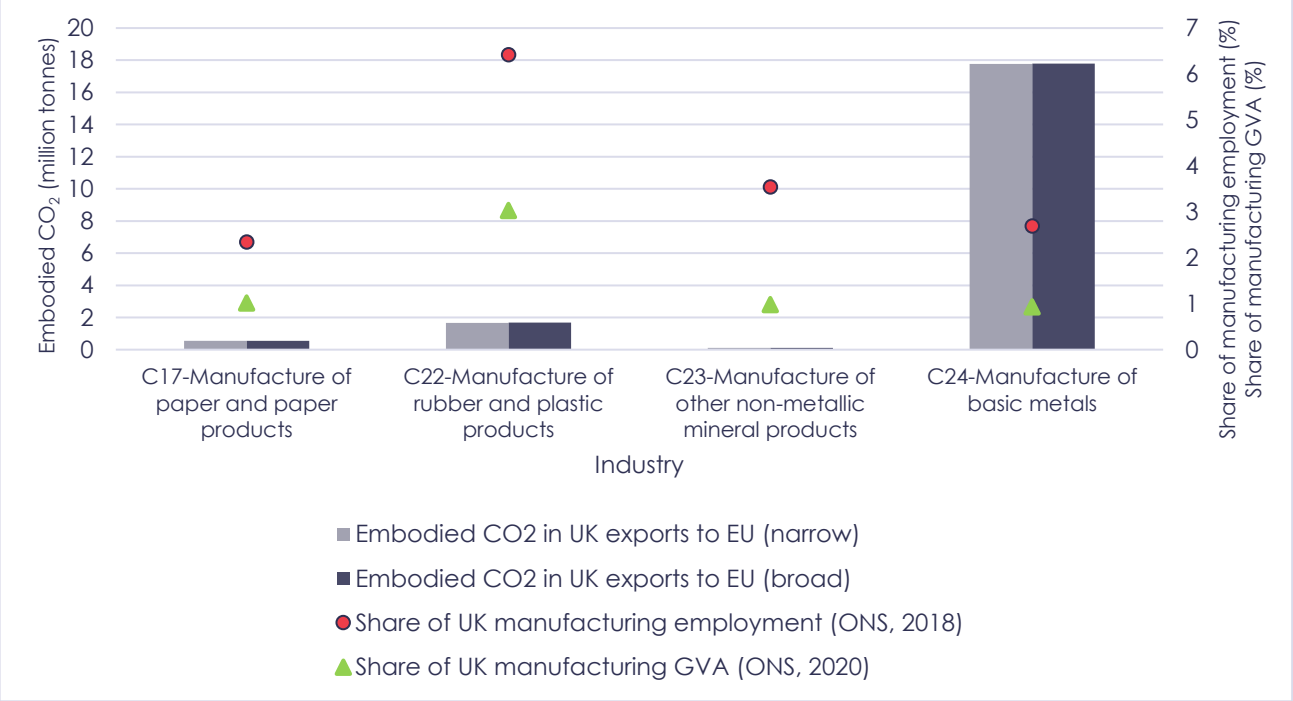
The importance of these industries to the UK economy can be assessed by examining each industry's share in manufacturing Gross Value Added (GVA)[5] or its share of manufacturing employment. Manufacturing is a relatively minor component of the UK's service-sector-dominated economy, accounting for 10.1% of total GVA and 8% of UK employment. Furthermore, Figure 8 (below) shows that the industries examined here account for a small share of both manufacturing GVA and manufacturing employment. Of these industries, the manufacture of rubber and plastic products (C22)[6] has the highest share of both manufacturing GVA and manufacturing employment at 3.03% and 6.42%, respectively. While manufacturing of basic metals (C24) contributes the largest amount of embodied

[5] Gross Value Added (GVA) measures the contribution to the economy of each individual producer, industry or sector. It is the value of the amount of goods and services that have been produced, less the cost of all inputs and raw materials that are directly attributable to that production.

[6] These numbers come from the Statistical Classification of Economic Activities in the European Community, commonly referred to as NACE.

emissions, it has the lowest share of manufacturing GVA (0.94%) and a low share of manufacturing employment (2.69%).

Figure 8. Contribution of affected industries to the UK's Gross Value Added (GVA) and employment



