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Preliminary Study on the economic impact that EU CBAM could potentially impose on foreign exporters of products to the EU market

The case of Thailand, India, and Vietnam

Final report, May 2021

WORLD BANK GROUP

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Table of Contents

1. Background to the EU Carbon Border Adjustment Mechanism

The issues of carbon leakage and competitiveness have always been major preoccupations for the policy makers and stakeholders involved in the debate on decarbonization and meeting the international commitments of the European Union (EU) on climate change. The EU has dealt with these issues in the context of carbon pricing through the EU emissions trading system (EU ETS) by means of the free allocation of allowances, which are currently granted to sectors regarded as being at significant risk of carbon leakage.

The EU institutions have recently adopted the ambitious target of reaching climate neutrality by 2050. This has led to increased interest, and urgency, in examining options to address the risk of carbon leakage as well as measures to safeguard against it. The European Commission's (EC) action plan, the European Green Deal (EGD), and the goal of net-zero emissions by 2050, with the EU ETS expected - according to senior Commission officials - to reach net-zero possibly as early as 2040, demonstrate the increasing ambition of the EU. On a global scale, those announcements are already highlighting that the asymmetry of climate efforts around the world will continue, with the EU showing a lot more ambition than its main trading partners.

The current approach of the EU to levelling the playing field resulting from asymmetrical climate change efforts is to use free allocation and compensation for indirect costs for those sectors deemed at risk of carbon leakage. Studies show that this approach may not be practical starting towards the end of 2020s, as under different scenarios the available free allocation may start to be insufficient for meeting the needs.

New ways to level the playing field and avoid carbon leakage need to be found, which can be applied (imperfect as they may be) at different levels of ambition. Applying a Border Carbon Adjustments (BCA) is one approach that has been put forward by the EC under the name of a "Carbon Border Adjustment Mechanism (CBAM)".

While cautious, if not outright sceptical as regards to BCAs in the past, the EC, following political direction, has started the discussion on the possible adoption of a CBAM, with a legislative proposal expected by July 2021.

1.1. CBAM legislative process

Since the EC's president Ursula von der Leyen announced in the Summer of 2019, as part of the political guidelines for the next European Commission, her intention to present an ambitious 'European Green Deal', coupled with a 'Carbon Border Tax', the CBAM has become an increasingly important topic on the EU's political agenda.

The EC’s work on a CBAM proposal was first endorsed by the European Council in December 2019. Since then, all three European institutions have included CBAM revenues in light of financing the EU’s recovery plan, and the July 2020 European Council conclusions included reference to the potential entry into operation of the CBAM by the start of 2023.

As the policy and political process continues, increasingly more is known about the scope and design of the mechanism the EC’s is leaning towards. The EC has also commenced its stakeholder consultation procedure, with the Inception Impact Assessment published in March, and a public consultation that concluded in October 2020.

Going forward, the EC plans to publish its CBAM legislative proposal, accompanied by an impact assessment, by June 2021. The publication of the proposal will be followed by interinstitutional negotiations with a view to reaching agreement on the legislative text, a process that could take from a few months to several years. In addition, it is possible that the July 2021 proposal only provides the CBAM design principles and framework, while the more detailed measures and technicalities technical details be left to non-legislative acts to be adopted subsequently by the EC.

As such, significant uncertainties remain with respect to the design of the mechanism that will be eventually adopted, and this report relies on a number of speculative assumptions, informed inter alia by insights from the debate in Brussels and internationally so far.

1.2. CBAM design elements

When designing the CBAM, the EU as the implementing jurisdiction has to determine inter alia the:

1. **Policy mechanism**, i.e. whether it would be a price-based instrument (e.g. tax or customs duty) or an EU ETS extension
2. **Coverage of trade flows**: imports only, or imports and exports
3. **Geographical scope**, i.e. whether to cover all countries exporting to the EU or provide exemptions for some countries on environmental or development grounds
4. **Sectoral scope**, i.e. whether to cover all traded products throughout the entire value chain or focus on products from sectors with high carbon intensity
5. **Emissions scope**, i.e. direct only, or direct and indirect emissions
6. **Approach to determining embedded emissions**, e.g. using assumptions on default carbon intensities, or by measuring emissions from the production process for each product individually
7. **Crediting for foreign climate policies**, i.e. whether or not (and how) foreign climate policies will be credited for

8. **Use of revenues**: whether revenues will accrue to Member States or as EU own resources, and whether revenues will be earmarked for specific objective (e.g. to support domestic or international climate objectives).

Below, we focus the discussion on sectoral coverage, the method to be applied for determining embedded emissions, as well as the emissions scope, as these are the three design elements of key relevance to the scoping, assumptions and scenarios of this project.

1.3. CBAM sectoral coverage[1]

When designing the Carbon Border Adjustment Mechanism (CBAM), the EU as the implementing jurisdiction has to determine which products should be affected by it. The determination of this design element entails two dimensions: 1) the type of materials/sectors to be covered; 2) how far downstream in the value chain to go in terms of product coverage, e.g. for the case of steel, CBAM could cover only crude steel, or also semi-finished steel products, or the steel content of more finished products (e.g. cars).

With respect to the first dimension of sectoral coverage (type of materials/sectors), most proposals to date have focused on products from sectors with high carbon intensity – where the climate policies adjusted for impose a non-trivial cost – and high trade intensity, limiting their ability to pass through that cost to consumers because these can easily substitute domestic with foreign products. Such energy-intensive and trade-exposed (EITE) sectors include cement, steel, and aluminium, where the value of embodied carbon products, as a percentage of value added, tends to be relatively high compared with manufactured products. Also, because these products tend to be basic or raw materials, determining their embedded emissions is much simpler than for more complex products further down the value chain. In short, focusing on products from EITE sectors greatly reduces the administrative and technical burden of a CBAM while still delivering significant environmental benefits[2].

With respect to the second dimension (how far downstream in the value chain to go in terms of product coverage), in theory CBAM could cover all traded products throughout the entire value chain, maximizing its ability to prevent leakage and level

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[1] This section is largely based on the paper: ERCST (2020), Border Carbon Adjustments in the EU: Issues and Options, September 2020

[2] Böhringer, C., Carbone, J.C., and Rutherford, T.F. (2012), 'Unilateral Climate Policy Design: Efficiency and Equity Implications of Alternative Instruments to Reduce Carbon Leakage', Energy Economics 34: 208- 217.

the competitive playing field. In practice, however, the administrative cost and technical complexity of covering a majority of traded products – especially in the case of complex manufactured goods – would be disproportionate to the environmental and competitiveness benefits of the CBAM. On the other hand, applying a CBAM only upstream would lead to higher costs for downstream producers, either incentivizing the relocation of production out of Europe or increasing imports of products at the next step in the value chain.

Many sectors, including steel and aluminium, have complex downstream value chains in which trading semi-finished products is significant. Where these semi-finished products contain a high share of the carbon-intensive raw material and the processing results in limited value-added, such as flat rolled and extruded aluminium products, exclusion from the coverage of a CBAM may render them vulnerable to substitution by imported products at the same level in the value chain. Since the direct and energy-related indirect emissions from producing semi-finished and finished products are often moderate relative to value added, their inclusion in a CBAM would have to reflect emissions from the upstream production of the intermediate goods incorporated in such products, such as the emissions embodied in the primary aluminium used as a raw material for flat rolled aluminium products.

Finally, sectoral coverage can evolve over time, starting with a limited number of products in a pilot or learning phase and expanding over time as the BCA design will have been able to demonstrate their viability and offer proof of concept. Indeed, a pilot phase concerning a limited number of products in key sectors is a likely way of the EU CBAM being initially introduced, before more products and sectors are added to the scope of the mechanism.

1.4. Method for determination of embedded emissions[3]

There are two basic means by which an implementing government can choose to calculate/estimate the GHG emissions embedded in a product at the point of import: a product-based approach, and a sectoral-based approach.

A product-based approach focuses on the individual products and aims to estimate actual GHG emissions embodied in those products. The only feasible way to do this is to require disclosure by the producer or importer of records, presumably third-party verified. This would have to be done shipment by shipment if anything beyond scope

[3] This section is largely based on the paper: ERCST (2020), Border Carbon Adjustments in the EU: Issues and Options, September 2020

1 emissions were covered, since the carbon footprints of inputs like electricity can vary seasonally depending on the mix.

From an environmental and competitiveness perspective this approach is effective – it calibrates the charges very specifically to the products' GHG intensity and offers incentives for improvement. For the same reason, this approach aligns well with trade law requirements that environmental measures not be arbitrary, and that the objective of the measure be strictly environmental. But it involves a complex administrative endeavour, difficult to police and costly to exporters. The complexity and cost of this approach increases as the scope of emissions covered increases, becoming much more difficult if emissions from intermediate goods are covered. For these same reasons, such an approach is likely to cause friction with trading partners.

A sector-based approach uses estimates of GHG-intensity, setting default values based on sectoral characteristics. These values could reflect best practice, average practice or worst practice domestically, globally or in the exporting country. The level of stringency for each option will thus be dictated by the relative GHG-intensity of domestic, global and exporter production in the covered sector. The *least* stringent option, assuming best practice in the least GHG-intensive geographical reference, would be more likely to be politically and legally acceptable, albeit to the detriment of effectiveness at preventing leakage and competitiveness impacts. A sector-based approach based on default values is easier to administer and as such likely to be used by CBAM. However, it comes to the detriment of incentivizing and rewarding companies that invest in cleaner technologies.

A possible compromise between the two approaches could be to make use of default values, while granting foreign producers the possibility to individually prove that they are "cleaner" than these default values.

1.5. Emissions scope[4]

When designing the CBAM, a decision also needs to be made on the emissions scope it covers. Direct emissions are those resulting from the production process itself, including process emissions and emissions from on-site combustion of fuels to generate heat and electricity. Indirect emissions include those related to the use of electricity, heat or steam generated offsite, as well as other emissions arising during the lifecycle of the product, such as emissions from other inputs such as raw materials, the transport of goods to market, product end use, and the disposal of the product. A common framework to describe these emissions is the Greenhouse Gas Protocol, which

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[4] This section is largely based on the paper: ERCST (2020), Border Carbon Adjustments in the EU: Issues and Options, September 2020

distinguishes three emission scopes: Scope 1 (direct emissions); Scope 2 (indirect emissions from purchased electricity, heat and steam); and Scope 3 (all other indirect emissions) (WRI et al., 2004).

The CBAM can be designed to cover any combination of direct (Scope 1) and indirect (Scope 2 and 3) emissions, and from the perspective of environmental and competitiveness benefits a larger scope will – all things being equal – result in greater benefits. In order to avoid discrimination between domestic and foreign products, however, the scope of emissions covered by the CBAM should not be greater than that of the domestic climate policy it adjusts for, in this case the EU ETS. That is not to say that a climate policy which only covers direct emissions cannot be accompanied by a CBAM that covers indirect emissions: if, for instance, the domestic climate policy covers direct emissions from electricity, like in the case of the EU ETS, the resulting cost will be at least partly passed through to industrial electricity consumers, meaning that their Scope 2 indirect emissions are subject to a carbon price at the location where they originated. Assuming that the direct emissions of industrial producers are likewise covered by the domestic climate policy, a CBAM adjusting for that policy should be able to cover both direct (Scope 1) and Scope 2 part of indirect emissions associated with imported products.

2. Project overview

2.1. Project objectives

The EU CBAM will, whatever the final proposal will look like, have an impact on the relative competitiveness of products covered and hence on trade flows and the economic growth of the exporting countries. The objective of the paper is to identify the costs incurred by selected countries as a result of EU CBAM.

The paper identifies the export volumes to the EU, assesses the domestic emissions linked to the production of the goods, estimates the loss of competitiveness due to carbon pricing and finally assesses the impact on GDP. It covers the following tasks:

- Identify main CBAM-relevant carbon-intensive exports from Thailand, Viet Nam and India to the EU;
- Assess CO_2 emission volumes embedded in the carbon intensive products under consideration; As an EU CBAM could cover either direct only emissions, or direct and indirect emissions, we estimate emissions (and CBAM payments) for both these cases. We have thus expanded the scope of the study compared to the ToR, which made reference to direct only emissions.
- Estimate the costs and competitiveness losses that could potentially be incurred by the exporting countries under study if a EU CBAM was put in place. Particularly, assess potential payments based on forecasted CO_2 prices and emission volumes

and additional fiscal burden on exports that may arise from CBAM introduction as the share of CBAM payments to current product prices;

- Assess GDP losses related to the implementation of CBAM in the sectors and countries under consideration.

2.2. General approach, assumptions, limitations and key data sources

The impact of the CBAM on trade and exports to the EU will be addressed by shifting production to cleaner technologies, shifting exports to destinations other than the EU or imposing policies that are more in line with the level of stringency in the EU.

We estimate CBAM payments as the additional tax burden incurred by foreign exporters of the selected products to the EU in 2023 (assumed first year of the EU CBAM being in force), assuming trade patterns remain unchanged compared to annual average trade volumes and values in 2017-2019.

As an EU CBAM could cover either direct only emissions, or direct and indirect emissions, we estimate emissions and CBAM payments for both these cases.

Assumptions and scenarios

The results will depend significantly on the assumptions regarding the design of the CBAM that will be eventually adopted. While significant uncertainty remains over the design of the EU CBAM that the European Commission will propose in 2021, we put forward the following assumptions:

- The CBAM would initially cover imports of a number of selected products and would be gradually extended; The most carbon-intensive and traded products would likely be affected i.e. at risk of carbon leakage. Other factors like the complexity of the value chain would also be taken into account.
- The additional cost imposed on imports would be based on a default carbon intensity value e.g. the average carbon intensity of EU producers, or of the producers in the exporting countries. Foreign producers could be granted the possibility to individually prove that they are cleaner than the default emission intensity.
- The level of adjustment (EUR/t CO_2) would mirror the price of emissions allowances under the EU ETS, which we assume to be at about EUR 41/t CO_2 in 2023. We also assume that hypothetical carbon prices of EUR 10/t CO_2 are in place in the exporting countries, for the examined scenarios that allow for crediting of foreign carbon pricing policies (see section 4.1 for more details).
- Trade patterns in 2023 (first year of CBAM implementation) remain unchanged compared to annual average trade volumes and values in 2017-2019
- CBAM would apply to imports of raw materials/commodities (e.g. primary aluminium, crude steel), as well as semi-finished products of the first processing

of these materials (e.g. aluminium rolled products, steel pipes), the content of which comprise nearly to its entirety of these materials. Practically, the calculations apply the emissions intensity of the primary material (crude steel) also to imports to the EU of semi-finished products (steel pipes). Since the direct and energy-related indirect emissions from producing semi-finished and finished products are often moderate relative to value added, their inclusion in a CBAM would have to reflect emissions from the upstream production of the intermediate goods incorporated in such products (e.g. the emissions embodied in the primary aluminium used as a raw material for flat rolled aluminium products; or the emissions embodied in crude steel as a raw material for steel pipes).

From the outset, we thus assume that the CBAM calculation will be based on 3 components:

- The default **carbon intensity** of a product, expressed in **tCO_2 /t of product**, with the default carbon intensity value representing for example the average carbon intensity of EU producers, or of producers in the exporting countries.
- The **carbon price** (EUR/t CO_2), which would mirror the price of emissions allowances under the EU ETS
- The **volume** (tons) **of exported products** to the EU, including raw materials and semi-finished products

We analyse six different CBAM scenarios to assess the range of possible impact of the CBAM that might ultimately be selected. The scenarios can be characterized by the choice of two core design elements:

1. **CO_2 intensity**, with the choice of applicable default (average) CO_2 intensity values being:
    a. EU average ($EU_{CO2intensity}$) ;
    b. Exporting country-specific average ($nonEU_{CO2intensity}$);
    c. The differential between average intensity values in the exporting country and the EU ($\Delta_{CO2intensity}$). This option implies that CBAM aims to incite alignment of foreign producers to EU production standards.

2. **CO_2 price at the border (level of adjustment)**, and whether CBAM:
    a. will account for crediting of foreign policies entailing a carbon price in exporting countries ($\Delta_{CO2\ price}$); or
    b. the full EU carbon price will be applied to exports ($EUA_{CO2price}$).

We thus present results for the following six possible CBAM scenarios, where scenarios (1)-(3) are the base designs that reflect the choice of carbon intensity default values, and scenarios (4)-(6) variations that serve as sensitivities whereby foreign carbon prices are credited:

Table 1 The six scenarios

	#	Approach to determining CBAM cost	Explanatory notes
Base design scenarios (no foreign carbon price crediting)	(1)	$EUA_{CO2\ price} * EU_{CO2\ intensity}$	• Carbon price for imports equal to the price of EU allowances under the EU ETS ($EUA_{CO2\ price}$) • Emissions embedded in imports determined based on the average carbon intensity of EU producers ($EU_{CO2\ intensity}$)
	(2)	$EUA_{CO2\ price} * nonEU_{CO2\ intensity}$	• Carbon price for imports equal to the price of EU allowances under the EU ETS ($EUA_{CO2\ price}$) • Emissions embedded in imports determined based on the average carbon intensity in exporting countries (non$EU_{CO2\ intensity}$)
	(3)	$EUA_{CO2\ price} * \Delta_{CO2\ intensity}$	• Carbon price for imports equal to the price of EU allowances under the EU ETS ($EUA_{CO2\ price}$) • Importers pay only for the part of their emissions intensity in excess to the average carbon intensity of EU producers ($\Delta_{CO2\ intensity}$)
Sensitivity scenarios (with foreign carbon price crediting)	(4)	$\Delta_{CO2\ price} * EU_{CO2\ intensity}$	• Crediting for foreign carbon pricing policies (carbon tax or ETS), with carbon price equal to the difference between the price of EU allowances under the EU ETS and carbon prices in exporting countries ($\Delta_{CO2\ price}$) • Emissions embedded in imports determined based on the average carbon intensity of EU producers ($EU_{CO2\ intensity}$)
	(5)	$\Delta_{CO2\ price} * nonEU_{CO2\ intensity}$	• Crediting for foreign carbon pricing policies (carbon tax or ETS), with carbon price equal to the difference between the price of EU allowances under the EU ETS and carbon prices in exporting countries ($\Delta_{CO2\ price}$) • Emissions embedded in imports determined based on the average carbon intensity in exporting countries (non$EU_{CO2\ intensity}$)
	(6)	$\Delta_{CO2\ price} * \Delta_{CO2\ intensity}$	• Crediting for foreign carbon pricing policies (carbon tax or ETS), with carbon price equal to the difference between the price of EU allowances under the EU ETS and carbon prices in exporting countries ($\Delta_{CO2\ price}$) • Signal to align to EU production standards ($\Delta_{CO2\ intensity}$)

There are currently no carbon pricing policies in the form of a carbon tax or an ETS in either of Thailand, Viet Nam[5], or India. Nonetheless we still run scenarios (4)-(6) assuming a hypothetical carbon price (e.g. EUR 10/t CO_2) having been introduced by the countries. Scenarios (4)-(6) thus serve as sensitivity scenarios, that allow to infer the extent to which the impact magnitude of an EU CBAM is reduced in case some form of carbon pricing were to be introduced.