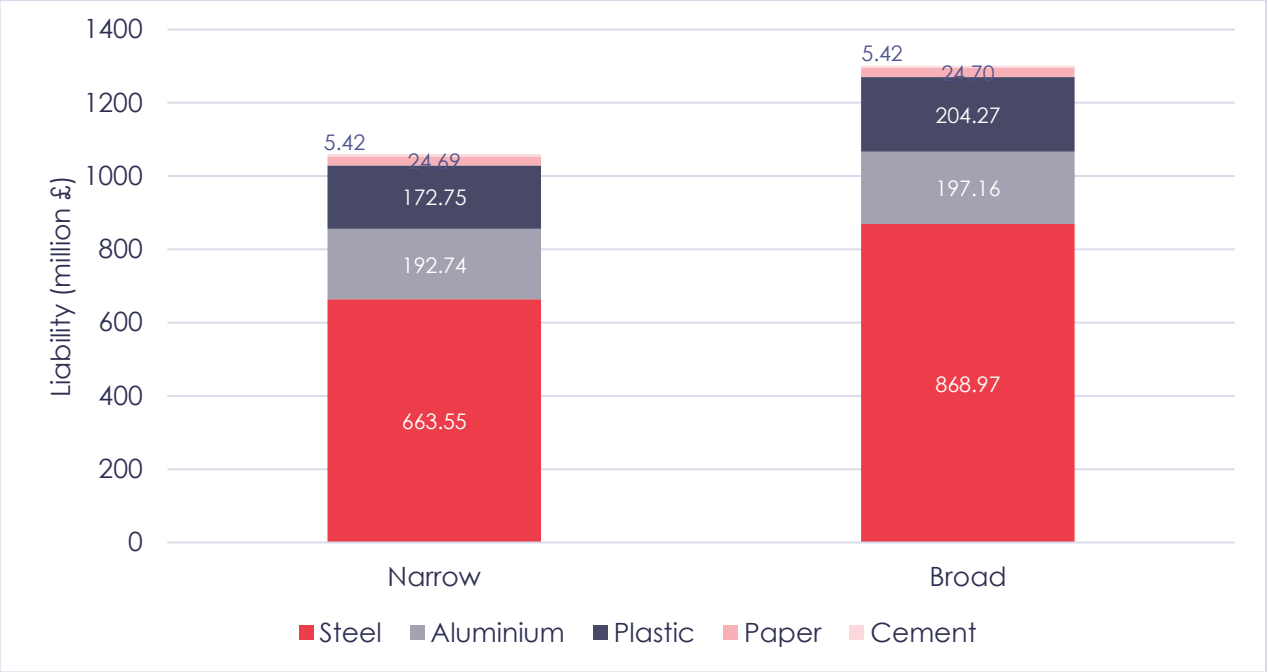
Notes: 'Narrow' includes products with raw material content >=90%. 'Broad' includes products with raw material content >=50%. Embodied CO_2 values are 2010–2018 mean.

What are the economic impacts to sectors, industries and products in absolute terms and relative to export value?

In the unlikely event that the UK is fully subject to an EU CBAM, the potential liabilities are large. Here, the economic vulnerability of a sector to a CBAM is largely driven by the carbon intensity of the traded materials and the carbon price differential. This gives us the size of the liability that each sector, industry or product might face. We then examine the actual/relative impact of the CBAM in two ways. Firstly, we look at the liability as a percentage of the monetary value of the trade flow. Secondly, to put into context the importance of the EU market for each UK industry, we look at the liability against the export share of production.

Across both scenarios, the largest tax liability is faced by the steel sector, followed by the aluminium then plastic sectors. Under the narrow CBAM scenario, the UK's raw-material steel, aluminium and plastic sectors would face £663.55m, £192.74m and £172.75m tax liabilities, respectively. When broadening the scope to include semi-finished products, tax liabilities across steel, aluminium and plastic are higher, but they remain the same for paper and cement. For the UK steel sector, broadening the product coverage to increase semi-finished goods increases the tax liability by 31% to £868.97m. For aluminium there is an increase of 2.2% to £197.16m and an increase for plastic of 18.2% to £204.27m.

Figure 9. Tax liabilities on UK exports to EU



Notes: 'Narrow' includes products with raw material content >=90%. 'Broad' includes products with raw material content >=50%. Liabilities are 2010–2018 mean. The CBAM adjustment assumes a €50/tonne carbon price in the EU, full adjustment to all trading partner countries (no crediting of equivalent climate policies or exemptions for developing countries) and carbon intensities set to EU ETS allocation benchmarks (data from Paulik et al., 2016).

The larger increases for steel and plastic suggest that a CBAM on raw materials only does not capture all materials at risk from leakage. In contrast, there is either a small or no change in liability for cement, paper and aluminium when the scope is enlarged. This shows that a narrow CBAM will capture almost all materials at risk of leakage in those three sectors. A broad CBAM that covers only imports can result in the cumulation of charges for materials that are part of integrated value chains and cross the UK–EU border multiple times during the production process. To avoid being subject to the adjustment multiple times, a mechanism is necessary to account for the charge paid at earlier stages.

Box 1. Integrated automotive value chains

The manufacture of vehicles is a good example to demonstrate how integrated value chains may be impacted by supply chain friction and regulatory divergence. Automotive supply chains are complex and interwoven, with a modern car often having in excess of 30,000 parts (Deloitte, 2019). Components using different raw materials and manufacturing processes are increasingly drawn from different parts of the world, with materials in value chains crossing the UK–EU border multiple times. For example, during the manufacture of fuel injection components for diesel lorries, components or materials used in the injector move between the UK and EU five times before the vehicle is sold. Bumpers used in Bentley vehicles, for example, are made in Eastern Europe, before being exported to Crewe in the UK, then on to Germany for further work, and then finally back to Crewe where they are installed in the cars. If a CBAM were applied at each stage, the cost could be substantial as it would affect not only the export of the finished cars, but also the export of parts used to make them.

Table 2. Summary of liabilities and relative price change

Sector	Monetary value of UK exports to EU (£m)		Tax liability (£m)		Relative price change (%)	
	Narrow (Raw materials)	**Broad** (Raw materials and semi-finished products)	**Narrow** (Raw materials)	**Broad** (Raw materials and semi-finished products)	**Narrow** (Raw materials)	**Broad** (Raw materials and semi-finished products)
Steel	7,581.50	31,979.69	663.55	868.97	8.75	2.72
Cement	49.21	49.21	5.42	5.42	11.01	11.01
Paper	1,963.98	1,973.02	24.69	24.70	1.26	1.25
Aluminium	896.50	6,442.57	192.74	197.16	21.50	3.06
Plastic	7,541.68	12,193.61	172.75	204.27	2.29	1.68
Total (£m)	18,032.87	52,638.1	1,059.15	1,300.52		

Assuming the liability is paid, the relative price change (assuming 100% cost pass-through[7]) for each sector can be calculated as the percentage of the monetary value of the trade flow that the tax liability represents (Pauliuk et al., 2016).