For the assessment of the impact on GDP it is important to establish a baseline. Here we assume as a reference that in today's system European producers pay for carbon or receive allowances for free (depending on the sector) and the cost of carbon is passed through only in sectors where the international trade intensity is very low. We make the additional assumption that with the introduction of the CBAM free allocation in the EU ETS is discontinued.

Key limitations

The impact of CBAM on trade will be partly mitigated by shifting production means to cleaner technologies (reducing carbon intensities), or by shifting exports to other final destinations outside the EU.

The analysis of CBAM payments is limited to the first order effect of the trade impact bilaterally between country of origin and the EU. It provides an assessment of the CBAM "bill" faced by exporters at the border, assuming unchanged trade flows compared to average 2017-19 values. In reality, CBAM payments could affect the level of commodity prices depending on the pass-through rate and also affect the level of trade flows depending on price elasticity.

Second order effects that would mitigate the impact of CBAM on trade include among other things a shift of production means to cleaner technologies (reducing carbon intensities), and a shift of exports to other final destinations outside the EU. The analysis does not take into account trade flows with third countries which would also play a role in trade flow changes. For this, the use of a global trade model would be needed. Yet, the introduction of CBAM could still have a positive impact on the volume of exports of a commodity from a country with relatively lower carbon intensity production compared to the intensity of other foreign producers exporting to the EU. All other things equal, CBAM would encourage an increase in exports from countries with low carbon intensities and vice versa. The assessment of the impact of CBAM on

[5] Viet Nam is in the initial phase of elaborating an ETS. The National Assembly having passed in November 2020 the revised Law on Environmental Protection that includes provisions to set up a domestic emissions trading scheme. The law will take effect in January 2022. Details such as sector scope, targets, timelines, and expected carbon price levels have not been specified yet, and are left to a future government decree.

GDP (see section 5.3), goes in this direction to some degree, in the sense that it assumes an increase in exports if the emissions intensity of production in the exporting country is lower than that in the EU, and vice versa. However, it still does not capture the impact of trade flow changes due to the relative emissions intensity of the exporting country of interest and other exporters to the EU.

Finally, the calculations in this study are based on "average" default intensities at the EU, regional or exporting country level, derived based on publicly available data or input provided during the study. In practice, exporters to the EU would be allowed to challenge carbon intensity default values, and foreign producers could be granted the possibility to individually prove that they are "cleaner" than default values.

Key information sources

This paper relies on a number of information sources. For trade data, it relies on data from Eurostat (export value and volumes of selected countries to the EU) which provides data at a high level of granularity (see section 0).

When it comes to deriving emissions, the paper considers data on established default CO_2 intensity values for the various sectors at the national, global, or EU level that are likely to be used by the EU for a CBAM methodology. In several instances, such default values are either unavailable or not tailored enough to the specificities of the countries in focus to this study. The paper thus resorts to estimating default CO_2 intensity values, based on data by sectoral associations and international organisations (e.g. IEA), on production volumes by technology type, emissions inventories, electricity consumption, electricity supply mix within the sector or electricity grid emissions factors (see section 4.2). Moreover, CO_2 intensity data has been provided by the Thailand Greenhouse Gas Management Organization based on their carbon footprint database. In addition, data concerning India has been provided or validated (triangulated) by the Council on Energy, Environment and Water (CEEW) in India[6].

Finally, regarding the level of the adjustment per ton of embedded CO_2 emissions, the paper uses the premise that the CBAM currently being elaborated in the EU will be commensurate with internal carbon pricing at the EU level, as revealed under the bloc's cap and trade system, the EU Emissions Trading System (ETS). Thus, it makes use of forecasts by analysts of the price (EUR/t CO_2) of European Union Allowances (EUA), the tradable unit under the EU ETS (see section 4.1).

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[6] The Council on Energy, Environment and Water is one of Asia's leading not-for-profit policy research institutions. For more information see: https://www.ceew.in

3. Carbon-intensive exports to the EU27

We take outset in the premise that the CBAM currently being elaborated in the EU should accompany and be commensurate with internal carbon pricing at the EU level. Carbon pricing in the EU consists of the carbon price revealed under the bloc's cap and trade system, the EU Emissions Trading System (ETS). A potential CBAM is intended to adjust for the carbon price under the EU ETS, a policy that covers emissions from industry, aviation and the electricity sector.

To be WTO compatible, CBAM import charges on covered products should not exceed the amount of the domestic carbon price faced by like domestic products. It follows naturally that the CBAM cannot cover products that do not face a carbon price domestically. This means that the sector/product coverage of the CBAM cannot be wider than the EU ETS coverage.

Therefore, from the outset the scope of work is narrowed down to industrial activities[7] that are covered by the EU ETS and are thus subject to internal carbon pricing, but not to other economic sectors such as agriculture.

3.1. Cement, steel, and aluminium

As already discussed in chapter 1, a CBAM could theoretically cover all traded products throughout the entire value chain. However, in practice focusing on basic or raw materials from sectors with high carbon intensity and high trade intensity, greatly reduces the administrative and technical burden of a CBAM while still delivering significant environmental benefits (ERCST, 2020, p.29).

Hence, most CBAM proposals discussed in the EU to-date have focused on products from sectors with high carbon intensity, and high trade intensity, such as *cement*, *steel*, and *aluminium*. Also, because these products tend to be basic or raw materials, determining their embedded emissions is relatively simpler as compared to more complex products further downstream (ERCST, 2020, p.29).

An EU proposal for a CBAM and hence more clarity on possible sectoral coverage is only anticipated in June 2021. However, we assess based on insights from the early

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[7] Unless the selected countries border the EU, we exclude power stations from the scope given the de facto lack of trade. Moreover, to date only intra-EU flights are covered by the EU ETS, and therefore we also exclude aviation.

stage of the political process that the following sectors are highly likely to be covered initially by the mechanism, in a "pilot" phase[8]:

1. Cement;
2. Steel; and
3. Aluminium

Our assessment thus covers the three aforementioned sectors in all three exporting countries. This allows us to provide an assessment, as well as a cross-country comparison of the magnitude of CBAM payments (additional tax burden) and competitiveness losses in each sector.

3.2. Additional sectors

The study carries out an exercise to identify additional sectors exposed to carbon leakage in the three countries and are therefore likely to be impacted by an EU CBAM. This adds some diversity in terms of the sectors assessed.

To identify additional CBAM-relevant sectors we analyse their exports to the EU and cross reference with sectors likely to be covered by CBAM:

1. We first prepare a table with a 'inclusive list' of exported goods above a certain value threshold (e.g., above EUR 10 million), using data by Eurostat.
2. We then drop products from the list if they do not fall within the sectors covered by the EU ETS. This results in a 'narrowed-down list' of EU ETS-relevant and therefore CBAM-relevant products.
3. As a third step, we derive a 'net list' of a limited number of CBAM-relevant carbon intensive products exported to the EU from the selected country, by carrying out a qualitative assessment of the likelihood of their inclusion in CBAM in the short to medium-term.

   To do so we use the project team's insights on the CBAM likely sectoral coverage from the early stage of the political process, as well as existing EU legislative documents that identify sectors that are regarded to be at significant

[8] 'Electricity' is an additional sector often mentioned as a likely candidate for inclusion in an EU BCA, however, we deem this not relevant for this report, given that the studied countries have no electricity interconnections to the EU.

risk of carbon leakage[9], and the importance of the sector, subsector or product in the country's exports to the EU.

Thailand

For Thailand, the exercise results in singling out the 'plastics in primary forms' and 'pulp & paper' sectors, as possible sectors of interest in addition to steel, aluminium.

Table 2 Additional CBAM relevant exports from Thailand to the EU27

SECTOR	NACE CODE - PRODUCT	VALUE_IN_EUROS avg 2017-2019	QUANTITY_IN_1000KG avg 2017-2019G
Basic chemicals	2016 - Plastics in primary forms	199.647.559	115.759
Iron & steel	2410 - Basic iron and steel and ferro-alloys	77.350.176	34.915
	2420 - Tubes, pipes, hollow profiles and related fittings, of steel	19.644.216	6.459
	2431, 2432, 2433, 2434 - Other products of the first processing of steel	7.229.860	5.766
Aluminium	2442 - Aluminium	20.356.027	7.309
Pulp & paper	1711 - Pulp	15.347.235	24.468
	1712 - Paper and paperboard	15.420.191	13.136
Cement	2351 – Cement	2.599	2,6

Source: Eurostat 'EU trade since 1988 by CPA 2.1' dataset [DS-1062396]

India

For India, the exercise results in singling out 'refined petroleum products', as a possible sector of interest in addition to steel, and aluminium. India is the world's fourth largest oil refiner and a net exporter of refined products[10].

Table 3 Additional CBAM relevant exports from India to the EU27

SECTOR	NACE CODE - PRODUCT	VALUE_IN_EUROS avg 2017-2019	QUANTITY_IN_1000KG avg 2017-2019G
Manufacture of refined petroleum products	1920 - Refined petroleum products	2.202.810.536	4.234.299
	- of which Kerosene-type jet fuel (O4661)		1.860.022
	- of which Road diesel (O46711)		1.997.959

[9] COMMISSION DELEGATED DECISION (EU) 2019/708 of 15 February 2019 concerning the determination of sectors and subsectors deemed at risk of carbon leakage for the period 2021 to 2030
[10] IEA (2020)

Iron & Steel	2410 - Basic iron and steel and ferro-alloys	2.188.785.566	3.072.763
	2420 - Tubes, pipes, hollow profiles and related fittings, of steel	334.873.378	152.451
	2431 - Cold drawn bars	144.771.215	66.555
	2432 - Cold rolled narrow strip	33.522.919	17.307
	2433 - Cold formed or folded products	509.439	227
	2434 - Cold drawn wire	86.634.974	38.316
Aluminium	2442 - Aluminium	491.609.230	278.927

Source: Eurostat 'EU trade since 1988 by CPA 2.1' dataset [DS-1062396]

India is the second largest producer of cement and steel in the world. India is expected to increase its annual steel production volumes by 2050 by when almost one-fifth of the steel produced globally is expected to come from India[11].

Vietnam

Finally for Vietnam, the exercise results in singling out the 'basic chemicals' including 'plastics in primary forms' or 'other inorganic chemicals', as additional possible sectors of interest. However, given the large diversity of products that could be included in this product group, all with distinct characteristics, the assessment focuses on the three key sectors of steel, aluminium and cement.

Table 4 Additional CBAM relevant exports from Vietnam to the EU27

SECTOR	NACE CODE - PRODUCT	VALUE_IN_EUROS avg 2017-2019	QUANTITY_IN_1000KG avg 2017-2019G
Basic chemicals	2016 - Plastics in primary forms	35.658.005	33.467
	2013 - Other inorganic basic chemicals	76.659.014	25.485
Iron & steel	2410 - Basic iron and steel and ferro-alloys	304.153.846	399.801
	2420 - Tubes, pipes, hollow profiles and related fittings, of steel	15.761.592	7.712
	2431, 2432, 2433, 2434 - Other products of the first processing of steel	12.844.966	10.908
Aluminium	2442 - Aluminium	22.685.710	9.675
Cement	2351 - Cement	13.901.107	215.872

Source: Eurostat 'EU trade since 1988 by CPA 2.1' dataset [DS-1062396]

[11] IEA (2020), IEA (2020b)

3.3. Trade data

The following table denotes the volume and value of exports from each of the three countries to the EU27 for the selected sectors discussed in the previous two sub-sections.

Table 5 Exports volume and value of selected products from India, Thailand and Viet Nam to EU27

SECTOR	NACE CODE - PRODUCT	VALUE_IN_EUROS avg 2017-2019*	QUANTITY_IN_1000KG avg 2017-2019*
THAILAND			
Iron & steel	2410 - Basic iron and steel and ferro-alloys	77.350.176	34.915
	2420 - Tubes, pipes, hollow profiles and related fittings, of steel	19.644.216	6.459
	2431, 2432, 2433, 2434 - Other products of the first processing of steel	7.229.860	5.766
Aluminium	2442 - Aluminium	20.356.027	7.309
Cement	2351 - Cement	2.599	2,6
Pulp and paper	1711 – Pulp	15.347.235	24.468
	1712 - Paper and paperboard	15.420.191	13.136
Chemicals	Plastics in primary form	199.647.559	115.759
INDIA			
Iron & steel	2410 - Basic iron and steel and ferro-alloys	2.188.785.566	3.072.763
	2420 - Tubes, pipes, hollow profiles and related fittings, of steel	334.873.378	152.451
	2431 - Cold drawn bars	144.771.215	66.555
	2432 - Cold rolled narrow strip	33.522.919	17.307
	2433 - Cold formed or folded products	509.439	227
	2434 - Cold drawn wire	86.634.974	38.316
Aluminium	2442 - Aluminium	491.609.230	278.927
Cement	2351 - Cement	1.665.484	16.481
Refined petroleum products	1920 - Refined petroleum products	2.202.810.536	4.234.299
	- of which Kerosene	846.965.013**	1.561.514
	- of which Diesel	1.134.688.203***	2.301.972

VIET NAM			
Iron & steel	2410 - Basic iron and steel and ferro-alloys	304.153.846	399.801
	2420 - Tubes, pipes, hollow profiles and related fittings, of steel	15.761.592	7.712
	2431, 2432, 2433, 2434 - Other products of the first processing of steel	12.844.966	10.908
Aluminium	2442 - Aluminium	22.685.710	9.675
Cement	2351 - Cement	13.901.107	215.872

Sources: Eurostat 'EU trade since 1988 by CPA 2.1' dataset [DS-1062396]; Eurostat dataset 'Imports of oil and petroleum products by partner country' [nrg_ti_oil]

*Note: 2017-2019 average values, except for the case of refined petroleum products were values concern 2018 (most recent year of available data)
** Estimated based on Jet fuel price average for 2018 of $81,1/bbl, 1 ton of jet fuel = 7,9 barrels; Average exchange rate in 2018: 1 USD = 0.8475 EUR
*** Estimated based on EU weighted average consumer prices of diesel net of duties and taxes between 01/01/2018-03/09/2018

We note that average cement exports from India and Thailand to the EU in 2017-2019 were modest. Notwithstanding, the cement industry is a vital part of the two economies.

Although total emissions embedded in exports to the EU, and thus total CBAM payments are low based on current export patterns, it is still worth exploring the CBAM payments per ton of product and the impact of the EU CBAM on competitiveness.

Moreover, if CBAM is applied there might be market diversification, and opportunities for boosting exports to the EU from countries with relatively low carbon intensities such as India (as 'cleaner' third country exporters enjoy a competitive advantage in terms of lower CBAM payments compared to 'dirtier' exporters facing higher CBAM payments). For this reason, we look at the cement sector for all three countries, even for those where current trade with the EU is limited.

4. CO_2 prices and CO_2 intensity

The calculation of the economic cost of CBAM on foreign exporters is based on two components: i) the default carbon intensity values of imports (tCO_2/t of product); ii) the carbon price (EUR/tCO_2).

This section first presents the data and assumptions with respect to the level of adjustment i.e., the carbon price applicable to imports to the EU (sub-section 4.1).

The work greatly hinges upon the identification of CO_2 intensity data (tCO_2/ton of product), and the data relevant for deriving CO_2 intensity values. Sub-section 4.2 present figures on the CO_2 intensity values for each of the sectors, and provides details of the approach, assumptions and sources used for deriving these values (for the general approach see section 2.2). These include average carbon intensity values of EU producers and average carbon intensity values of production in exporting countries. Finally, sub-section 4.3 presents the intensity values for each region/country in a table format.

4.1. Level of adjustment (CO_2 price)

For the level of the adjustment per ton of embedded CO_2 emissions in imports (carbon price for imports), the assumption is that the CBAM currently being developed by the EC will use the carbon price in the EU Emissions Trading System (ETS).

For scenarios (1)-(3) that entail no crediting of foreign carbon pricing, the Bloomberg EUA price forecast of about 41 EUR/t CO_2 in 2023 is used. This is consistent with the EUA price forecast of 41.05 EUR/t CO_2 in 2023 produced by Carbon Pulse and based on the average EUA price forecast provided by 13 analysts (e.g. Berenberg, BNEF, ClearBlue, Commerzbank etc).

As mentioned in the previous chapter, there are currently no carbon pricing policies in the form of a carbon tax or an ETS in Thailand, Viet Nam[12] or India[13]. Nonetheless we

[12] Viet Nam however is in the initial phase of elaborating an ETS. The National Assembly having passed in November 2020 the revised Law on Environmental Protection that includes provisions to set up a domestic emissions trading scheme. The law will take effect in January 2022. Details such as sector scope, targets, timelines, and expected carbon price levels have not been specified yet, and are left to a future government decree.

[13] In India, the Perform Achieve and Trade (PAT) is a cap-and-trade mechanism that supports energy efficiency in energy-intensive sectors, such as the industrial and power sectors. Plants are assigned an energy consumption target over the compliance period, and can issue tradable Energy Saving Certificates (ESCerts) for the level by which they overachieve the target. Plants that do not miss their targets can

still run scenarios (4)-(6) assuming that a hypothetical carbon price of EUR 10/t CO_2 having been introduced in the countries. Scenarios (4)-(6) thus serve as sensitivity analysis that allows to understand the extent to which the impact of the CBAM would be reduced in case some form of carbon pricing were to be introduced.

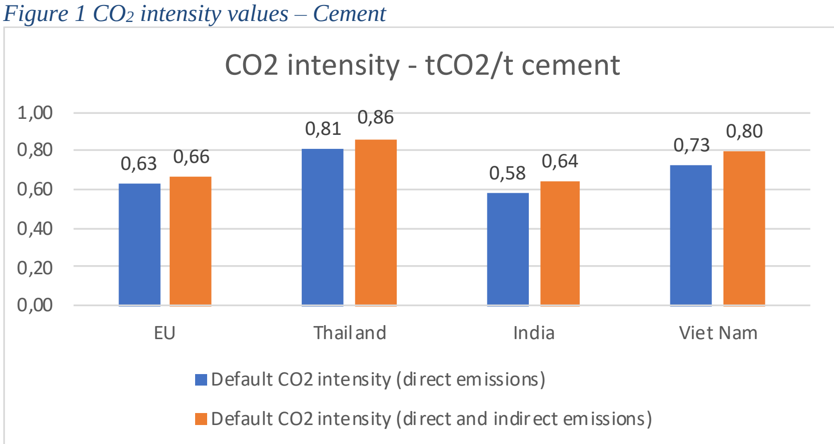
4.2. CO_2 intensity by sector

This section presents figures on CO_2 intensity values organized by sector, which allows a cross-country comparison. Below each figure, a description of the methodology and assumptions used for deriving the values in the various sectors is provided.