The relative price change is greatest for aluminium under the narrow CBAM and cement under the broad CBAM. This is because UK exports to the EU of aluminium have a much lower total value than steel and so the tax liability represents a relatively larger percentage of the value of the trade flow. Similarly, cement faces the lowest tax liability of all the commodities. However, the relative price change for cement is relatively high for both groups, because the trade flow from the UK to the EU of cement has the lowest total value among these sectors. In contrast, plastic faces a high tax liability, but a small relative price change, due to the large total value of UK exports of plastic to the EU.

Industry-level analysis

The extent of the impact on industrial sectors is largely influenced by two factors: economic liabilities caused by an EU CBAM and the strength of the trading relationship between the UK and the EU, which is indicated by the export share of production. On the basis of these two factors, the industry most directly hit by the narrow carbon border tax would be manufacturing of basic metals (C24; see Figure 10), which includes the activities of smelting and/or refining ferrous and non-ferrous metals from ore, pig or scrap, using electro-metallurgic and other process metallurgic techniques (European Commission, 2021). This industry is an outlier in terms of both its export share of production and its tax liability. An export share of production of 1.73 conveys that the value of UK exports of raw material products to the EU in this industry exceeds the value of UK production, indicating that the UK re-exports products. This industry is also faced with a high tax liability of £800m and contributes most significantly to the total value of UK exports of raw material products to the EU.

As C24 is such an outlier, we look at this in more detail in section that follows Figure 10 below.

[7] 100% cost pass-through provides an upper-bound cost estimate.

Figure 10 indicates the potential impact of a narrow EU CBAM on UK exports; the size of the circle reflects the value of industry exports.

Figure 10. Potential impact of a narrow EU CBAM on UK exports from industrial sectors

Notes: 'Narrow' includes products with raw material content >=90%. Liabilities are 2010–2018 mean. The second graph is a magnified version of the content framed in the top graph.

Manufacturing of basic metals – C24

The products manufactured by industry C24 that contribute the most to the tax liability are shown in Table 3.

Table 3. Products manufactured by industry C24 with the largest embodied emissions

NACE code	Product	Material content	Embodied emissions in tonnes (2010–2018 mean)
24421153	Unwrought aluminium alloys in primary form (excluding aluminium powders and flakes)	96% Aluminium	1,070,503
24422430	Aluminium plates, sheets and strips > 0.2 mm thick	96% Aluminium	988,814.5
2410T231	Hot rolled wire rod	98% Steel	831,216.1
24103110	Flat-rolled products of iron or non-alloy steel, of a width <= 600 mm, simply hot-rolled, not clad, plated or coated, in coils	98% Steel	686,657.1
24102170	Ingots, other primary forms and long semi-finished products, of non-alloy steel	98% Steel	669,814.8
24102122	Other ingots, primary forms and long semi-finished products including blanks (of non-alloy steel)	98% Steel	669,273.7
24102121	Ingots, other primary forms and long semi-finished products for seamless tubes (of non-alloy steel)	98% Steel	644,249.1
2410T310	Cold rolled sheet, plate and strip and blackplate >= 600 wide	98% Steel	562,047.3
2410T242	Other hot rolled bars	98% Steel	538,736.4
2410T222	Plate, sheet and wide flat, hot rolled in mills other than wide strip mills	98% Steel	538,462.3

The high carbon intensity of the products described in Table 3 means that an EU CBAM would disproportionately impact C24 products. We show this below by looking at the top 10 products with the largest relative price change.[8]

Table 4 shows that six of the 10 largest relative liabilities (price changes) under a narrow CBAM[9] are for C24 manufactured products. For the three products with the largest relative price change, aluminium and cement are the largest contributors. In absolute terms, 'Unwrought aluminium alloys in primary form (excluding aluminium powders and flakes)' has the biggest liability, but because it has a large export value, its relative price change is not the highest.

[8] The relative price changes at the 8-digit NACE code level are much greater than those at the sector level (steel, cement, etc.), which is a result of the smaller export values for these products compared to sector-level products.

[9] Table A2, in the Appendix, shows the 10 largest relative price changes for raw material and semi-finished products.

Table 4. Summary of relative price changes for raw material products under a narrow EU CBAM

NACE code	Raw material product	Liability (£m)	Relative price change (%)
24422230	Aluminium bars, rods and profiles (excluding rods and profiles prepared for use in structures)	24.13	51.32
23511100	Cement clinker	0.60	47.63
25931270	Aluminium stranded wire, cables, plaited bands and the like excluding electrically insulated, barbed wire and loosely twisted non-barbed double fencing wire, insulated electric wire and cables	0.13	39.87
24101300	Ferrous products obtained by direct reduction of iron ore and other spongy ferrous products, in lumps, pellets or similar forms; iron having a minimum purity by weight of 99.94%, in lumps, pellets or similar forms	0.55	31.94
24421155	Unwrought aluminium alloys in secondary form (excluding aluminium powders and flakes)	11.67	31.93
24421130	Unwrought non-alloy aluminium (excluding powders and flakes)	4.70	31.39
24421153	Unwrought aluminium alloys in primary form (excluding aluminium powders and flakes)	48.17	31.17
23511210	Portland cement	3.29	28.13
30203300	Railway or tramway goods vans and wagons, not self-propelled	0.21	27.97
24203470	Tubes and pipes, of other non-circular cross-section than square or rectangular, hot or cold formed and welded, of steel other than stainless steel	0.05	26.07

The impact of a CBAM depends on product coverage

Our analysis illustrates that product coverage of the CBAM (narrow versus broad) has significant implications for the expected carbon leakage and competitiveness impacts, as well as possible indirect effects.