CO_2 intensity - cement

The following figure presents CO_2 intensity values in the cement sector.

Figure 1 CO_2 intensity values – Cement



Source: ERCST own elaboration based on Central Electricity Authority (2019), European Environment Agency (2020), Nordic Partnership Initiative (2014), WBCSD (2020), World Bank (2018), Thailand Greenhouse Gas Management Organization's Carbon Footprint Database

Direct CO_2 intensity values for cement are sourced from the Getting the Numbers Right database (WBCSD, 2020) managed by the Global Cement and Concrete Association for the case of the EU and India. Intensities are sourced from an analysis of the emissions of Vietnam' cement industry (Nordic Partnership Initiative, 2014) for the

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either buy certificates or face a penalty. The first cycle of the PAT scheme in 2012-2015 covered 478 plants across eight sectors, namely aluminium, cement, chlorarlkali, fertilisers, iron and steel, pulp and paper, textiles and thermal power plants, achieving 7.67 Mtoe in energy savings, corresponding to reducing 31 million tonnes of CO_2 equivalent. The PAT cycles II, III and IV are being implemented, covering 848 designated plants.

case of Vietnam, and from Thailand Greenhouse Gas Management Organization's carbon footprint database for the case of Thailand. For the case of Thailand, using GNR data would have resulted in lower direct and total emissions intensities of 0,70 and 0,75 tCO2/ton of product respectively.

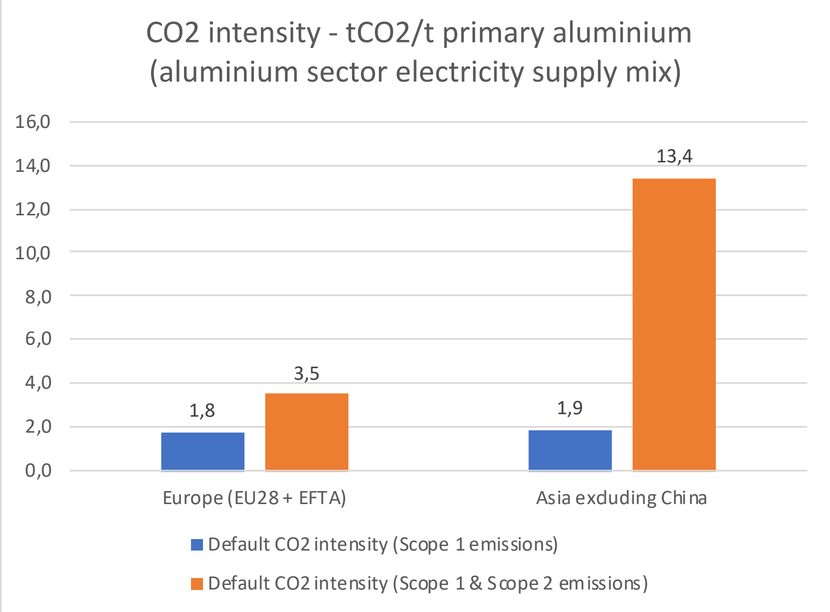
Similarly, indirect emissions for the case of the EU and India are calculated based on electricity consumption in the cement sector data from the Getting the Numbers Right database, and country-specific electricity grid emissions factors (Central Electricity Authority (2019), European Environment Agency (2020)). For Vietnam, electricity consumption is sourced from the Nordic Partnership Initiative (2014) and the national grid emissions factors from World Bank (2018). Finally, for Thailand, total emissions intensity is based on the Thailand Greenhouse Gas Management Organization's Carbon Footprint Database[14].

CO2 intensity - aluminium

For the aluminium sector, direct CO_2 intensity as well as electricity intensity values are based on greenhouse gas emissions data for the Aluminium Sector greenhouse gas inventory data collected by the International Aluminium Institute compiled at the regional level (International Aluminium Institute, 2018). The following figure presents CO_2 intensity values in the aluminium sector for the regions of 'Europe' and 'Asia excluding China', using an aluminium sector-specific electricity supply mix data by the International Aluminium Institute (2017; see Table 6). The presented intensity values take into account Scope 1 and Scope 2 emissions from anode/paste and electrolysis steps. Emissions from bauxite mining and alumina refining are not taken into account.

[14] Ibid.

Figure 2 CO_2 intensity values – Aluminium, using aluminium sector electricity supply mix



Source: ERCST own elaboration based on International Aluminium Institute (2018), International Aluminium Institute (2017), World Bank (2014)

Data availability and granularity allow us to derive CO_2 emissions intensity values at the regional level:

- 'Europe': International Aluminium Institute data concerns the wider region of Europe (=EU28+EFTA). We use these values for the EU27.
- 'Asia excluding China': International Aluminium Institute data concerns the wider region of Asia excluding China'. We derive one set of values and apply these to Thailand, India, and Viet Nam.

Electricity is the most significant input to aluminium production (about 15MWh/ton of product) and therefore accounts for a significant part of emissions from the sector. Often, the aluminium industry electricity supply mix differs from the national or regional grid mix, due to captive or directly delivered power supplies (International Aluminium Institute, 2017, p.6). Therefore, rather than using national power grid emissions factors to derive indirect CO_2 intensities, we use regional aluminium industry-specific electricity supply mix data by the International Aluminium Institute and electricity emission factors by fuel type.

Table 6 Aluminium industry-specific electricity supply mix

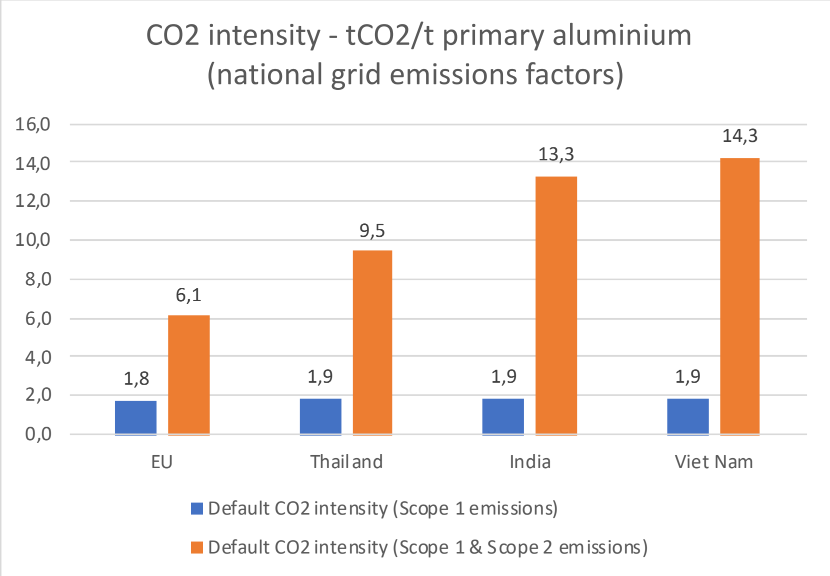
Region	**Hydro**	**Coal**	**Oil**	**Natural gas**	**Nuclear**	**Resulting aluminium industry-specific electricity emissions factor (tCO2/GWh)**
Europe (EU28 + EFTA)	68%	10%	1%	5%	16%	115
Asia (excluding China)	14%	86%	0%	0%	0%	756
World	30%	59%	0%	9%	2%	554

Source: ERCST elaboration based on International Aluminium Institute (2017), World Bank (2014)

Alternatively, the use of national grid emissions factors results in higher indirect emissions intensities for Vietnam (due to the national grid emissions factor of 815 t CO_2/GWh respectively that is higher than the resulting electricity emissions factor of 756 tCO_2/GWh specific to the aluminium industry in Asia); a lower indirect emissions intensity for the case of Thailand (due to a lower national grid emissions factor of 499 tCO_2/GWh); and a marginally lower value for India (national grid emissions factors of 753 tCO_2/GWh).

Taking a conservative stance, we use the lowest of the two indirect intensity values resulting from the two approaches, i.e. based on national grid emissions factors for Thailand and India. For the EU, and Vietnam, we use the intensities that are based on aluminium industry-specific electricity supply mix in 'Asia excluding China' (see figure below). We note that for the case of the EU, the use of the European (EU28 + EFTA) electricity mix specific to the aluminium sector likely results in an underestimation of indirect and total intensities, as the inclusion of EFTA countries such as Norway and Iceland boosts the share of hydro in the mix. On the other hand, in India, the indirect intensity is probably an underestimation, as the Indian aluminium sector makes use of captive power plants that are almost exclusively coal-based.

Figure 3 CO_2 intensity values – Aluminium



Source: ERCST own elaboration based on Central Electricity Authority (2019), European Environment Agency (2020), International Aluminium Institute (2018), International Aluminium Institute (2017), World Bank (2014), World Bank (2018)

CO_2 intensity - steel

Steel production is currently highly emissions-intensive, and globally each tonne of crude steel results in around 1.4 t of direct CO_2 emissions on average, and 0.6 t of indirect CO_2 emissions on a sectoral basis (IEA, 2020). The focus of the analysis is on crude steel, as the vast majority of the sectors' emissions are attributed to upstream processes, while about 12% of emissions stem from downstream processes like foundry casting, hot rolling, cold rolling, surface treatment (tinning and galvanizing) and further processing[15].

The intensities vary significantly depending on the production technology routes. The two main routes include blast furnace-basic oxygen furnace (BF-BOF) and electric arc furnace (EAF), which together account for 95% of global steel production. The blast furnace-basic oxygen furnace (BF-BOF) is the most common primary production pathway, accounting for around 70% of global steel production and around 90% of primary production.

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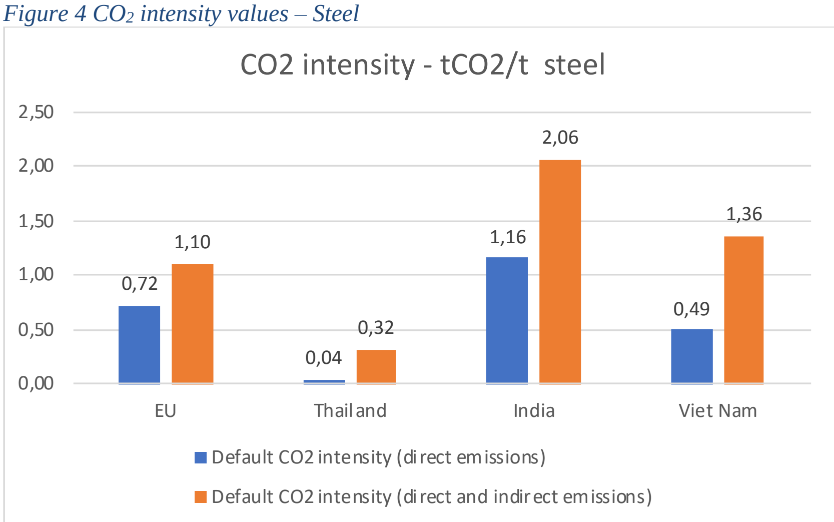
[15] "According to a rough estimation of Eurofer, about 88% of the sector's CO_2 emissions can be attributed to the production of only coke, sinter, BOF crude steel and EAF crude steel, while the remaining 12% stem from downstream processes like foundy casting, hot rolling, cold rolling, surface treatment (tinning and galvanizing) and further processing." Source: p.9 in: https://ec.europa.eu/clima/sites/clima/files/ets/allowances/docs/bm_study-iron_and_steel_en.pdf

Electric arc furnaces (EAFs) are the most commonly used furnace for scrap-based production. EAFs are also used for the other main method of primary steel production, the direct reduced iron-electric arc furnace (DRI-EAF) route. The DRI-EAF route accounts for a negligible share of production in the EU and is not deployed in neither Thailand nor Vietnam. DRI-EAF production is common, however, in India, where it accounts for an estimated 26% of total production (IEA, 2019). Also, when deriving emissions intensities for India, a further distinction needs to be made between the natural gas-based DRI-EAF and the coal-based DRI-EAF route, the latter producing almost three times more direct emissions and a similar quantity of indirect emissions as its gas-based counterpart (IEA, 2020). More than 70% of the global DRI-EAF plants use natural gas, however DRI production in India is primarily (80%) coal-based (Indian Steel Ministry, 2020).

For the case of the steel sector, emissions intensities are estimated by weighting the emission intensities of specific production technologies (BF-BOF, scrap-based EAF and DRI-EAF) from IEA (2020) to the production mix by process technology in each country based on World Steel Association (2019), IEA (2019), and Indian Ministry of Steel (2020) data.

The figure below presents CO_2 intensity values in relation to the production of crude steel in the EU, Thailand, India and Vietnam, taking into account the production routes employed in each country.

Figure 4 CO_2 intensity values – Steel

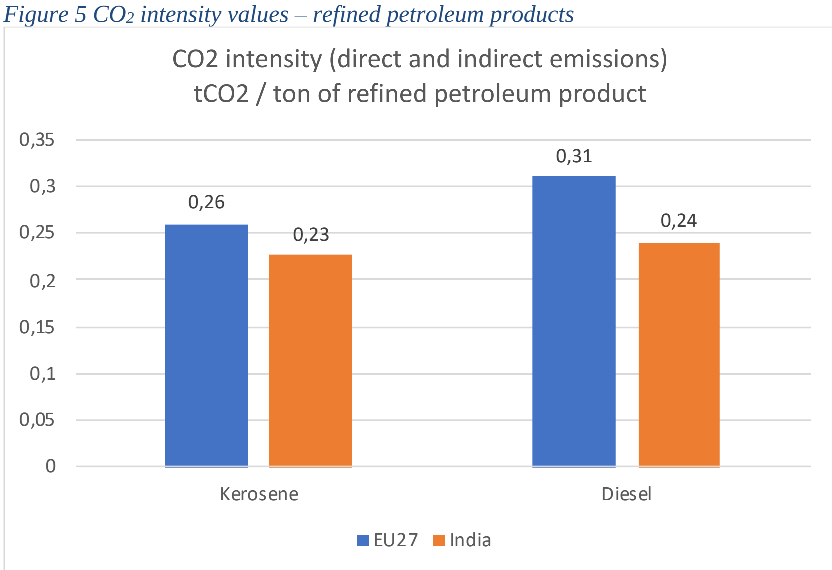


Source: ERCST own elaboration based on IEA (2019), IEA (2020), Central Electricity Authority (2019), Indian Ministry of Steel (2020), European Environment Agency (2020), World Bank (2018), World Steel Association (2019)

CO2 intensity – refined petroleum products

The figure below presents CO_2 intensity values for kerosene and diesel. Given the interchangeability of fuel and electricity in refineries, whereby either fuel or electricity can be used to produce heat or mechanical energy for the production of an equivalent product, only total CO_2 intensities are provided.

Figure 5 CO_2 intensity values – refined petroleum products



Source: ERCST own elaboration based on Concawe (2017), and CEEW (2021)

Estimating CO_2 intensities associated with the production of individual refined petroleum products is a challenging and complex exercise given that the refining sector involves co-production of different products through a combination of interrelated processes.

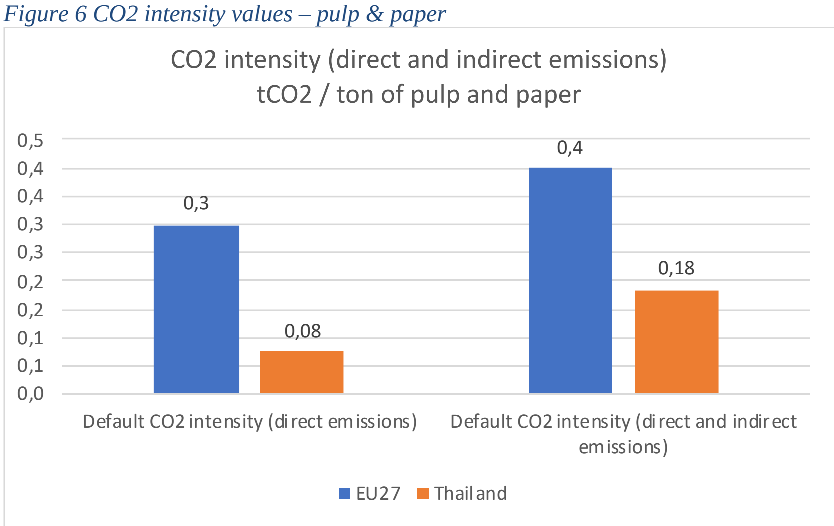
For EU CO_2 intensity values, we rely on work by the JEC consortium (JRC-Eucar-Concawe) that has developed a model to allocate emissions to specific products for the EU refining sector. Average CO_2 intensities for India have been calculated by CEEW based on refinery data by the Indian Petroleum and Natural Gas Statistics (2017-18), refining emissions, energy density of fuels, and crude conversion rates.

Since energy accounts for more than 50% of operating costs, EU refineries are on average amongst the most efficient in the world, only bettered by the new super scale Asian export refineries (Concawe, 2019, p.18), with an average energy intensity of about 90% of that in the EU. In reality, CO_2 intensity and energy performance varies per refinery in Europe and globally.

CO2 intensity – pulp and paper

The figure below presents CO_2 intensity values in the pulp & paper sector in the EU and Thailand respectively. Intensity values are sourced from the European association representing the paper industry (Cepi) and Thailand Greenhouse Gas Management Organization's Carbon Footprint Database.

Figure 6 CO2 intensity values – pulp & paper

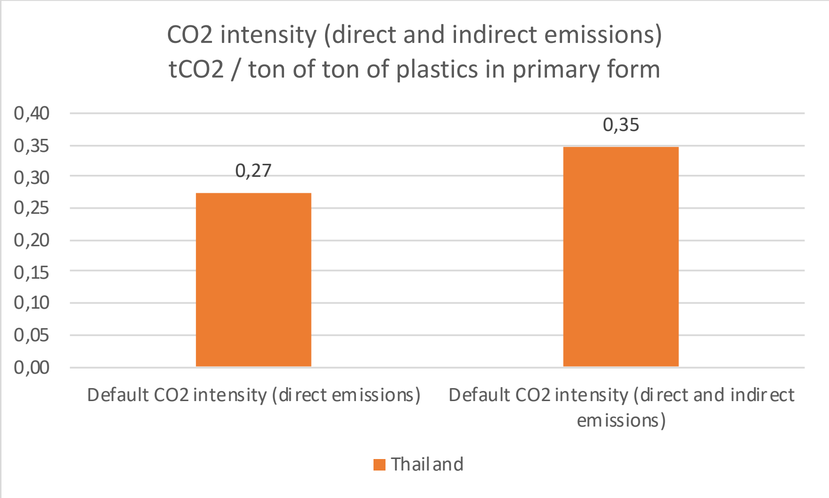


Source: ERCST own elaboration based on CEPI (2020), Thailand Greenhouse Gas Management Organization's Carbon Footprint Database

CO2 intensity – plastics in primary forms

The figure below presents CO_2 intensity values concerning 'plastics in primary forms' sourced from Thailand Greenhouse Gas Management Organization's Carbon Footprint Database.

Figure 7 CO_2 intensity values – plastics in primary forms



Source: ERCST own elaboration based on data from Thailand Greenhouse Gas Management Organization's Carbon Footprint Database

We note the lack of data for EU carbon intensity for the case of plastics in primary forms, and hence for this case only Scenarios 2 and 5 are analyzed in the subsequent chapters of the report.

4.3. CO2 intensity by country or region

This section presents CO_2 intensity values in a concise table format, this time organized by country. The following four tables denote the calculated CO_2 intensity values concerning the selected sectors in the EU, Thailand, India and Viet Nam respectively.

Table 7 CO_2 intensity values - EU

	Default CO_2 intensity (direct emissions) tCO_2 / ton product	**Default CO_2 intensity (direct & indirect emissions)** tCO_2 / ton product
Cement	0,63	0,66
Primary Aluminium	1,79	3,50
Steel	0,72	1,10
Kerosene	n/a	0,26
Diesel	n/a	0,31
Pulp & paper	0,30	0,40

Source: ERCST own elaboration based on WBCSD (2020), European Environment Agency (2020), International Aluminium Institute (2018), International Aluminium Institute (2017), World Bank (2014), IEA (2020), World Steel Association (2019), Concawe (2019), CEPI (2020)

Table 8 CO_2 intensity values - Thailand

	Default CO_2 intensity (direct emissions) tCO_2 / ton product	**Default CO_2 intensity (direct & indirect emissions)** tCO_2 / ton product
Cement	0,81	0,86
Primary Aluminium	1,9	9,5
Steel	0,04	0,32
Pulp and paper	0,08	0,18
Plastics in primary forms	0,27	0,35

Source: ERCST own elaboration based on International Aluminium Institute (2018), International Aluminium Institute (2017), IEA (2020), World Bank (2014), WBCSD (2020), Thailand Greenhouse Gas Management Organization's Carbon Footprint Database

Table 9 CO_2 intensity values - India

	Default CO_2 intensity (direct emissions) tCO_2 / ton product	**Default CO_2 intensity (direct & indirect emissions)** tCO_2 / ton product
Cement	0,58	0,64
Primary Aluminium	1,9	13,3
Steel	1,16	2,06
Kerosene	n/a	0,23
Diesel	n/a	0,24

Source: ERCST own elaboration based on Central Electricity Authority (2019), CEEW (2021), Concawe (2019), IEA (2019), IEA (2020), International Aluminium Institute (2018), International Aluminium Institute (2017), World Bank (2014), WBCSD (2020), World Steel Association (2019)

Table 10 CO_2 intensity values - Viet Nam

	Default CO_2 intensity (direct emissions) tCO_2 / ton product	**Default CO_2 intensity (direct & indirect emissions)** tCO_2 / ton product
Cement	0,73	0,80
Primary Aluminium	1,9	13,4
Steel	0,49	1,36

Source: ERCST own elaboration based on IEA (2020), International Aluminium Institute (2018), International Aluminium Institute (2017), Nordic Partnership Initiative (2014), World Bank (2014), World Bank (2018), WBCSD (2020), World Steel Association (2019)

5. Results

This chapter presents results obtained with respect to CO_2 emissions volumes (section 5.1), as well as CBAM costs and associated competitiveness losses (section 5.2). It also provides a discussion on possible GDP losses (or gains) related to the implementation of CBAM in the selected sectors (section 5.3).

5.1. CO_2 emission volumes of carbon intensive products

We estimate CO_2 emissions embedded in exports from the three countries to the EU27 as the product of the CO_2 intensity values presented in section 4, as well as Eurostat data on the volume of exports from the three respective countries to the EU27 (see Table 5):

$$\textit{CO}_2 \textit{ emissions embedded in exports of product } i = \textit{CO}_2 \textit{ intensity}_{\textit{product } i} \textit{ (tCO2/t of product)} * \textit{exports volume}_{\textit{product } i} \textit{ (tons)}$$

The results distinguish between direct (Scope 1) and indirect emissions from electricity and heat (Scope 2) embedded in exports from the three countries. Emissions results are presented for the possible three CBAM design choices with respect to the default (average) CO_2 intensity value applied to exports:

a. EU average CO_2 intensity values ($EU_{CO2intensity}$),
b. Exporting country-specific CO_2 intensity values ($nonEU_{CO2intensity}$),
c. The differential between average intensity values in the exporting country and the EU ($\Delta_{CO2intensity}$). This option implies that CBAM aims to incite alignment of foreign producers to EU production standards.

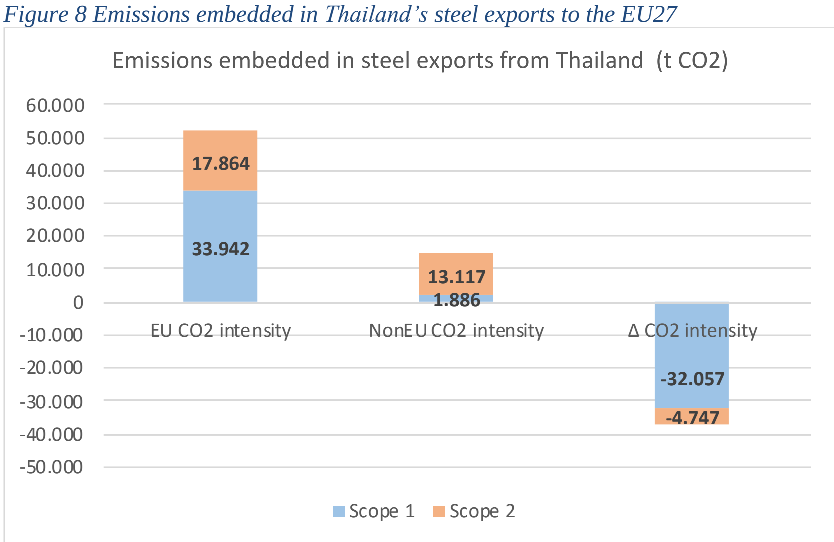
Thailand

When using Thailand-specific carbon intensities, a total of 84.185 tCO_2 are embedded in Thailand's exports of cement, steel and aluminium to the EU, of which 15.471 tCO2 direct emissions and 68.715 tCO_2 indirect. When pulp & paper, and plastics in primary forms are also taken into account, the total amounts to 163.187 tCO_2 of which 50.109 direct emissions and 113.078 tCO_2 indirect.

The breakdown by sector is presented in the following figures. Figure 8, Figure 9, and Figure 10 present the total CO_2 embedded in Thailand's exports of steel, aluminium, cement, pulp & paper, and plastics in primary forms respectively.

Emissions embedded in exports of steel are lower when Thailand-specific intensity values are used, given that total production in Thailand is based on scrap-based EAF technology, which is less CO_2 intensive when compared to BF-BOF technology that is used for a significant part of the EU production in addition to scrap-based EAF.

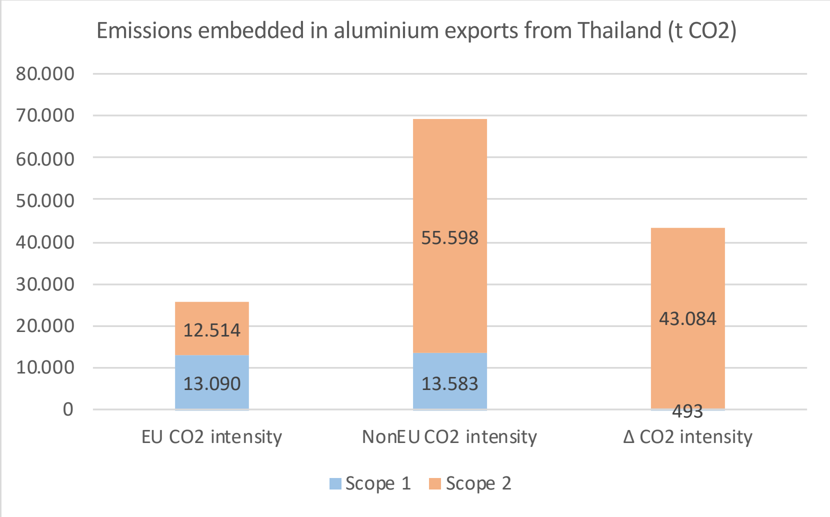
Figure 8 Emissions embedded in Thailand's steel exports to the EU27



Source: ERCST own elaboration

For aluminium, indirect emissions are significantly higher when Thailand-specific intensity values are used, given the high electro-intensity of aluminium production (circa 15MWh/t) and a higher electricity emissions factor in Thailand compared to the EU.

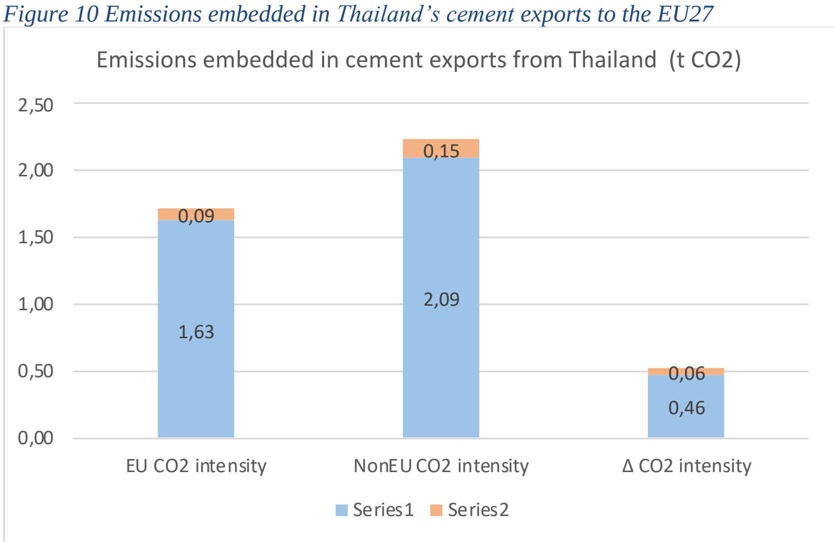
Figure 9 Emissions embedded in Thailand's aluminium exports to the EU27



Source: ERCST own elaboration

For cement, total emissions embedded in exports are negligible given the current level of exports from Thailand to the EU. Notwithstanding, emissions are higher when Thailand-specific emissions intensity is used, reflecting a higher reliance of Thailand on the burning of fossil fuels such as coal and lignite for its cement industries (the use of alternative fuels and biomass residue, is growing but remains low).

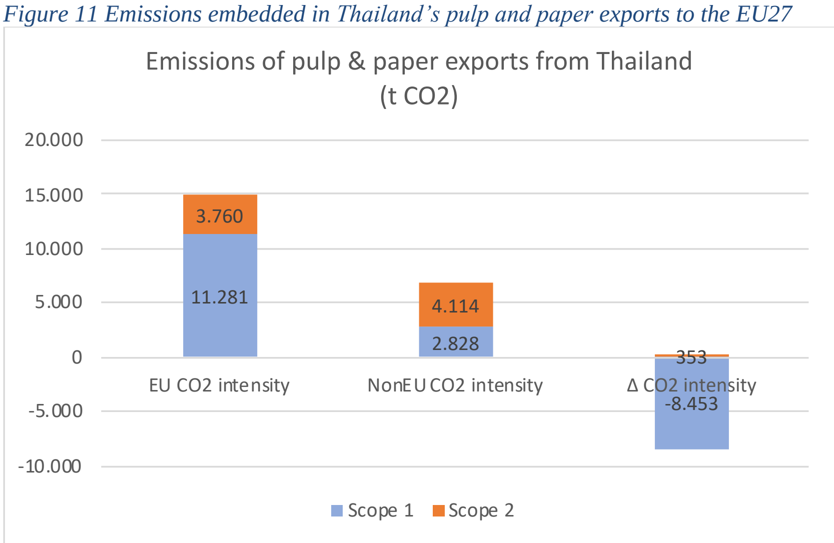
Figure 10 Emissions embedded in Thailand's cement exports to the EU27



Source: ERCST own elaboration

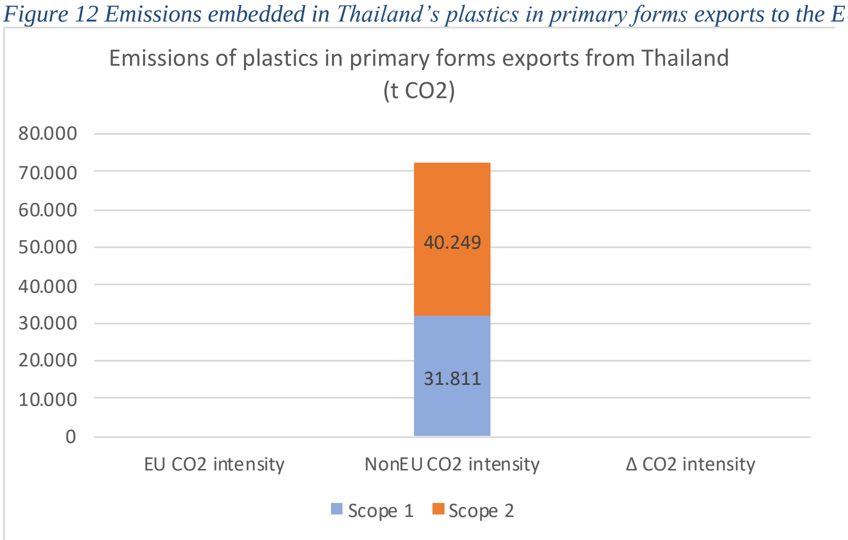
Emissions embedded in exports of pulp & paper, are lower when Thailand-specific intensity values are used (Figure 11), while for plastics emissions have been calculated only for the case of Thailand-specific intensity values (Figure 12).

Figure 11 Emissions embedded in Thailand's pulp and paper exports to the EU27



Source: ERCST own elaboration

Figure 12 Emissions embedded in Thailand's plastics in primary forms exports to the EU27



Source: ERCST own elaboration

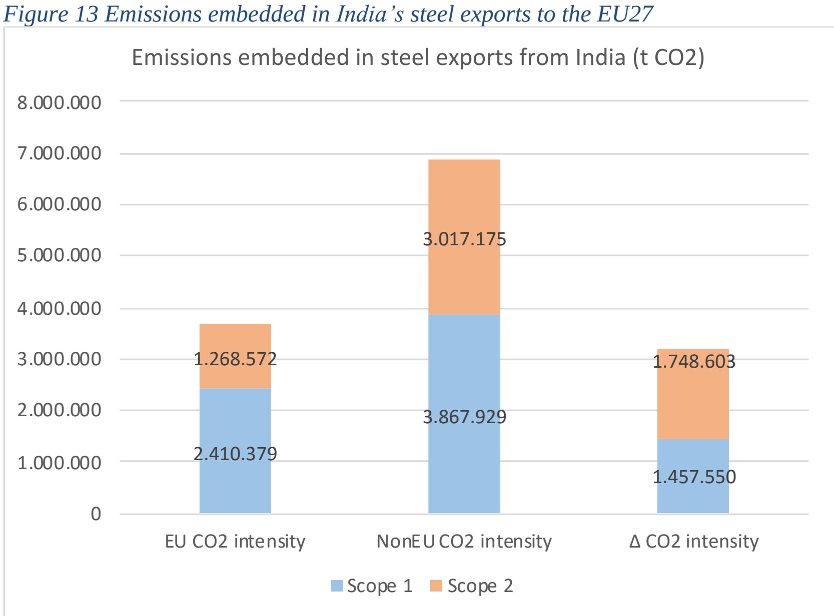
India

When using India-specific carbon intensities, a total of 10.615.911 tCO_2 are embedded in India's exports of cement, steel and aluminium to the EU, of which 4.395.880 tCO_2 direct emissions and 6.220.031 tCO_2 indirect. When refined petroleum products (kerosene and diesel) are also taken into account, the total amounts to 11.520.271 tCO_2.

Figure 13, Figure 14, Figure 15 and Figure 16 present the total CO_2 embedded in India's exports of steel, aluminium, cement, and refined petroleum products respectively.

For steel, emissions are more than double when Indian-specific intensities are used, reflecting a high share of the coal-based DRI-EAF production route in India.

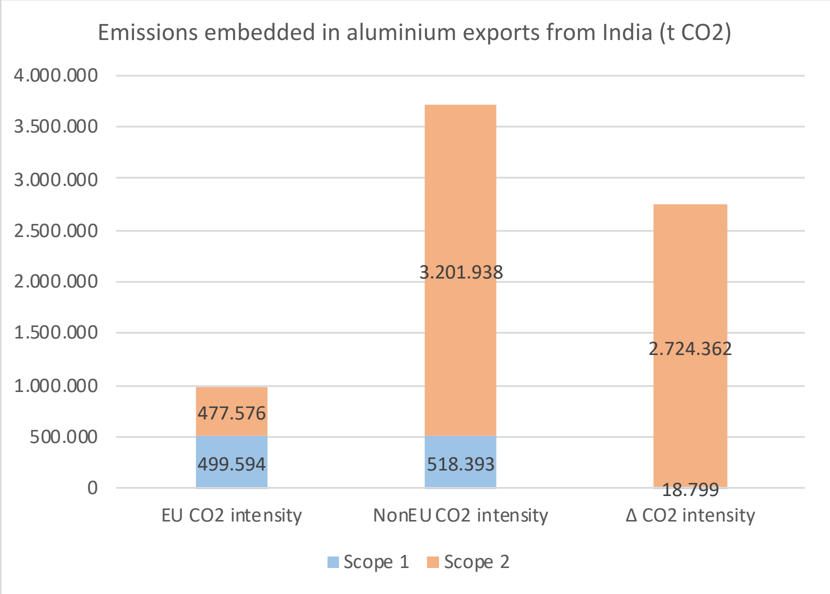
Figure 13 Emissions embedded in India's steel exports to the EU27



Source: ERCST own elaboration

For aluminium, indirect emissions are significantly higher when India-specific intensity values are used, given the higher electricity emissions factor in India when compared to the EU and the overall high electro-intensity of aluminium production (circa 15MWh/t).