Leakage and competitiveness

Under a high convergence scenario, where the UK implements an import-only CBAM with the EU, UK exporters to non-EU countries will be unable to pass on costs to export markets. This means reduced margins and reduced profitability for UK exporters to non-EU countries, which may lead to carbon leakage and reduce the competitiveness of UK exporters if it increases production in non-UK and non-EU countries. Our analysis suggests this could be particularly acute for UK exports to non-EU countries with high carbon intensity and for exports such as steel and aluminium under a broad CBAM where the value of trading relationships with non-EU countries exceeds EU countries. For steel and aluminium, additional protection may be needed to ensure that the result is not simply loss of global market share or leakage. The role of free allowances in mitigating a loss of competitiveness in export markets with low climate policy stringency is important in this regard and is discussed further in Section 4.

If the CBAM is on raw basic materials only, in a high convergence scenario, a handful of EITI sectors may be indirectly exposed to leakage risk. To assess this risk, we can look at whether sectors and industries experience indirect impacts from carbon pricing via higher input costs. This is because input suppliers, such as energy, raw materials and equipment, also face costs from carbon pricing that they may pass through to their consumers (BEIS, 2017). Studies have previously examined the indirect impacts of carbon pricing on carbon leakage, in the form of raised electricity prices. In this context it is likely that a number of

downstream producers that consume basic materials will be indirectly affected by the UK implementing a CBAM with the EU. This is because a CBAM could raise the costs of indirectly affected products (both those imported and those produced in the UK), resulting in higher input costs for downstream producers than for non-UK/EU competitors. This may lead to an increase in downstream imports of cheaper products from non-UK/EU countries with lower carbon pricing, reducing competitiveness of UK downstream producers.

These indirect effects may be felt by all industries and sectors that buy raw materials at market prices, regardless of whether or not they are directly covered by the EU CBAM. For each sector or subsector, the indirect impacts would depend on the amount of basic raw materials content as well as the cost pass-through for these materials. This implies the need for a mechanism like the existing compensation for indirect electricity costs, either as part of the CBAM or as a complementary policy.

Under a high divergence scenario, the EU CBAM effectively acts as an export tax for UK exporters to the EU. The market-based impact of the EU CBAM for UK exporters might be to reduce sales of basic products to the EU in favour of higher sales to non-EU countries, or export semi-finished products to the EU instead, as they would not be subject to the CBAM. However, this will depend on who exporters to the EU are competing with. This in itself can be seen as a form of carbon leakage and is distinct from resource reshuffling: it is not driven by contractual gaming of existing trade flows – where there is no change in the emissions-producing activities in and outside of the region or industry covered by a system of carbon pricing – but rather by profit-maximisation across multiple export markets (see Mehling and Ritz, 2020).

For the domestic UK market, as imports from the EU will also be more expensive, the market effect may be to make domestic sales and production within the UK a more attractive proposition, enabling domestic producers of raw materials to gain competitiveness in UK markets. However, as a result, UK emissions might increase as production is on-shored in the UK. Leakage might subsequently occur if UK producers begin importing raw materials from non-EU countries instead, as a way of reducing domestic emissions.

4. What does an EU CBAM mean for UK carbon pricing policy design?

A higher carbon price is needed

A robust carbon pricing framework with anti-carbon leakage measures is needed to support the deep decarbonisation of industry. This includes higher carbon prices than those currently in place. This is because firstly, the currently policy framework (made up of carbon prices and complementary policies) is insufficient to meet the UK's increasingly stringent carbon targets. And secondly, a tighter target means moving up the marginal abatement cost curve more quickly, even if the dynamic cost of achieving net-zero is the same cost as the previous 80%-reduction target in the Climate Change Act.

An international expert commission led by Joseph Stiglitz and Nicholas Stern suggests that a global carbon price of £30–58/tCO_2 by 2020 and £36–73/tCO_2 by 2030 is needed (Carbon Pricing Leadership Coalition, 2017). Recently published research by Kaufmann et al. (2020) derived similar values: to achieve net-zero by 2050 they suggest a carbon price of £38/tCO_2 in 2025 and roughly £73/tCO_2 in 2030. This is also consistent with the findings from Burke et al. (2019), who suggest a carbon price that is consistent with net-zero would start at £50/tCO_2 (with a range of £40–100) in 2020, reaching £75/tCO_2 (£60–140) in 2030. Strengthening measures to prevent carbon leakage will therefore remain a challenge for countries like the UK and EU member states that have relatively high carbon prices today and have committed to net-zero carbon targets over the next few decades.

Extending carbon pricing coverage to other sectors should also be considered, alongside higher prices. The UK currently has a comparatively low coverage of carbon emissions compared with other countries. For example, in Sweden the share of emissions covered is 40% and in the Canadian province of British Columbia it is 70%. By comparison, in the UK, the Carbon Price Support – an upstream tax paid by fossil fuel generators – only covers 23% of emissions.

The need for a higher, net-zero-consistent carbon price is not affected by Brexit. The reasons for this are twofold. Firstly, maintaining sufficient carbon pricing ambition should be at the heart of any reforms, in order to reduce greenhouse gases in a fair and cost-effective manner (Bowen, 2011). Secondly, low UK ambition and high divergence may bring strategically important energy-intensive UK sectors under the auspices of the EU CBAM. Given that much of the UK's manufacturing base is located in the North of England, additional trade barriers could also undermine the Government's levelling-up agenda.