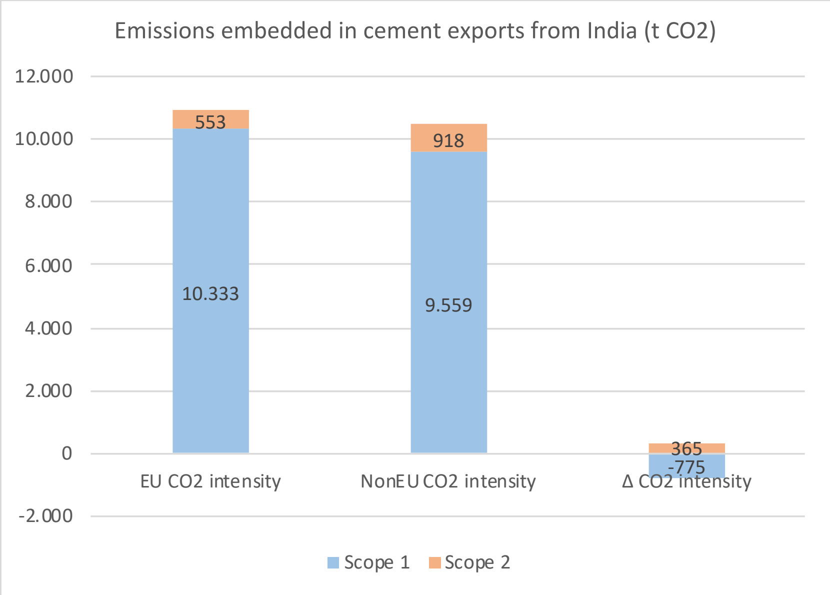
Figure 14 Emissions embedded in India's aluminium exports to the EU27



Source: ERCST own elaboration

For cement, direct emissions are lower when Indian-specific intensity is used, reflecting possibly a more modern fleet than the one in the EU. Indirect emissions are higher when Indian-specific intensity is used. Although the sector's electricity intensity is lower in India when compared to the EU, the effect of a higher national grid emissions factor in India dominates.

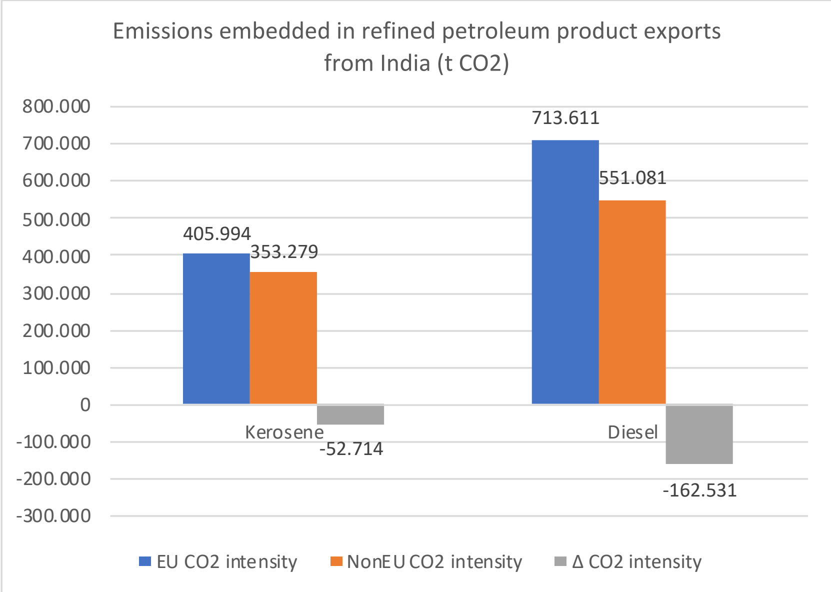
Figure 15 Emissions embedded in India's cement exports to the EU27



Source: ERCST own elaboration

Finally, for refined petroleum products, emissions are lower when Indian-specific intensity is used, reflecting the fact that the new super scale Asian export refineries are the most efficient in the world (Concawe, 2019, p.18).

Figure 16 - Emissions embedded in India's exports of refined petroleum products to the EU27



Source: ERCST own elaboration

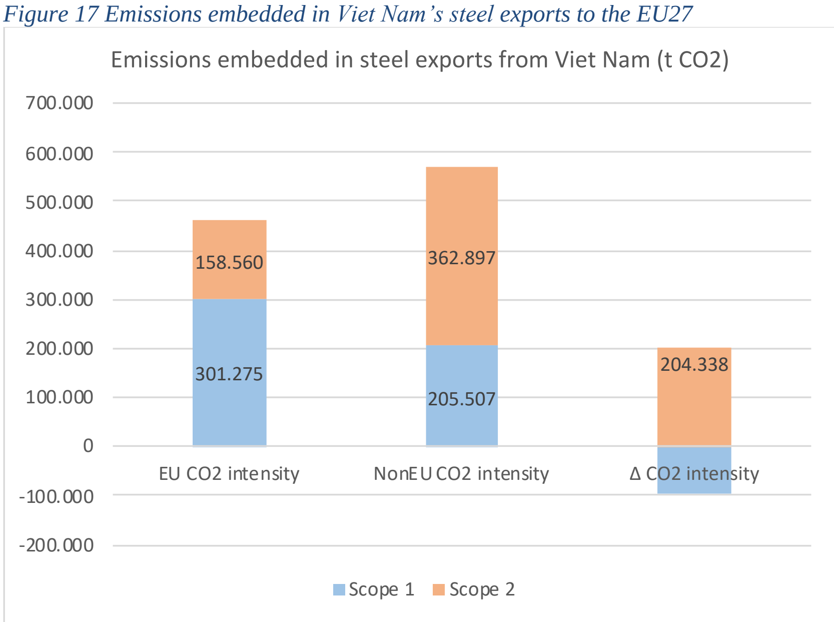
Viet Nam

When using Vietnam-specific carbon intensities, a total of 869.704 tCO_2 are embedded in Vietnam's exports of cement, steel and aluminium to the EU, of which 379.995 tCO2 direct emissions and 489.708 tCO_2 indirect.

Figure 17, Figure 18, and Figure 19 present the total CO_2 embedded in Viet Nam's exports of steel, aluminium and cement respectively.

For steel, direct emissions are lower when Vietnam-specific direct intensity values are used, because of a higher share of scrap-based EAF technology in the country compared to the EU, which is less CO_2 intensive when compared to BF-BOF technology. Indirect emissions are however higher when Vietnam-specific direct intensity values are used, largely owing to the high national grid emissions factor.

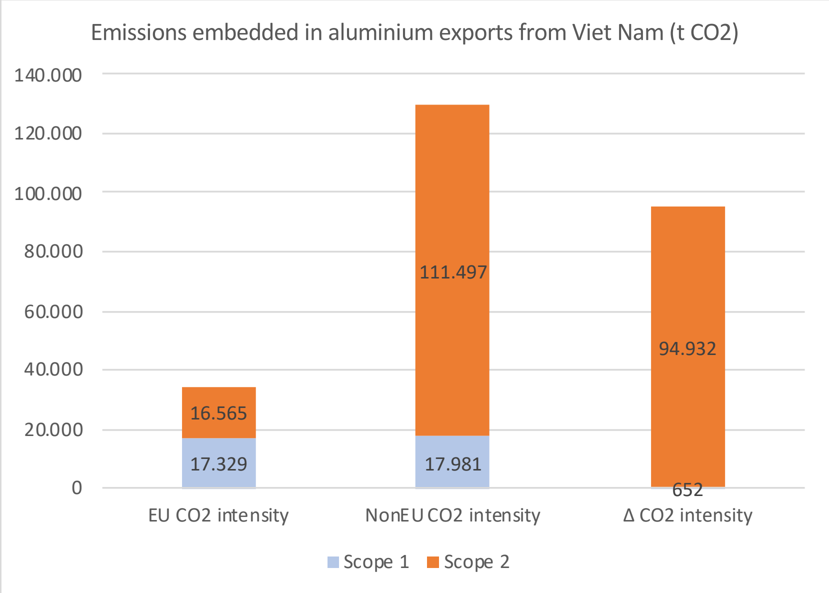
Figure 17 Emissions embedded in Viet Nam's steel exports to the EU27



Source: ERCST own elaboration

For aluminium, indirect emissions are significantly higher when Vietnam-specific intensity values are used, given the higher electricity emissions factor in the country when compared to the EU and the overall high electro-intensity of aluminium production (circa 15MWh/t).

Figure 18 Emissions embedded in Viet Nam's aluminium exports to the EU27

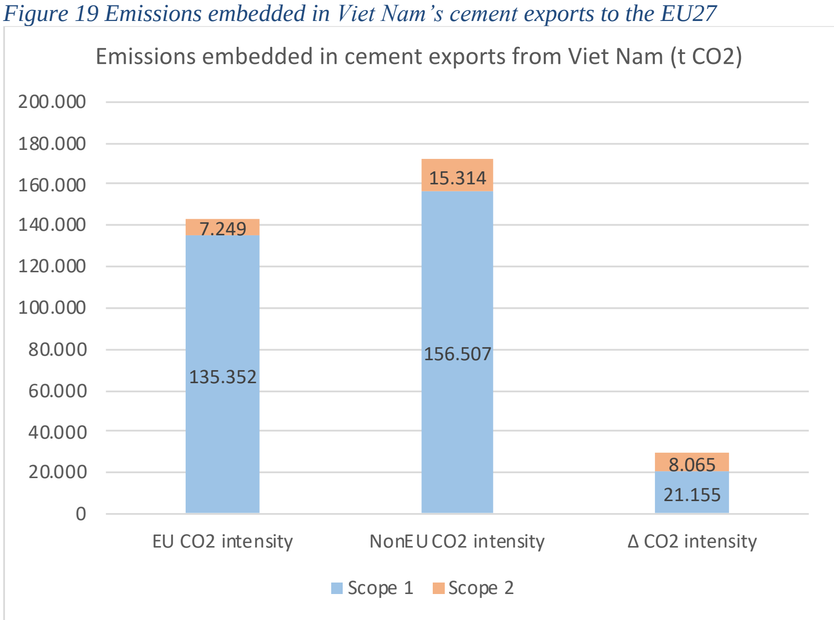


Source: ERCST own elaboration

For cement, the higher emissions when using Vietnam-specific intensity values reflect a combination of a relatively high thermal energy intensity with the use of CO_2 intensive fuels by the Vietnamese cement industry: As of 2014, the Vietnamese industry used virtually exclusively coal, as the source of thermal energy for the clinker kilns, with about 1% or less biomass and waste as alternative fuels. It was found that even some of the more recent installations consumed more thermal energy per ton of clinker compared to older ones. Although the Vietnamese cement sector had deployed modern BAT PHPC installations, it did not reach the thermal efficiency achievable with this modern technology, with evidence suggesting that individual smaller and less experienced companies lacked the technical and operational knowledge and competence to efficiently run the installations (Nordic Partnership Initiative, 2014). The situation might be expected to improve in the future, as Vietnam brought the cement sector into its 2020 submission of its climate plan to the UN[16].

[16] Climate Home News, 'Vietnam brings cement sector into new climate submission to the UN', 14/09/2020 https://www.climatechangenews.com/2020/09/14/vietnam-brings-cement-sector-new-climate-submission-un/

Figure 19 Emissions embedded in Viet Nam's cement exports to the EU27



Source: ERCST own elaboration

5.2. Costs and competitiveness losses potentially incurred by exporters

This section presents the costs and competitiveness losses that could potentially be incurred by companies in countries under study if CBAM was put in place. In particular, for each country the study assesses the potential CBAM payments (additional fiscal burden) that may arise from CBAM introduction, based on forecasted CO_2 emission prices and emission volumes.

Further, as an index of competitiveness losses, the study estimates the share of CBAM payment for a ton of product to current product prices (whereby unit prices are approximated as the share of export values to export volumes based on Eurostat data). This index is limited by the fact that it assumes zero pass through of CBAM costs to prices.

As explained in section 2.2, the results for the selected sectors are presented for six scenarios that reflect possible options with respect to two CBAM core design elements:

1. **CO_2 intensity**, with the choice of applicable default (average) CO_2 intensity values being:
   a. EU average ($EU_{CO2intensity}$) ;
   b. Exporting country-specific average ($nonEU_{CO2intensity}$);
   c. The differential between average intensity values in the exporting country and the EU ($\Delta_{CO2intensity}$). This option implies that CBAM aims to incite alignment of foreign producers to EU production standards.

2. **CO_2 price at the border (level of adjustment)**, and whether CBAM:
    a. will account for crediting of foreign policies entailing a carbon price in exporting countries ($\Delta_{CO2\ price}$); or
    b. the full EU carbon price will be applied to exports ($EUA_{CO2price}$).

The six scenarios are summarized in in section 2.2, Table 1.

Thailand

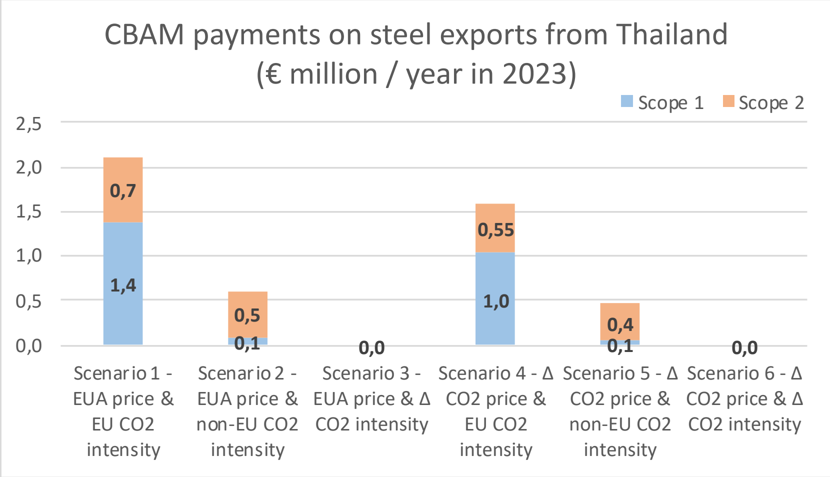
Potential CBAM payments (additional fiscal burden)

When using Thailand-specific carbon intensities, CBAM costs amount to a total of EUR 109 million for the three sectors of steel, cement and aluminium, of which about EUR 21 million for direct emissions and about EUR 87 million for indirect. When pulp & paper, and plastics in primary forms are also taken into account, the total CBAM cost amounts to EUR 111 million of which EUR 23 million are for direct emissions and EUR 88 million are for indirect.

Figure 20, Figure 21, Figure 22, and Figure 23 present the total potential CBAM payments for Thailand's exports of steel, aluminium, pulp & paper, and plastics in primary forms respectively[17].

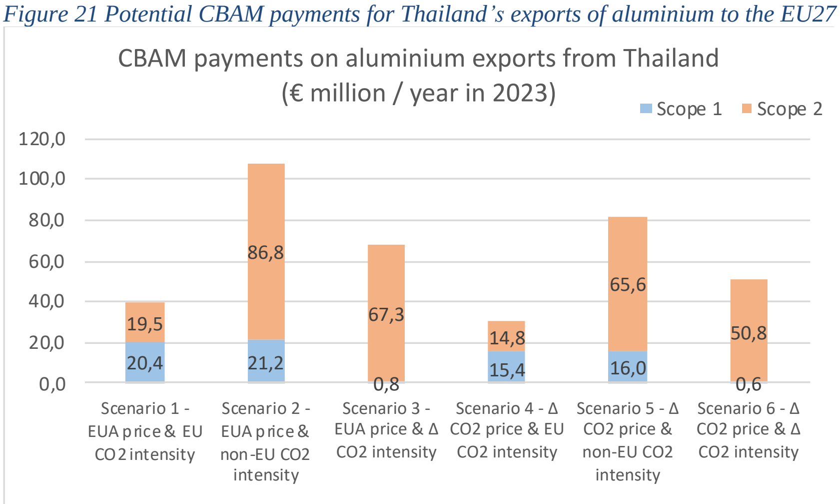
[17] Export volumes of cement from Thailand to the EU27, total emissions embedded in these exports, and hence total CBAM payments amount to insignificant figures (total CBAM payments under any of six scenarios would be below EUR 600). We therefore refrain from presenting a graph on total CBAM payments in this case. Notwithstanding, the cement industry is a vital part of the Thai economy, and therefore it is still worth exploring the CBAM payments per ton of product and the impact of an EU CBAM on competitiveness (see ensuing sub-section).