It is therefore encouraging that the UK Government has committed to ensuring that any replacement of the EU ETS will be at least as ambitious as the current system (BEIS, 2019). These ambitions have been further reinforced in the EU–UK Trade and Cooperation Agreement of 2020, which agrees to uphold common high standards on carbon pricing and tax transparency. However, the decision to implement a non-linked UK ETS makes high convergence difficult to achieve in terms of price levels – one of a number of factors that determines whether a CBAM should be implemented. For example, now that the UK has opted for an ETS over a tax, achieving dynamic price alignment will be very difficult as the carbon price differential will be in constant flux.

The recent announcement by the Department for Business, Energy and Industrial Strategy (BEIS) to increase the initially low auction reserve price (ARP) in a UK ETS from £15/tonne to £22/tonne is a welcome increase in policy ambition against a backdrop of EU ETS prices

breaching €40/tonne for the first time in March 2021. Depending on where UK ETS trading prices settle, UK industrial sectors may enjoy a price advantage of about £13/tonne. That said, the UK has committed to implementing a UK ETS with a target-consistent (net-zero) cap, which may push prices higher than the ARP. However, with the EU adopting a more ambitious target of 55% emissions reduction by 2030, it is not inconceivable that the carbon price differential may become even greater, especially as EU carbon market prices could rise to as much as €65 by 2030 (European Commission, 2020b).

Robust carbon pricing needs to be part of a broader framework to support the low-carbon transformation of these energy-intensive sectors. This should include anti-carbon-leakage measures such as a CBAM and the introduction of carbon contracts for difference for hydrogen production may be needed. If the UK fails to sufficiently align with the EU, it would risk undermining the role of UK carbon pricing in supporting deep decarbonisation in sectors that would otherwise be at risk of carbon leakage. Collaboration with the EU on carbon pricing and anti-leakage measures remains an area for close multilateral cooperation.

Linking markets should be prioritised

High convergence and collaboration, characterised by carbon market linkage, should remain a high priority for the UK, post-Brexit. There are a number of strong arguments to support this:

- Firstly, it will bring additional effort- and risk-sharing benefits. The former derives from the differences across ETSs in the *expected* marginal cost of emissions reductions. The latter is generated by *unexpected* changes in the marginal abatement cost due to business cycles, weather and technology shocks (Doda and Taschini, 2017; Doda et al., 2019).
- Secondly, being part of a bigger market can reduce transaction costs, as finding counterparties for permit transactions will be easier and the more transactions there are, the lower the transaction costs will be.
- Thirdly, linking provides a common platform on which to collaborate with the EU on anti-carbon leakage measures, which would also serve to mitigate the economic impacts to the UK of the EU CBAM.

All else being equal, if a bilateral linking agreement with perfect fungibility is agreed between the UK and the EU ETS, this will enable the harmonisation of carbon prices across both markets. Price convergence could also be achieved with a one-way link, but only where the UK is permitted to use EU allowances and is a net *buyer* rather than a net *seller*. If the UK were a net seller, this would likely result in the UK price being lower than the EU price.

Any technical barriers to linking should be surmountable, given that the UK ETS has been designed to virtually mirror the EU ETS, although ultimately this will be dictated by politics rather than technicalities. If a linking agreement is not made, the UK may wish to close the carbon pricing gap another way but this would require additional design measures – such as a UK Supply Adjustment Mechanism and a more ambitious auction price reserve – to achieve a sufficiently high and aligned price collar.

The benefits of high convergence are clear. However, that does not mean there are not risks. The UK may become linked to a market without a say over how it is governed, in other words it may be a 'rule taker'. There is also the possibility that EU carbon prices may become lower than a counterfactual UK ETS, which could undermine UK decarbonisation efforts. Given the reforms to the EU ETS, however, this scenario looks unlikely. On balance, given that the UK has opted for an emissions trading scheme (rather than a carbon tax), the benefits of linking far exceed these risks. Should a linking agreement be negotiated, the

CBAM discussion will likely move towards protecting trade-exposed industry from non-EU competition.

Reassessing free allocation of permits

Much of the discussion around the implementation of the EU CBAM assumes that the mechanism would lead to the discontinuation of free allocation to the EITE sectors. An abrupt end to free allocation is unlikely; in practice, free allocation will likely be phased out over time. Indeed, the decision by the European Parliament in March 2021 to vote against an amendment to gradually phase out free allocation of permits alongside the introduction of the EU CBAM illustrates just how politically challenging this will be. Aside from the fact that double compensation (free allocations plus a CBAM) may not be WTO-compatible, it raises further suspicion and breeds deeper mistrust that a CBAM is motivated primarily by protectionism rather than environmental grounds.

The UK decision to end free allocation will rest partially on whether the UK ETS and the EU ETS link and the speed at which the EU phases out free allocation. If the UK ETS does link with the EU ETS, and the EU decides to eventually phase out free allocation with the introduction of its CBAM, it is likely that the UK would be required to do the same, as a pre-condition of linking in order to prevent the UK from having a competitive advantage. This would reinforce the case for the UK to jointly implement a CBAM with the EU at the same time as linking, otherwise the UK would forgo the benefit of free allocation without the additional protection against carbon leakage afforded by a CBAM.