Figure 20 Potential CBAM payments for Thailand's exports of steel to the EU27



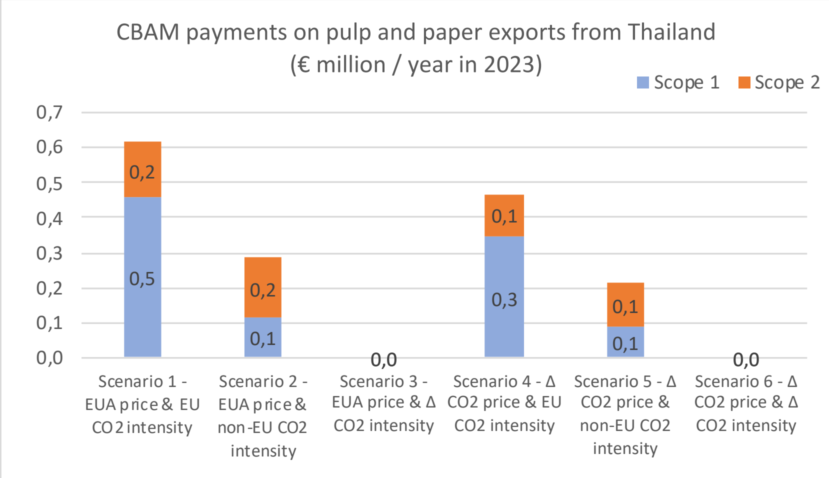
Source: ERCST own elaboration

Figure 21 Potential CBAM payments for Thailand's exports of aluminium to the EU27



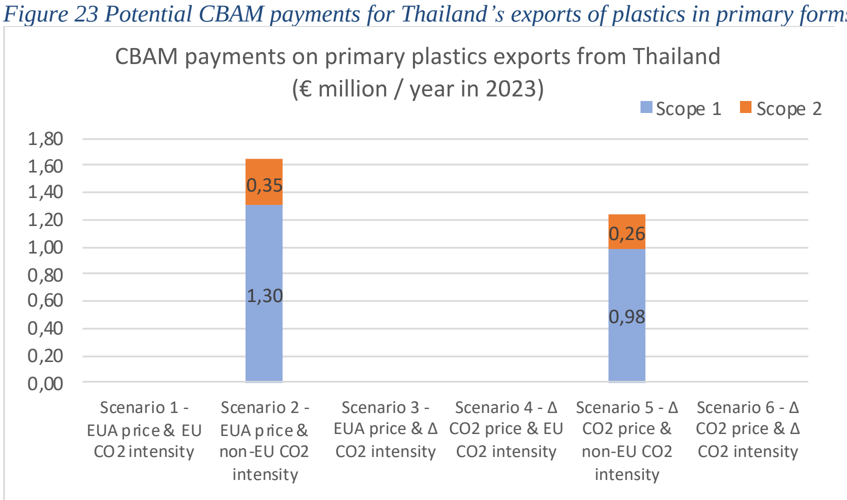
Source: ERCST own elaboration

Figure 22 Potential CBAM payments for Thailand's exports of pulp and paper to the EU27



Source: ERCST own elaboration

Figure 23 Potential CBAM payments for Thailand's exports of plastics in primary forms to the EU27



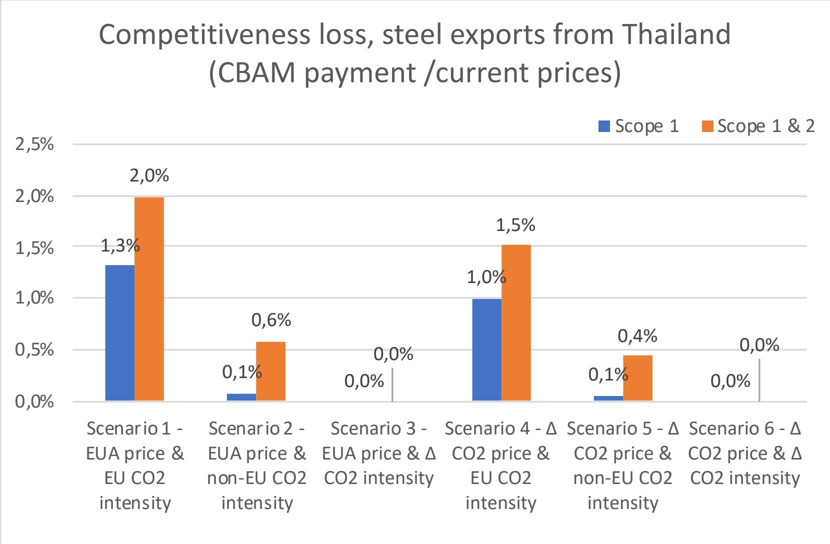
Source: ERCST own elaboration

Competitiveness losses

Figure 24, Figure 25, and Figure 26 present estimates of competitiveness losses that could potentially be incurred by Thailand if an EU CBAM was, expressed as the share of CBAM payments for a ton of steel, aluminium and cement, to current product prices. Similarly, Figure 27 and Figure 28 present the share of CBAM payments for a ton of product to current prices for the case of pulp & paper and plastics in primary forms.

For steel, CBAM payments represent up to 2% of current prices, under Scenario 1 when both direct and indirect emissions are taken into account.

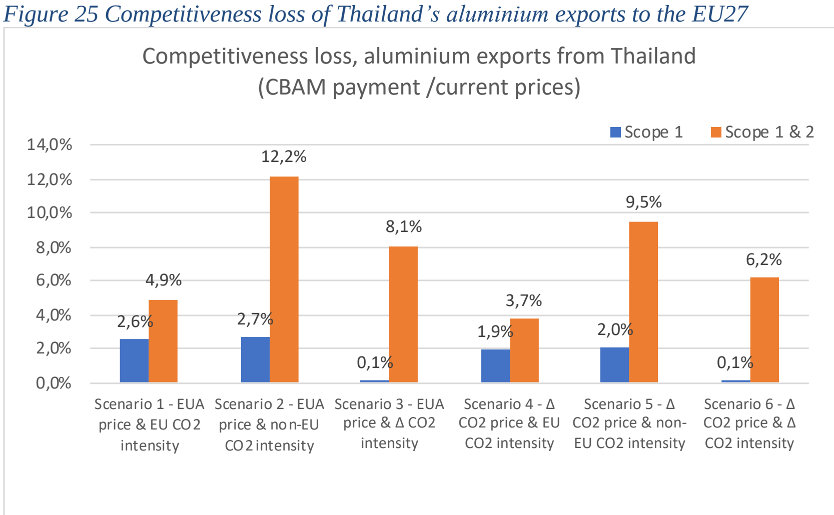
Figure 24 Competitiveness loss of Thailand's steel exports to the EU27



Source: ERCST own elaboration

For aluminium, CBAM payments represent up to 2.7% of current prices (Scenario 2) when direct only emissions are taken into account, and given the high electro-intensity of the sector up to 12,2% when both direct and indirect emissions are taken into account.

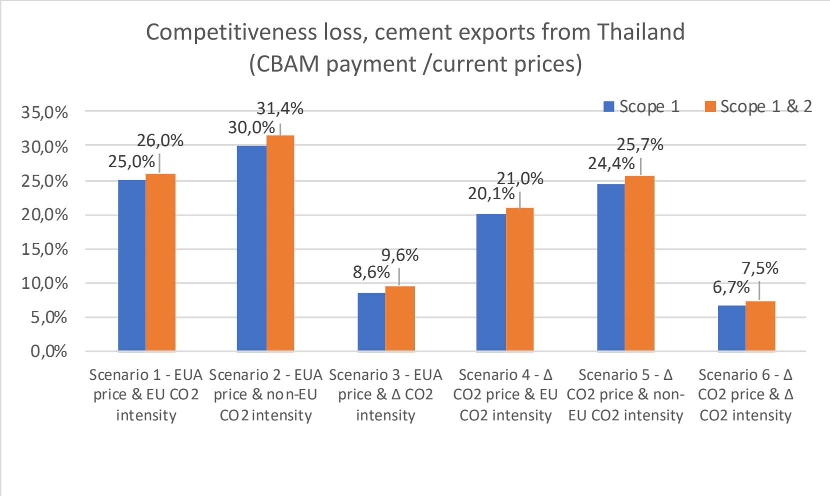
Figure 25 Competitiveness loss of Thailand's aluminium exports to the EU27



Source: ERCST own elaboration

For cement, CBAM payments as a share of current prices represent up to 30% when direct only emissions are considered, and up to 31,5% when both direct and indirect emissions are taken into account[18][19].

Figure 26 Competitiveness loss of Thailand's cement exports to the EU27



Source: ERCST own elaboration

For pulp & paper, CBAM payments as a share of current prices represent up to 1,5% when direct only emissions are considered, and up to 2% when both direct and indirect emissions are taken into account.

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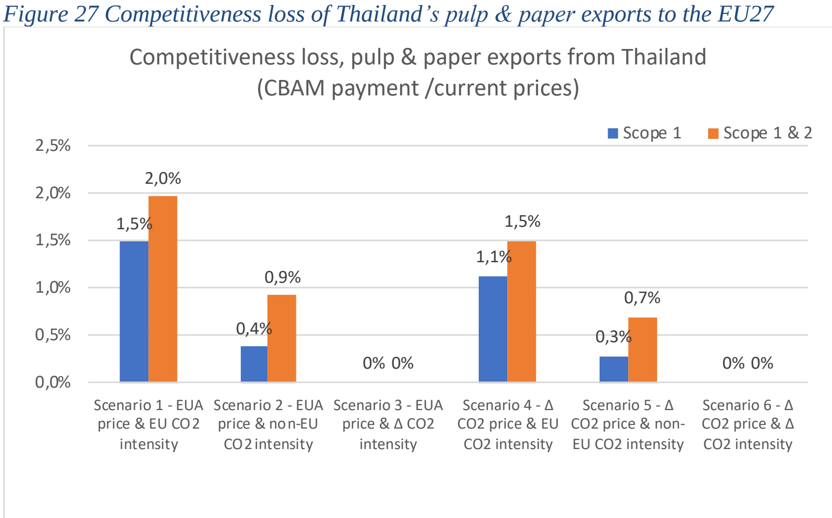
[18] For the case of cement, the average 2017-19 price of exports to the EU from all countries in the South East Asia region has been used rather than from Thailand alone, given the low exports volumes from the latter. The price has been derived by dividing the exports value by the exports quantity from the region.

[19] Using instead carbon intensities based on GNR data would result in slightly lower competitiveness losses.

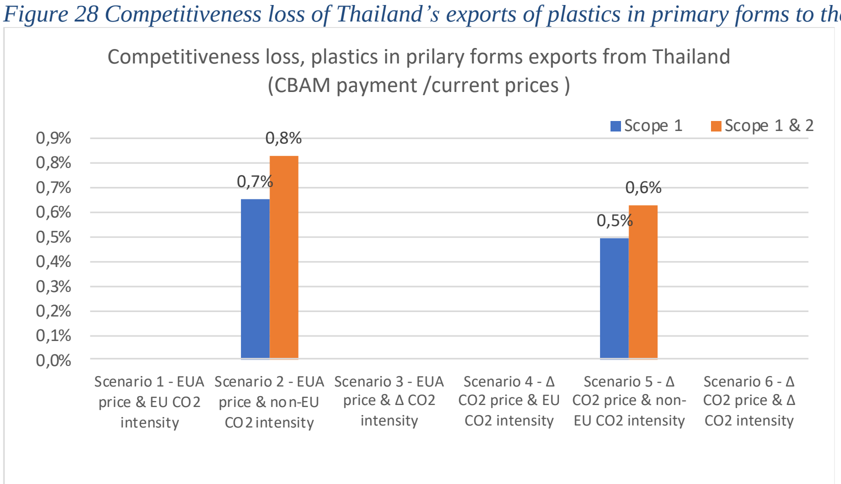
Figure 27 Competitiveness loss of Thailand's pulp & paper exports to the EU27



Source: ERCST own elaboration

For plastics in primary forms, CBAM payments as a share of current prices represent up to 0,7% when direct only emissions are considered, and up to 0,8% when both direct and indirect emissions are taken into account.

Figure 28 Competitiveness loss of Thailand's exports of plastics in primary forms to the EU27



Source: ERCST own elaboration

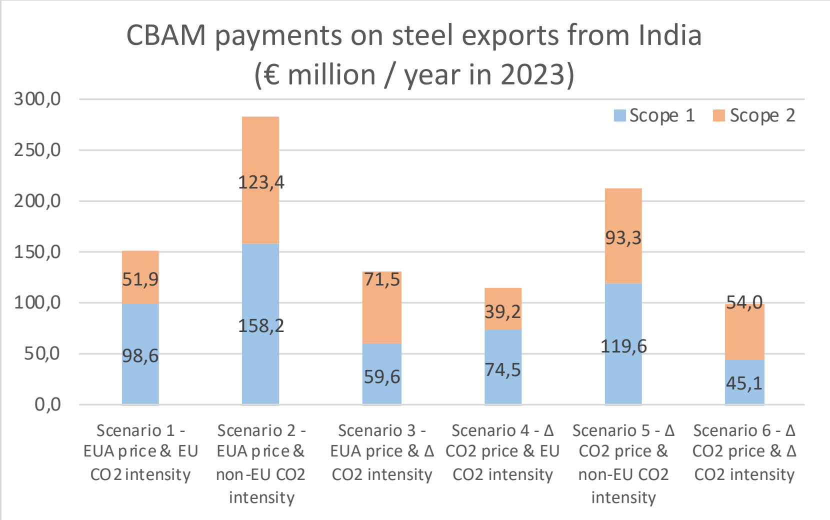
India

Potential CBAM payments (additional fiscal burden)

When using India-specific carbon intensities, CBAM costs amount to a total of EUR 434 million for the three sectors of steel, cement and aluminium, of which about EUR 180 million for direct emissions and about EUR 255 million for indirect. When refined petroleum products are also taken into account, the total CBAM cost amounts to EUR 471 million.

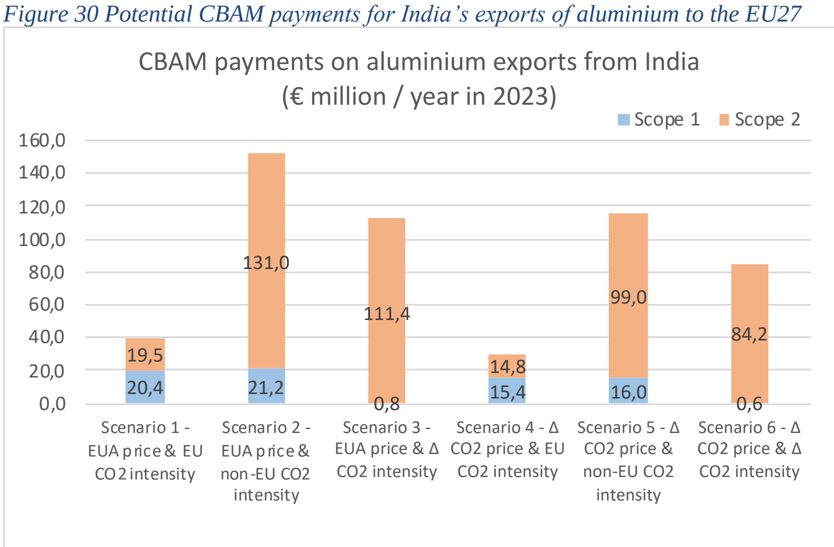
Figure 29, Figure 30, Figure 31, and Figure 32 present the total potential CBAM payments for India's exports of steel, aluminium, cement and refined petroleum products respectively.

Figure 29 Potential CBAM payments for India's exports of steel to the EU27



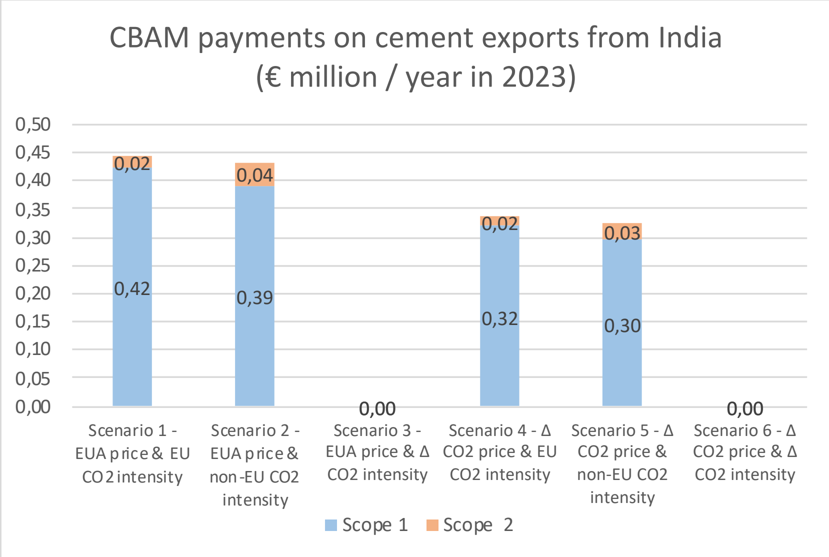
Source: ERCST own elaboration

Figure 30 Potential CBAM payments for India's exports of aluminium to the EU27



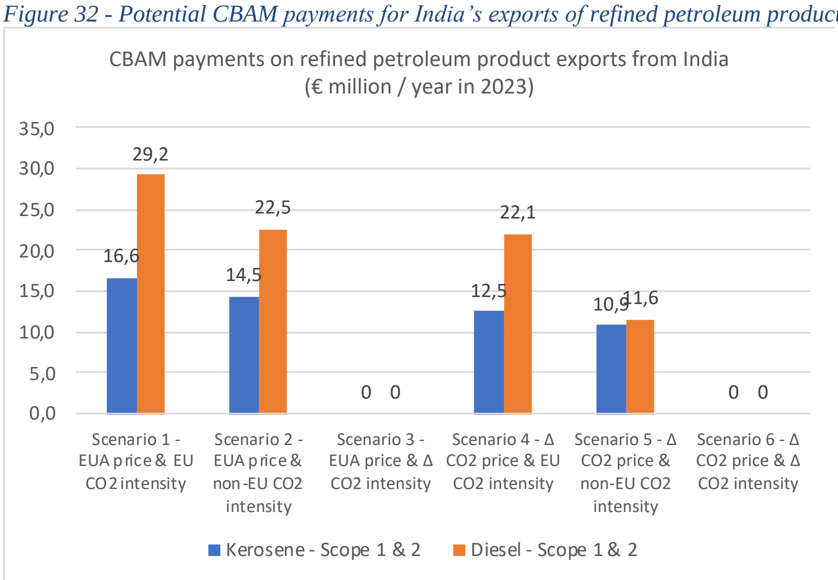
Source: ERCST own elaboration

Figure 31 Potential CBAM payments for India's exports of cement to the EU27



Source: ERCST own elaboration

Figure 32 - Potential CBAM payments for India's exports of refined petroleum products to the EU27



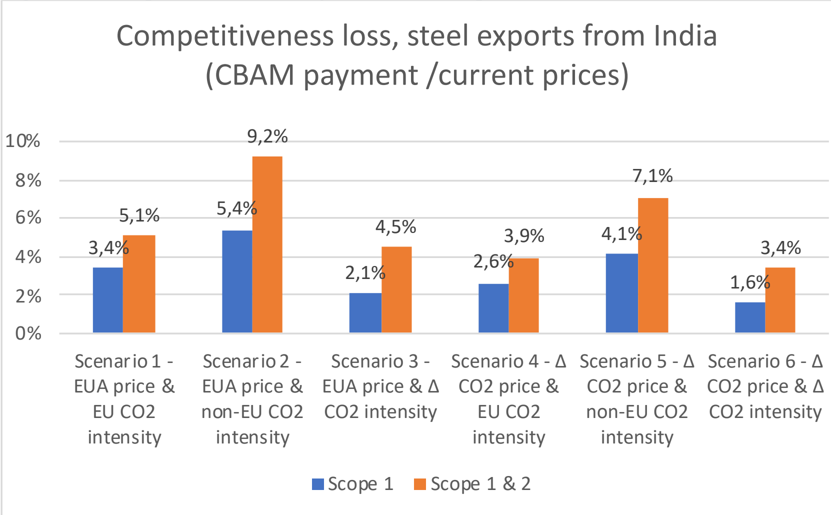
Source: ERCST own elaboration

Competitiveness losses

Figure 33, Figure 34, Figure 35, and Figure 36 estimate the competitiveness losses that could be potentially incurred by India if an EU CBAM was implemented, as the share of CBAM payments for a ton of steel, aluminium, cement, and refined petroleum products to current product prices.

For steel, CBAM payments represent up to 5,4% of current prices (under Scenario 2) when direct only emissions are taken into account, and up to about 9% when both direct and indirect emissions are taken into account.

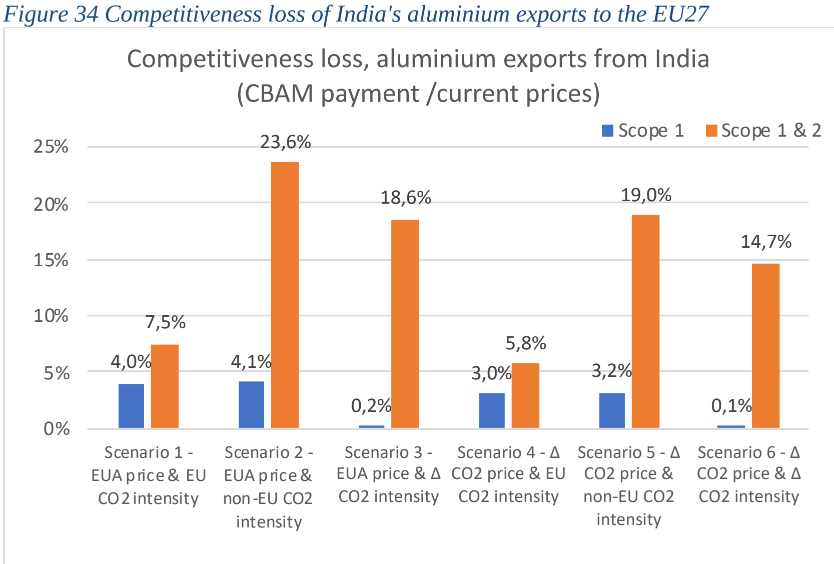
Figure 33 Competitiveness loss of India's steel exports to the EU27



Source: ERCST own elaboration

For aluminium, CBAM payments represent up to 4,1% of current prices (Scenario 2) when direct only emissions are taken into account, and given the high electro-intensity of the sector and high electricity emissions factor in the country up to nearly 24% when both direct and indirect emissions are taken into account.

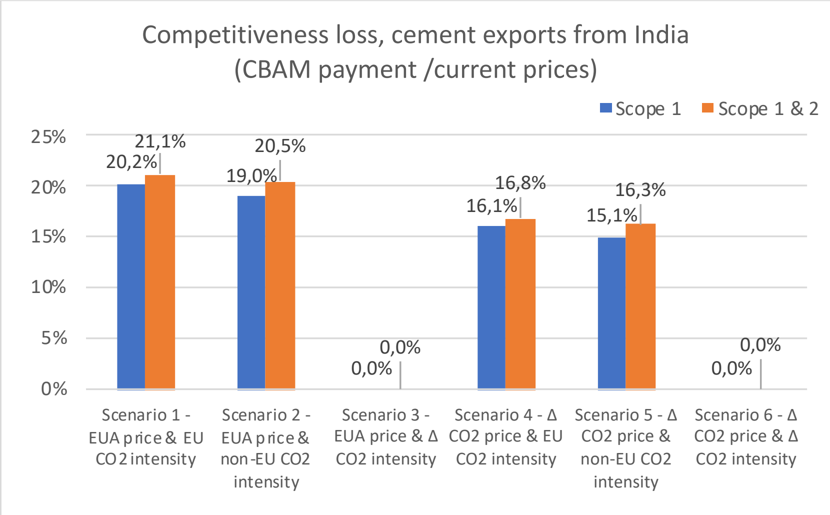
Figure 34 Competitiveness loss of India's aluminium exports to the EU27



Source: ERCST own elaboration

For cement, CBAM payments as a share of current prices represent up to 20% when direct only emissions are considered, and up to 21% when both direct and indirect emissions are taken into account.

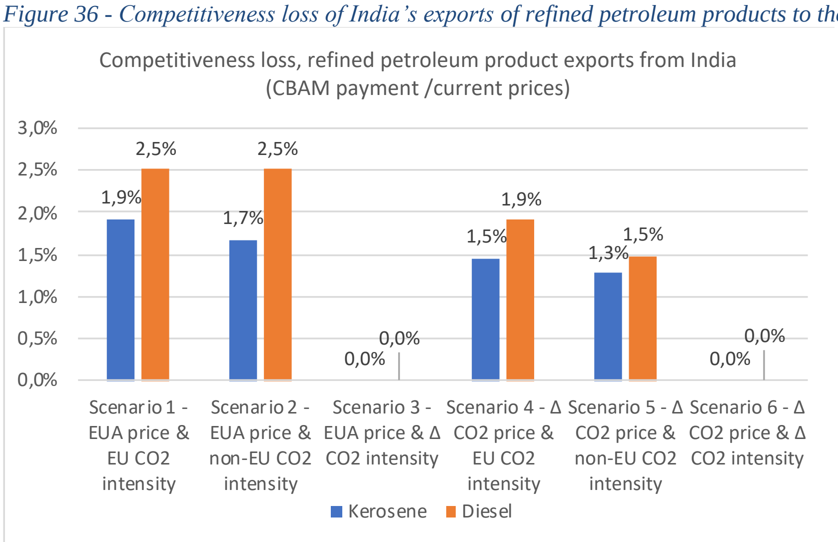
Figure 35 Competitiveness loss of India's cement exports to the EU27



Source: ERCST own elaboration

Finally, for refined petroleum products, CBAM payments as a share of current prices represent up to about 2% (for kerosene) and 2,5% (for diesel) when both direct and indirect emissions are taken into account.

Figure 36 - Competitiveness loss of India's exports of refined petroleum products to the EU27



Source: ERCST own elaboration

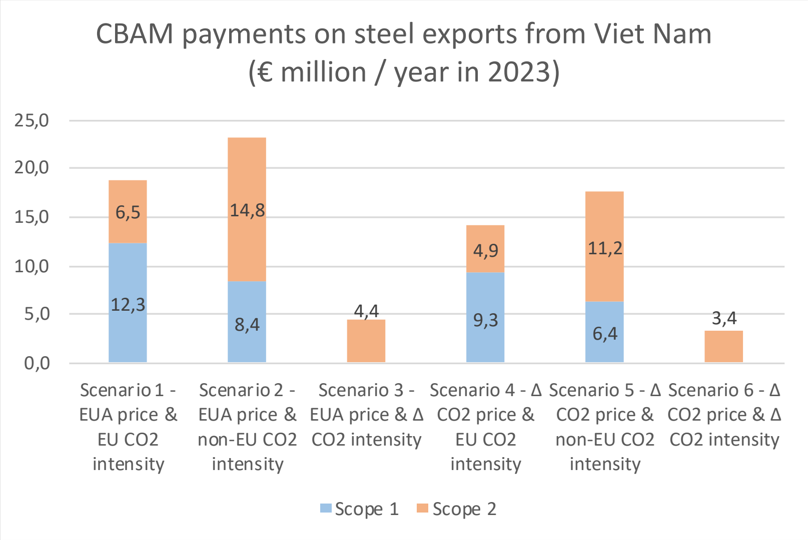
Viet Nam

Potential CBAM payments (additional fiscal burden)

When using Vietnam-specific carbon intensities, CBAM costs amount to a total of EUR 36 million for the three sectors of steel, cement and aluminium, of which about EUR 16 million for direct emissions and about EUR 20 million for indirect.

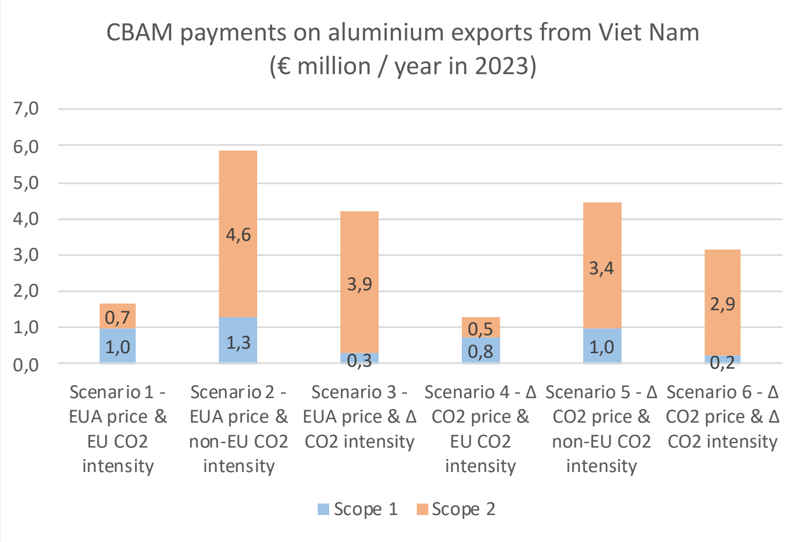
Figure 37, Figure 38, and Figure 39 present the total potential CBAM payments for Viet Nam's exports of steel, aluminium, and cement respectively.

Figure 37 Potential CBAM payments for Viet Nam's exports of steel to the EU27



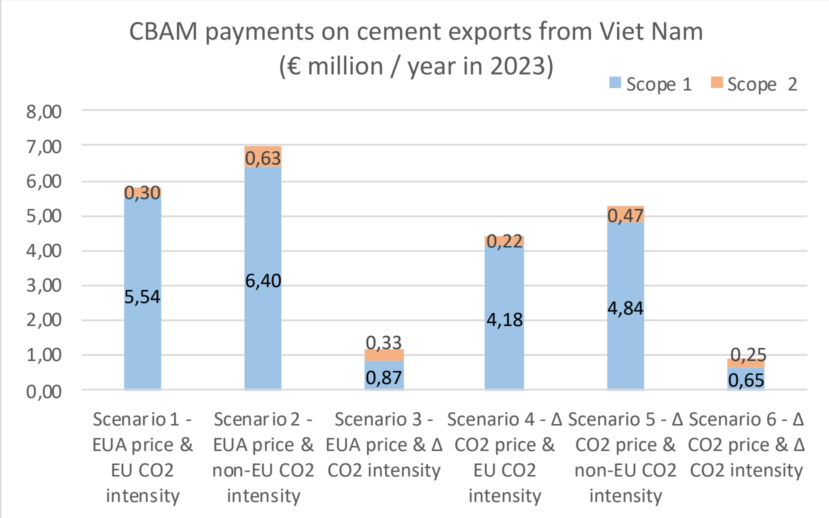
Source: ERCST own elaboration

Figure 38 Potential CBAM payments for Viet Nam's exports of aluminium to the EU27



Source: ERCST own elaboration

Figure 39 Potential CBAM payments for Viet Nam's exports of cement to the EU27



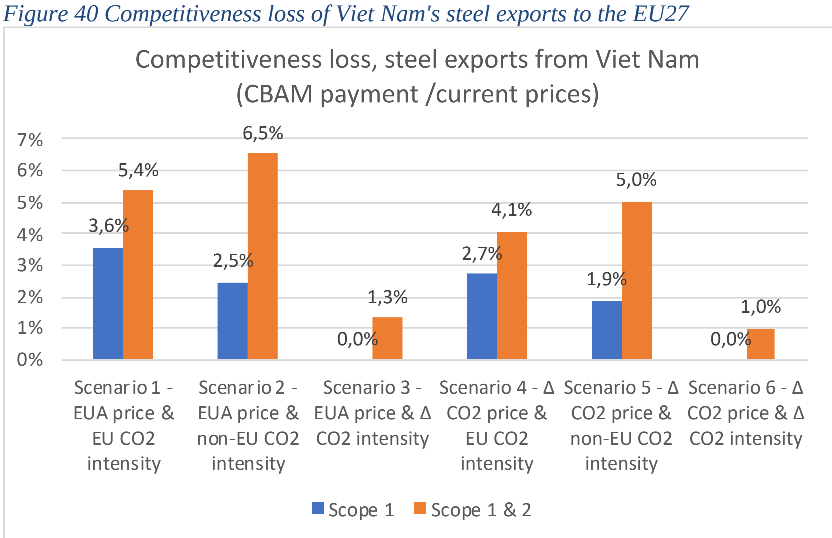
Source: ERCST own elaboration

Competitiveness losses

Figure 40, Figure 41, and Figure 42 present estimates of competitiveness losses that could potentially be incurred by Viet Nam if an EU CBAM was implemented, as the share of CBAM payments for a ton of steel, aluminium and cement, to current product prices.

For steel, CBAM payments represent up to 3,6% of current prices (under Scenario 1) when direct only emissions are taken into account, and up to 6,5% of current prices (under Scenario 2) when both direct and indirect emissions are taken into account.

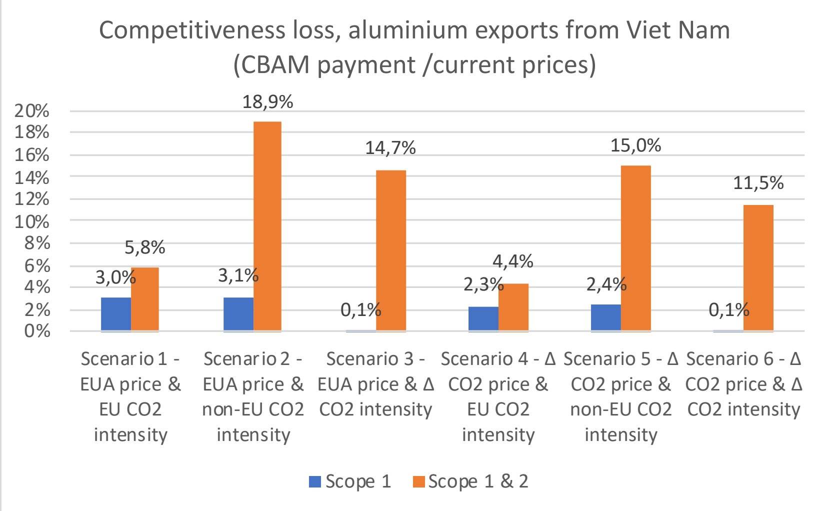
Figure 40 Competitiveness loss of Viet Nam's steel exports to the EU27



Source: ERCST own elaboration

For aluminium, CBAM payments represent up to 3,1% of current prices (Scenario 2) when direct only emissions are taken into account, and given the high electro-intensity of the sector and high electricity emissions factor in the country up to close to 19% when both direct and indirect emissions are taken into account (under Scenario 2).

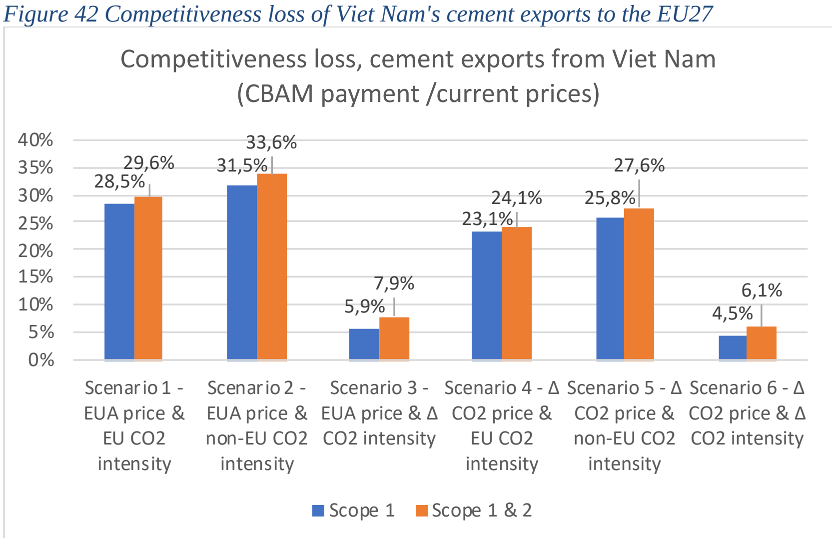
Figure 41 Competitiveness loss of Viet Nam's aluminium exports to the EU27



Source: ERCST own elaboration

Finally, for the case of cement, CBAM payments as a share of current prices represent up to 31,5% when direct only emissions are considered, and up to about 33,6% when both direct and indirect emissions are taken into account. The high share reflects a combination of a relatively high thermal energy intensity with the use of CO_2 intensive fuels by the Vietnamese cement industry:

Figure 42 Competitiveness loss of Viet Nam's cement exports to the EU27



Source: ERCST own elaboration

5.3. GDP losses related to the implementation of CBAM

The sectors likely to be covered by the CBAM currently enjoy free allocation of CO_2 allowances under the EU ETS. These are usually sectors with low pass-through ratios of the carbon price, since European industry has argued for free allocation to protect competitiveness with regards to non-European imports.

For sectors that fall in this category it can be anticipated that the simultaneous introduction of the CBAM and the removal of the free allocation of allowance for EU industry will lead to an increase in the pass through of the cost of CO_2. Thus, as long as CBAM level and carbon prices are aligned, the impact on the relative competitiveness is likely to be modest.

Notwithstanding, we assess the impact of the CBAM on the national GDP of the exporting countries as follows:

- → Impact on the relative competitiveness depends on unit carbon costs faced by exporters relative to the unit carbon costs faced by EU producers.
- → We therefore calculate GDP loss (or gain) as the delta of CBAM payments / per ton of product * (times) the export volumes, plus any loss of trade value due to reduced exports (=loss of trade volume times unit price).

GDP loss (or gain) *= Δ CBAM payment (EUR/ton) * Volume of exports (tons)*
*+ Lost exports volume (tons) * unit price*

, where Δ CBAM payment (EUR/ton) is the carbon cost/ton differential between exporters and EU producers

GDP loss (gain) in Thailand

Using the above formula, we calculate the GDP loss (gain) for Thailand under scenario 2, which makes use of Thailand-specific CO_2 intensity values for inferring CBAM payments. The differential of CBAM payments per ton of product for the various sectors is presented in the following table.

Table 11 Δ CBAM payment/ton, Thailand, Scenario 2

	Δ CBAM payment /ton - direct emissions (EUR/ton)	**Δ CBAM payment /ton - direct & indirect emissions (EUR/ton)**
Cement	7,3	8,2
Aluminium	3	244
Steel	-27,8	-31,9
Pulp & paper	-9,20	-8,8
Plastics in primary forms	n/a	n/a

Then, the impact on GDP is calculated for three cases: 1) assuming no changes in export volume; 2) assuming a 5% change in export volume; or 3) 10 % change in exports volume. The percentage changes in export volumes are negative when Δ CBAM is positive, and vice versa (see Table 12).

Table 12 Export volume changes

	No exports volume change	**5 % exports volume change**	**10 % exports volume change**
Cement (-)	2,6	2,5	2,3
Aluminium (-)	7.309	6.943	6.578
Steel (+)	47.140	49.497	51.854
Pulp & paper (+)	37.604	39.484	41.364
Plastics in primary forms (unknown)	115.759	109.971	121.547

The following table presents results with respect to GDP losses associated with the implementation of CBAM in the selected sectors, for the case of Thailand, when Thailand-specific default CO_2 emissions factors are used.