In making this decision the UK needs to weigh up the risks that ending free allocation may pose to UK exporters to both EU and non-EU countries. For exporters to EU countries, if the UK does not link and becomes the recipient of the EU CBAM – which offsets any true future carbon price differential – the relative competitiveness of UK producers in EU export markets will remain unchanged as it will simply revert to when the UK participated in the EU ETS. With regard to the latter, under a linking agreement where the UK phases out its free allocation, exporters to non-EU countries with lower carbon prices would be disproportionately affected. This is because an import-only CBAM does not protect from leakage in export markets. An exporter to non-EU countries would no longer have free allocation to shield themselves from domestic carbon pricing and since the design of the EU CBAM will most likely be import-only, this would prevent any rebates on exports to jurisdictions with lower carbon prices. The extent to which UK sectors are more exposed to non-EU export markets will dictate how badly affected they would be by an import-only EU CBAM. For example, UK exporters of steel and aluminium will be disproportionately impacted due to their stronger trading relationship with non-EU export markets.

Alignment with the EU CBAM

Although the UK has agreed to uphold common high standards on carbon pricing, as set out in Article 7.3 of the Trade and Cooperation Agreement (TCA), it is not obliged to. Indeed, to prevent itself from being tethered to EU rules and policies, the UK has forcefully pushed back on agreeing to permanent measures of equivalence concerning environmental standards. Should this view be entrenched, and the EU seeks to address future imbalances, through the CBAM or other tariffs, this would fall under the EU's right to implement unilateral measures where systemic divergences that distort trade emerge. But what constitutes a material carbon price differential that necessitates action from the EU via a CBAM is a critical and yet unknown question.

Institutional architecture within the trade agreement is equipped to deal with this eventuality. For example, a newly established 'Arbitration Tribunal' and 'Partnership Council' with 19 sub-committees, including on energy, have been set up, with wide-

ranging powers to implement a 'rebalancing mechanism' such as retaliatory tariffs for occasions where future divergence occurs.

Notwithstanding the UK's desire for regulatory sovereignty, raising UK carbon prices has historically proven hard to achieve, as the political feasibility and durability of UK carbon pricing policy over time have wavered. With the phase-out of coal now fast approaching, this lack of rationale could also deprive carbon pricing in the power sector of its political legitimacy (Newberry et al., 2018). Given that Article 7.3 of the Trade and Cooperation Agreement states that both UK and EU carbon pricing must cover the power sector, political will to maintain the UK carbon price support should be strengthened. This should be considered within the broader context of engaging with and forging close multilateral cooperation and a common approach to the design and implementation of the EU CBAM. Widening consideration in this way could include areas such as policy accreditation, emissions benchmarking, sectoral coverage and leakage mitigation measures. Failure to make this engagement risks the UK being forced into adopting a policy without having a say over the design and governance – in other words, it would be a 'rule taker'.

5. Conclusions and recommendations

The EU has announced that a CBAM will come into force by the end of 2022. Our analysis has shown that the potential impacts of an EU CBAM would be focused on a few areas of the UK's economic activity. While the majority of vulnerable sectors account for small shares of carbon emissions and employment, this does not mean that the potential emissions leakage from those sectors can be ignored. In the unlikely event that the UK is fully subject to the EU CBAM, the potential liabilities would be large in absolute and relative terms (measured by the relative price change), with the manufacture of steel and basic metals particularly prone to leakage, because the EU is the UK's main trading partner for this sector.

The product coverage of the CBAM also has significant implications for the expected carbon leakage and competitiveness impacts as well as paid/collected fiscal revenue. It matters particularly for steel, where semi-finished products account for a significant share of sectoral trade-embodied carbon.

This analysis reinforces the need to reduce uncertainty around the UK's post-Brexit climate policy and particularly around anti-carbon-leakage measures, while prioritising high decarbonisation ambition, carbon market linkage to nullify the impacts of an EU CBAM and collaboration with the EU on anti-leakage measures.

High-level recommendations

- A strong policy framework that includes a high carbon price and complementary carbon leakage measures is needed for the decarbonisation of industry. The carbon price should rise to £75/tonne in 2030.
- Given strong trade linkages and integrated supply chains with the EU, the uncertainty around the UK's post-Brexit climate policy and particularly around anti-carbon-leakage measures further reduces long-term investment security for carbon-neutral production processes for UK industry. Putting in place measures to address this uncertainty and enable investors to recover the incremental costs of carbon-neutral investments should be prioritised.
- To reduce investment uncertainty, the UK should consider close multilateral cooperation with the EU on a robust policy package to support industrial decarbonisation, including ETS linking, equitable CBAM design, the gradual phase-out of free allocation, innovation support and carbon contracts for difference.
- Policies to address carbon leakage should focus on specific sub-sectors and may be differentiated. For example, leakage provisions that are tailored to steel and aluminium are needed if the UK has a broad import-only CBAM in conjunction with the EU CBAM. This could include a slower phasing out of free allocation in these sectors than in others.

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Appendix

Methodology

The analysis in Section 5 is based on two data sources obtained from Eurostat: 'EU Trade Since 1988' and 'ProdCom'. These data describe the raw material content of 8-digit NACE code products and the trade flows of these products.

The data cover the years 2010–2018. For the analysis, the 2010–2018 mean volumes and values of trade flows are calculated.

Products with content of at least one raw material greater than or equal to 90% are defined as *raw material products*. Products with raw material content between 50% and 90% are defined as *semi-finished products*.

The *material content* of a trade flow is calculated as the raw material content of the product multiplied by the volume of the trade flow. *Embodied emissions* are calculated by multiplying the emissions benchmark for each raw material by the material content of the trade flow.