Table 13 GDP losses, Thailand, Scenario 2

	No exports volume change		**5 % exports volume change**		**10 % exports volume change**	
	Direct emissions	**Direct & indirect emissions**	**Direct emissions**	**Direct & indirect emissions**	**Direct emissions**	**Direct & indirect emissions**
Cement	19	21	28	30	37	39
Aluminium	20.150	1.782.656	1.036.944	2.711.325	2.053.738	3.639.994
Steel	-1.311.397	-1.505.582	-6.588.180	-6.792.073	-11.864.962	-12.078.565
Pulp & paper	-345.814	-331.354	-1.993.562	-4.504.904	-3.457.139	-2.404.125
Plastics in primary forms	n/a	n/a	n/a	n/a	n/a	n/a
Total loss (gain) in EUR	***-1.637.042***	***-54.258***	***-7.544.769***	***-8.585.622***	***-13.268.326***	***-10.842.657***
Total loss (gain), as % of Thailand's GDP forecast in 2023[20]	***-0,0003%***	***0,0000%***	***-0,0016%***	***-0,0018%***	***-0,0028%***	***-0,0023%***

Note: negative figures denote GDP gains; positive figures denote GDP losses

[20] GDP forecast in Thailand in 2023 of USD 538.735.000.000 (EUR 472.470.595.000); Source: IMF, datamapper, 2021, https://www.imf.org/external/datamapper/NGDPD@WEO/THA/IND/VNM

For the case of no change in export volumes, and when direct only emissions are taken into account, we see losses in the cement and aluminium sectors and gains in the steel and pulp & paper sector. In total for these four sectors, there are GDP gains of EUR 1,6 million or about 0,0003% of Thailand's GDP forecast for 2023. When both direct and indirect emissions are considered, losses in the aluminium sector increase significantly (due to high electro intensity in the sector, and high electricity grid emissions factor), and so the total gains are reduced to EUR 0,05 million, representing about 0,00001% of Thailand's GDP forecast for 2023.

When assuming a 5% or 10% change in export volumes, the overall gains increase to about EUR 8,6 and EUR 10,9 million respectively, representing in both cases about 0,002% of Thailand's GDP forecast in 2023.

GDP loss (gain) in India

Using the same formula, we calculate the GDP loss (gain) for India under scenario 2, which uses Indian-specific CO_2 intensity values for inferring CBAM payments. The differential of CBAM payments per ton of product for the various sectors is presented in the following table.

Table 14 Δ CBAM payment/ton, India, Scenario 2

	Δ CBAM payment /ton - direct emissions (EUR/ton)	**Δ CBAM payment /ton - direct & indirect emissions (EUR/ton)**
Cement	-1,9	-1,0
Aluminium	3	402
Steel	17,8	39,2
Kerosene	n/a	-1,4
Diesel	n/a	-2,9

Then, the impact on GDP is calculated for three cases: 1) assuming no changes in export volume; 2) assuming a 5% change in export volume; or 3) 10 % change in exports volume. The percentage changes in export volumes are negative when Δ CBAM is positive, and vice versa (see Table 15).

Table 15 Export volume changes

	No exports volume change	5 % exports volume change	10 % exports volume change
Cement (+)	16.481	17.305	18.129
Aluminium (-)	278.927	264.981	251.034
Steel (-)	3.347.619	3.180.238	3.012.857
Kerosene (+)	1.561.514	1.639.589	1.717.665
Diesel (+)	2.301.972	2.417.071	2.532.170

The following table presents results with respect to GDP losses associated with the implementation of CBAM in the selected sectors, for the case of India, when India-specific default CO_2 emissions factors are used.

Table 16 GDP losses, India, Scenario 2

	No exports volume change		**5 % exports volume change**		**10 % exports volume change**	
	Direct emissions	**Direct & indirect emissions**	**Direct emissions**	**Direct & indirect emissions**	**Direct emissions**	**Direct & indirect emissions**
Cement	-31.687	-16.759	-116.546	-100.871	-201.405	-184.983
Aluminium	769.036	112.218.706	25.311.045	131.188.232	49.853.055	150.157.759
Steel	59.626.231	131.159.027	196.099.794	264.055.950	332.573.357	396.952.873
Kerosene	n/a	-2.156.470	n/a	-44.612.544	n/a	-87.068.618
Diesel	n/a	-6.648.892	n/a	-63.715.747	n/a	-120.782.602
Total loss (gain) in EUR	***60.363.579***	***234.555.613***	***221.294.294***	***286.815.021***	***382.225.008***	***339.074.430***
Total loss (gain), as % of Indian GDP forecast in 2023[21]	***0,0019%***	***0,0074%***	***0,0070%***	***0,0091%***	***0,0121%***	***0,0108%***

Note: negative figure denote GDP gains; positive figures denote GDP losses

[21] GDP forecast in India in 2023 of USD 3.591.026.000.000 (EUR 3.149.329.802.000); Source: IMF, datamapper, 2021, https://www.imf.org/external/datamapper/NGDPD@WEO/THA/IND/VNM

For the case of no change in export volumes, and when direct only emissions are taken into account, we see losses in the aluminium and steel sectors and gains in the cement sector. In total for the three sectors of cement, aluminium and steel we have a GDP loss of EUR 60 million. When both direct and indirect emissions are considered, losses in the aluminium sector increase significantly (due to high electro intensity in the sector, and high electricity grid emissions factor in India), and so do losses in the steel sector, albeit to a lesser extent. Cement and refined petroleum products – whose carbon intensities are lower in India than in the EU - show gains, however, not enough to compensate for the losses in the other two sectors. The total impact from all sectors is now a loss of about EUR 235 million, or less than 0,01% of India's GDP forecast for 2023.

When assuming a 5% or 10% change in export volumes, GDP losses amount to EUR 287 and EUR 339 million respectively, representing always less than 0,02% of the Indian GDP forecast in 2023.

GDP loss (gain) in Vietnam

Finally, the same exercise is carried out to calculate the GDP loss (gain) for Vietnam under scenario 2, which makes use of Vietnam-specific CO_2 intensity values for inferring CBAM payments. The differential of CBAM payments per ton of product for the various sectors is presented in the following table.

Table 17 Δ CBAM payment/ton, Vietnam, Scenario 2

	Δ CBAM payment /ton - direct emissions (EUR/ton)	**Δ CBAM payment /ton - direct & indirect emissions (EUR/ton)**
Cement	4,0	5,5
Aluminium	3	404
Steel	-9,4	10,6

Then, the impact on GDP is calculated for three cases: 1) assuming no changes in export volume; 2) assuming a 5% change in export volume; or 3) 10 % change in exports volume. The percentage changes in export volumes are negative when Δ CBAM is positive, and vice versa (see Table 18).

Table 18 Export volume changes

	No exports volume change	5 % exports volume change	10 % exports volume change
Cement (-)	215.872	205.078	194.285
Aluminium (-)	9.675	9.191	8.707
Steel (-)	418.421	397.500	376.579
Steel (+)	418.421	439.342	460.263

The following table presents results with respect to GDP losses associated with the implementation of CBAM in the selected sectors, for the case of Vietnam, when Vietnam-specific default CO_2 emissions factors are used.

Table 19 GDP losses, Vietnam, Scenario 2

	No exports volume change		**5 % exports volume change**		**10 % exports volume change**	
	Direct emissions	**Direct & indirect emissions**	**Direct emissions**	**Direct & indirect emissions**	**Direct emissions**	**Direct & indirect emissions**
Cement	865.438	1.195.371	1.517.222	1.830.658	2.169.005	2.465.945
Aluminium	26.675	3.910.198	1.159.627	4.848.974	2.292.579	5.787.749
Steel	-3.917.725	4.441.433	-21.544.163	21.649.914	-39.170.602	38.858.394
Total loss (gain) in EUR	***-3.025.611***	***9.547.003***	***-18.867.315***	***28.329.546***	***-34.709.018***	***47.112.089***
Total loss (gain), as % of Indian GDP forecast in 2023	***-0,0010%***	***0,0031%***	***-0,0061%***	***0,0091%***	***-0,0112%***	***0,0151%***

Note: negative figure denote GDP gains; positive figures denote GDP losses

For the case of no change in export volumes, and when direct only emissions are taken into account, we see losses in the cement and aluminium sectors, which are however more than compensated by gains in the steel sector. In total for these three sectors there are GDP gains of EUR 3 million or about 0,001% of Vietnam's GDP forecast for 2023. When both direct and indirect emissions are considered, losses in the aluminium sector increase significantly (due to high electro intensity in the sector, and high electricity grid emissions factor), while gains in the steel sector turn to losses, and therefore we see total losses of about EUR 9,5 million or about 0,003% of Vietnam's GDP forecast for 2023.

When assuming a 5% or 10% change in export volumes, the impacts are accentuated, meaning gains are increased when direct only emissions are taken into account, while losses also increase when both direct and indirect emissions are taken into account. This is largely driven by impacts in the steel sector. In all cases, overall gains or losses do not represent more than 0,02% of Vietnam's GDP forecast in 2023.

6. Key observations

Energy-intensive and trade-exposed (EITE) sectors like cement, steel, and aluminum, are highly likely candidates to be covered by CBAM in the near to medium-term. According to the calculations, exporters of these products from Thailand, India, and Vietnam would face a total CBAM "bill" at the border of EUR 109 million, EUR 434 million and EUR 36 million annually respectively, when both direct emissions and indirect emissions from electricity and heat are considered[22]. CBAM payments would represent as little as 0,02% of Thailand's GDP forecast in 2023, 0,01% of India's GDP forecast and 0,01% of Vietnam's GDP forecast.

CBAM payments for a ton of product can represent a significant share of current prices even when full cost pass through is assumed. For cement, for example, the CBAM payment share of current prices is high (above 20% for all countries under scenario 2 when both direct and indirect emissions are considered), largely explained by the low price/ton. While high, the share ranges for the three exporting countries between 20% in India, reflecting possibly a more modern fleet, and 34% in Vietnam, likely reflecting a relatively high share of coal burning by the cement industry as well as a lower plant thermal efficiency. When only direct emissions are considered, the CBAM share of current prices is also high and largely unchanged (ranging between 19% and 32% for the three countries), given the low electro-intensity of the sector, and the associated indirect emissions.

The CBAM share is significantly lower in the case of crude steel, but with large variations between the countries analysed: from as little as 0,6% in Thailand where only the scrap-based EAF production route is used, to as high as 9% in India, where the production mix includes a significant share of the coal-based direct reduced iron-electric arc furnace (DRI-EAF) route.

For aluminium, CBAM payments represent between 12% and 24% of current prices when total emissions are considered. The size of the share is largely driven by the high electro-intensity of the sector (about 15MWh/ton of product), with electricity accounting for a significant part of emissions from the sector. The variation is largely a reflection of country or regional differences with respect to the electricity supply mix and associated emissions factors. When only direct emissions are considered, the CBAM share is greatly reduced to about 3-4%, with little variation among countries. This reflects the fact that direct emissions are relatively homogenous across primary aluminium production plants, ranging from 2 to 2,5 tCO2e per ton of aluminium[23].

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[22] These figures refer to results under Scenario 2, whereby exporting country-specific CO2 intensity values are used.

[23] ERCST (2021b), p. 46

Overall, because of the electrolytic reduction process, indirect emissions greatly outweigh direct emissions in primary aluminium production.

An assessment of the impact of CBAM on national GDP is also provided in this paper. The assessment takes into account changes in the relative competitiveness of the sectors stemming from the differences in the emissions intensity (and associated carbon costs) of exporters relative to that of EU producers.

This exercise found the impact of CBAM on GDP to be negligible: even at an assumed 10% change in exports volumes to the EU, GDP losses did not exceed 0,02%. This estimate can be considered an upper bound, as it does not take into account the possible redirection of exports to alternative markets. In some cases, the assessment showed GDP gains, albeit also at a negligible level, driven by products for which the carbon intensity in the exporting country is lower than that in the EU.

Export volumes for some of the products considered are insignificant (e.g. cement exports from India or Thailand), and at first instance may not appear relevant. However, the analysis considers all three main CBAM-candidate products (cement, steel, aluminium) from all countries, as the introduction of CBAM can be expected to result in market diversification and opportunities for boosting exports to the EU from countries with low carbon intensities.

For instance, the specific energy consumption and CO2 emissions from cement production in India is relatively low, and India could enjoy a competitive advantage relative to other exporting countries to the EU. This could lead to an increase or redirection of part of India's total exports of cement towards the EU. Transport costs that are inter alia a factor of distance would attenuate this effect. On the other hand, rising EU ETS prices (and therefore an increasing CBAM level of adjustment which would mirror the ETS price) would further pronounce it.

With respect to product scope, the analysis in this paper assumes that a CBAM would apply to imports of raw materials (e.g. primary aluminium, crude steel), as well as semi-finished products of these materials (e.g. aluminium rolled products, steel pipes), which contain a high percentage of these materials. Since the direct and energy-related indirect emissions from producing semi-finished and finished products are often moderate relative to value added, their inclusion in a CBAM would reflect emissions from the upstream production of the intermediate goods incorporated in such products (e.g. the emissions embodied in the primary aluminium used as a raw material for flat rolled aluminium products; or the emissions embodied in crude steel as a raw material for steel pipes)[24].

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[24] ERCST (2021a), p. 67

Practically, the calculations in this paper apply the emission intensity of the primary material (e.g. crude steel) also to imports of semi-finished products (e.g. steel pipes). The underlying assumption is that CBAM will focus on emissions from upstream processes, while applying these emissions factors also to certain downstream products that consist almost to their entirety of the upstream basic material.

In fact, the knock-on effects in the value chain of a CBAM applied only upstream could be considerable. For example, applying a CBAM to primary aluminium only would lead to higher costs for EU downstream producers that rely on imported primary aluminium as their main input, incentivizing the relocation of downstream production out of Europe, and at the same time increasing imports to the EU of semi-finished aluminium products at the next step in the value chain[25]. For instance, if only primary aluminium were covered by a CBAM, road wheel producers in the EU might move production out of Europe, or European original equipment manufacturers (OEMs) would source finished aluminium road wheels from abroad. A design that does not account for such downstream impacts would put the EU industries of semifinished products - at risk, while presenting export opportunities for more processed products not subject to CBAM for foreign producers.

The introduction of a tariff on primary aluminium by the Trump Administration serves as an immediate illustration of the potential impact: from June 2018 to May 2019, imports to the US of aluminium wire, plaited bands and similar aluminium products increased by 152%, which led the Trump Administration to subsequently extend the tariffs further down the value chain[26].

Yet, there is still significant uncertainty regarding the design of CBAM with respect to how far down the value chain product coverage would go. The total ‘CBAM bill’ would be lower in case only upstream materials are covered, and higher the more downstream products it covers in the value chain.

Another consideration concerns the ability of CBAM to distinguish between imports of virgin versus recycled basic materials, or to determine the recycled-content of more processed products that might contain a mix. The analysis in this paper takes into account scrap-based production[27] when deriving carbon intensities for crude steel. On the other hand, the analysis assumes zero recycled content for primary (unwrought) aluminium production, and hence the CBAM impacts in the sector would be an upper bound in case the CBAM design distinguishes between virgin and recycled content.

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[25] ERCST (2021a), p. 50

[26] Zachmann, G. and McWilliams, B. (2020), p. 9

[27] By assuming that all crude steel produced via non-DRI EAF route is scrap-based, and all steel produced by BOF route is non-scrap based. However, this is a simplification as in reality some scrap can be used in the BOF route, and some non-scrap in the non-DRI EAF route.

It is worth noting here that currently trade statistics do not distinguish between virgin and recycled imports of unwrought aluminium, and that when CBAM is implemented a mechanism enabling this distinction at the customs would be needed. For more processed products, traceability of recycled content would be needed.

This links to both the CO2 price in the EU (as revealed by the EU ETS), as well as carbon pricing in the exporting countries. The total CBAM "bill" faced by exporters to the EU would be proportionally reduced, when exporting countries impose carbon pricing to domestic producers, as this would very likely be deducted from the payable level of adjustment (ΔCO2 price; cf. results for Scenarios 4-6, using a hypothetical carbon price in the exporting countries).

On the other hand, EU ETS prices have been on the rise in the first months of 2021, as the EU is working towards further tightening emissions targets. Analysts have been revising upwards their CO2 forecasts for 2023 to about 50 EUR/tCO2. Thus, the CBAM impact could be higher at increasing price levels through to 2030, compared to earlier forecasts of about 41 EUR/tCO2 in 2023.

The choice of applicable default CO2 intensity values also has a significant impact on costs. In undertaking such an exercise, there could be serious implementation problems related to data availability, transparency and reliability. Moreover, intensity values change over time, and any default values should ideally be product-specific and change over time to reflect technology change.

The calculations in this study are based on derived "average" default intensities at the EU, regional or exporting country level, based on publicly available data or input provided during the study. The derived intensities used in the calculations do not comprise recommended default intensity levels to be used by CBAM. This exercise would have to be carried out at a very technical and detailed level, and making use of possibly confidential data.

Furthermore, in practice the CBAM design may possibly allow exporters to the EU to challenge carbon intensity default values with foreign producers being granted the possibility to individually prove that they are "cleaner" than default values.

This would potentially reduce the tax burden imposed by the EU CBAM, but could invite resource shuffling, whereby the exporting country directs all its 'clean' production to the EU, and the 'dirtier' production is either exported to other countries without a CBAM or consumed domestically, with no to little effect on climate mitigation.

The analysis undertaken is not without limitations. It is limited to the first order effect of the trade impact bilaterally between the country of origin and the EU, and has provided an assessment of the CBAM "bill" faced by exporters at the border, assuming unchanged trade flows compared to average 2017-19 values.

In reality, CBAM payments could affect the level of product prices depending on the pass-through rate, as well as impact the level of trade flows depending on price elasticity.

Second order effects that would mitigate the impact of CBAM on trade include, among others, a shift of production means to cleaner technologies (reducing carbon intensities), and a shift of exports to other final destinations outside the EU. This analysis does not take into account trade flows with third countries which would also play a role in trade flow changes.

For example, the introduction of a CBAM could still have a positive impact on the volume of exports of a commodity from a country with a relatively lower carbon intensity production compared to the intensity of other foreign producers exporting to the EU. All other things equal, CBAM would encourage an increase in exports from countries with low carbon intensities and vice versa. The assessment of the impact of CBAM on GDP (section 5.3), goes in this direction to some degree, in the sense that it assumes an increase in exports if the emissions intensity of production in the exporting country is lower than that in the EU, and vice versa. Nonetheless, it still does not capture the impact of trade flow changes due to the relative emissions intensity of the exporting country of interest and other exporters to the EU.

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