Table A1. Emissions benchmarks used for determining the embodied emissions in UK exports

Commodity	Emissions benchmark for primary production (kg CO_2/kg)
Steel	1.78
Aluminium	12.82
Plastic	1.50
Paper	0.40
Cement	0.69

Source: Pauliak et al. (2016)

The size of the *tax liability* that each sector, industry or product might face is calculated as the embodied emissions in the trade flow multiplied by the differential between the carbon prices of the EU and the UK. To construct the carbon price differentials, we outline two scenarios with different price levels across UK, EU and rest of the world (RoW) markets.

Scenario 1 – High convergence
UK and EU carbon price:[10] €50/tonne. RoW carbon price: €0/tonne

Scenario 2 – High divergence
UK carbon price: £0/tonne. EU carbon price: €50/tonne

For both sectors and products, the relative impact of the EU CBAM is examined by contextualising the tax liability faced. The relative price change for a sector or product is the size of the tax liability as a percentage of the monetary value of the trade flow.

In the industry-level analysis, we examine the strength of the trading relationship between the EU and UK. A trade intensity metric, which conveys the value of trade between two countries, can be used to measure this characteristic as it indicates how much of the economic liabilities industry would have to absorb before buyers switch to alternative products. However, we instead use the export share of production to examine the importance of the EU market for each UK industry, calculated as the value of exports from the UK to the EU, divided by the value of UK production.

[10] Price harmonisation achieved through linking carbon markets.

Limitations

It is important to recognise the limitations to our approach. We do not have data for the demand elasticities for the sectors we have modelled. As such, the size of the liabilities is only a static representation of the cost.

Figure A1. Embodied CO_2 in UK exports

Notes: 'Narrow' includes products with raw material content >=90%. 'Broad' includes products with raw material content >=50%. Embodied CO_2 values are 2010–2018 mean.

Table A2. Summary of relative price changes under a broad EU CBAM

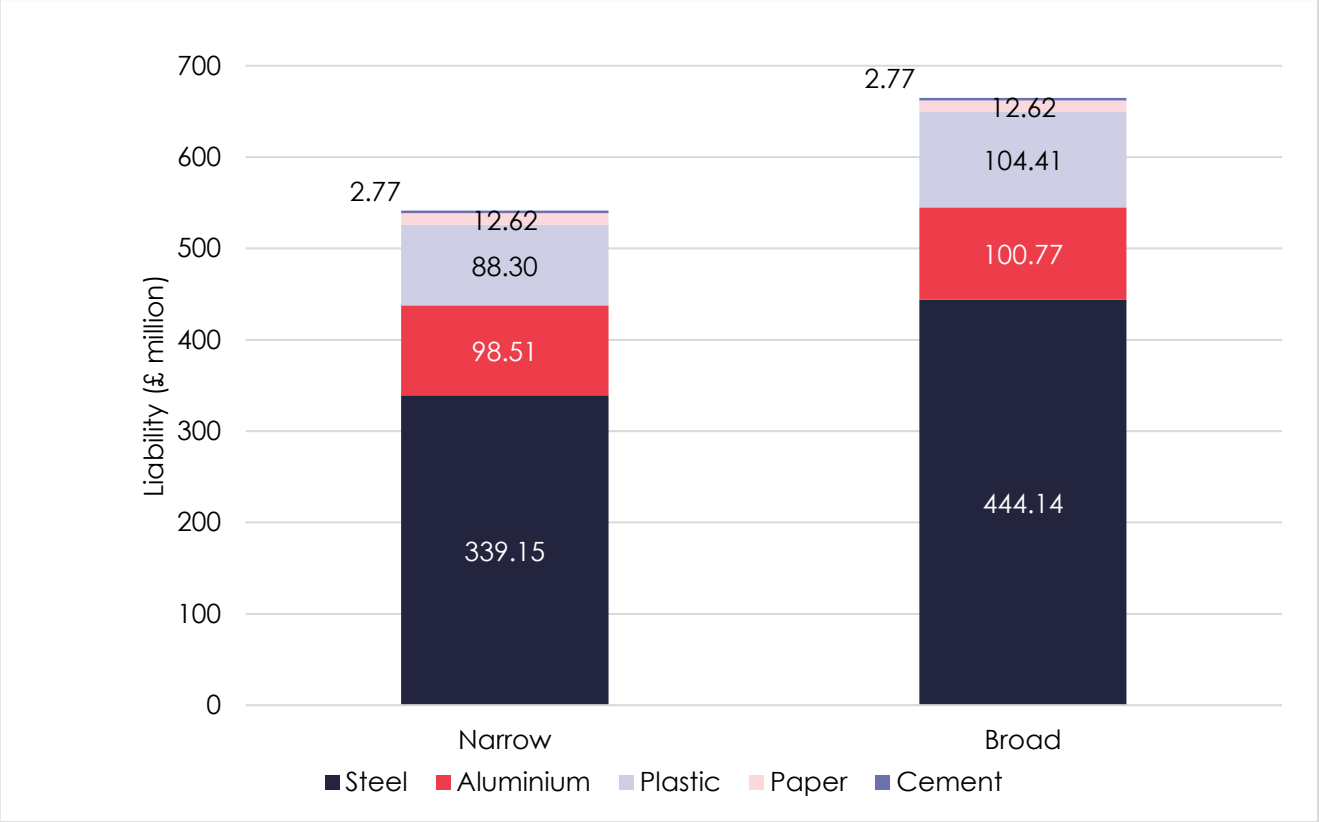
NACE code	Raw material and semi-finished products	Liability (£m)	Relative price change (%)
24422230	Aluminium bars, rods and profiles (excluding rods and profiles prepared for use in structures)	24.13	51.32
23511100	Cement clinker	0.60	47.63
28293130	Continuous and discontinuous totalisers	0.06	44.18
25931270	Aluminium stranded wire, cables, plaited bands and the like excluding electrically insulated, barbed wire and loosely twisted non-barbed double fencing wire, insulated electric wire and cables	0.13	39.87
25302100	Nuclear reactors	0.00	36.53
28131145	Positive displacement pumps, hand pumps	5.55	34.77
24101300	Ferrous products obtained by direct reduction of iron ore and other spongy ferrous products, in lumps, pellets or similar forms; iron having a minimum purity by weight of 99.94%, in lumps, pellets or similar forms	0.55	31.94
24421155	Unwrought aluminium alloys in secondary form (excluding aluminium powders and flakes)	11.67	31.93
24421130	Unwrought non-alloy aluminium (excluding powders and flakes)	4.70	31.39
24421153	Unwrought aluminium alloys in primary form (excluding aluminium powders and flakes)	48.17	31.17

Alternative divergence scenario

As an alternative to Scenario 2, the 'High Divergence' scenario, considered in the analysis thus far, we now consider a divergence scenario where the EU credits the UK carbon price. In practice, defining the value that should be credited is a complex issue because of difficulties associated with determining policy equivalence and relative policy stringency across jurisdictions. For the purposes of this analysis, we assume a UK carbon price of £22/tonne and an EU carbon price of €50/tonne. This reduces the carbon price differential between the UK and the EU compared with Scenario 2, and consequently reduces the economic impact of the EU CBAM on UK exports.

The following figures show that the size of the liability that each sector, industry or product might face under the EU CBAM is reduced compared with the case where there is no crediting of the UK carbon price.

Figure A2. Tax liabilities on UK exports to the EU



Notes: 'Narrow' includes products with raw material content >=90%. 'Broad' includes products with raw material content >=50%. Liabilities are 2010–2018 mean.

Table A3. Summary of liabilities and relative price change

Sector	Monetary value of trade flow (£m)		Tax liability (£m)		Relative price change (%)	
	Narrow (raw materials)	**Broad** (raw materials and semi-finished products)	**Narrow** (raw materials)	**Broad** (raw materials and semi-finished products)	**Narrow** (raw materials)	**Broad** (raw materials and semi-finished products)
Steel	7,581.50	31,979.69	339.15	444.14	4.47	1.39
Cement	49.21	49.21	2.77	2.77	5.63	5.63
Paper	1,963.98	1,973.02	12.62	12.62	0.64	0.64
Aluminium	896.50	6,442.57	98.51	100.77	10.99	1.56
Plastics	7,541.68	12,193.61	88.30	104.41	1.17	0.86

Figure A3. Potential impact of a narrow EU CBAM on UK exports from industrial sectors

Notes: 'Narrow' includes products with raw material content >=90%. Liabilities are 2010–2018 mean.

Table A4. Summary of relative price changes for raw material products under a narrow EU CBAM

NACE code	Raw material product	Liability (£m)	Relative price change (%)
24422230	Aluminium bars, rods and profiles (excluding rods and profiles prepared for use in structures)	12.33	26.23
23511100	Cement clinker	0.31	24.34
25931270	Aluminium stranded wire, cables, plaited bands and the like excluding electrically insulated, barbed wire and loosely twisted non-barbed double fencing wire, insulated electric wire and cables	0.07	20.38
24101300	Ferrous products obtained by direct reduction of iron ore and other spongy ferrous products, in lumps, pellets or similar forms; iron having a minimum purity by weight of 99.94%, in lumps, pellets or similar forms	0.28	16.33
24421155	Unwrought aluminium alloys in secondary form (excluding aluminium powders and flakes)	5.97	16.32
24421130	Unwrought non-alloy aluminium (excluding powders and flakes)	2.40	16.05
24421153	Unwrought aluminium alloys in primary form (excluding aluminium powders and flakes)	24.62	15.93
23511210	Portland cement	1.68	14.38
30203300	Railway or tramway goods vans and wagons, not self-propelled	0.11	14.30
24203470	Tubes and pipes, of other non-circular cross-section than square or rectangular, hot or cold formed and welded, of steel other than stainless steel	0.02	13.32

Table A5. Summary of relative price changes under a broad EU CBAM

NACE code	Raw material and semi-finished products	Liability (£m)	Relative price change (%)
24422230	Aluminium bars, rods and profiles (excluding rods and profiles prepared for use in structures)	12.33	26.23
23511100	Cement clinker	0.31	24.34
28293130	Continuous and discontinuous totalisers	0.03	22.58
25931270	Aluminium stranded wire, cables, plaited bands and the like excluding electrically insulated, barbed wire and loosely twisted non-barbed double fencing wire, insulated electric wire and cables	0.07	20.38
25302100	Nuclear reactors	0.00	18.67
28131145	Positive displacement pumps, hand pumps	2.84	17.77
24101300	Ferrous products obtained by direct reduction of iron ore and other spongy ferrous products, in lumps, pellets or similar forms; iron having a minimum purity by weight of 99.94%, in lumps, pellets or similar forms	0.28	16.33
24421155	Unwrought aluminium alloys in secondary form (excluding aluminium powders and flakes)	5.97	16.32
24421130	Unwrought non-alloy aluminium (excluding powders and flakes)	2.40	16.05
24421153	Unwrought aluminium alloys in primary form (excluding aluminium powders and flakes)	24.62	15.93