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Estimating the impact of the EU carbon border adjustment mechanism on South African steel and aluminium industries

Dissertation submitted in partial satisfaction of the requirements an MSc in Sustainability, Enterprise and Environment

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Abstract

The introduction of the EU carbon border adjustment mechanism (CBAM) may have considerable and adverse effects on trading partners in regulated industries. Using a mixed-methods approach, this study estimates the impact of the CBAM on the South African steel and aluminium industries. Using the gravity model of trade, this study estimates a loss of revenue for South African firms in aforementioned industries of between $114 million to $185 million, had the CBAM been in place in 2022. Stakeholder interviews serve to highlight a range of additional threats to industry, including the risk of increased competition in domestic and alternate markets as well as constrained access to input materials as global steel and aluminium markets adjust to reduced EU access. We recommend policy reforms for the CBAM to address inequity and limit unintended losses for developing economies, including exemptions for smaller countries, relative carbon pricing and mobilisation of additional funding.

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Finally, to Nisha and Faisal. Moon of woman. Arbiter of the truth. You are the reason I'm here. Thank you for giving me everything I could have wanted and needed.

Glossary for abbreviated terms

AFCFTA	African Continental Free Trade Area
BCA	Border Carbon Adjustments
BOF	Basic Oxygen Furnace steelmaking
CBAM	Carbon Border Adjustment Mechanism
CBDR	Common but differentiated responsibility
CEPII	Centre d'Etudes Prospectives et d'Informations Internationales
CGE	Computational General Equilibrium
CIF	Cost, insurance, and freight
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
EAF	Electric Arc Furnace steelmaking
EC	European Commission
EFTA	European Free Trade Association
EGD	European Green Deal
ETS	Emissions Trading System
EU	European Union (referring to the 27 remaining members)
EUA	EU Allowance
GATT	General Agreement on Tariffs and Trade, 1947
GDP	Gross domestic product
GHG	Greenhouse gas
GNP	Gross National Product
IMF	International Monetary Fund
IRA	US Inflation Reduction Act
LDCs	Least developed countries
MFN	Most favoured nation
NDC	National determined contributions
OECD	Organisation for Economic Co-operation and Development
PPP	Purchasing power parity
RTA	Regional trade agreement
SA	South Africa or South African (as the case may be)
TRQ	Tariff rate quota
UNFCCC	United Nations Framework Convention on Climate Change
US	United States of America
WTO	World Trade Organisation

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1. Introduction

1.1. Context: the development of EU climate policy and introduction of CBAM

The extent of anthropogenic climate change and the resultant climate crisis prompts a need for urgent action. As global temperatures increase, greater proportions of humanity are exposed to excess heat, drought, floods and other extreme weather events, with profound risks to global food systems; increasing vulnerability for the poor (Pörtner et al, 2022).

Building on decades of climate policy, the EU announced the EGD in 2019, significantly increasing ambition, with an overall target of reaching carbon neutrality by 2050. The EGD also includes a package of interventions, with an intermediate target of reducing EU territorial emissions by 55% of their 1990 levels by 2030, including (i) a further decreasing cap and phasing out of free allowances under the EU ETS; (ii) the introduction of a CBAM to protect against 'carbon leakage'; and (iii) dedicated investment and other support programmes for 'green' technologies.

The CBAM is intended by legislators to "level the playing field" and protect EU industries from "unfair" competition resulting from firms operating in jurisdictions with less stringent climate policy (EPRS, 2023). The CBAM has the further potential to spur the proliferation of climate-positive policies around the world (Helm et al, 2012).

However, the introduction of the CBAM is likely to have considerable and adverse effects on trading partners. For developing and less-well-resourced countries these effects may be severe, even where the direct exposure of exports to the EU is minimal. There are continued debates about its legality under the WTO, and considerable arguments against its compatibility under the Paris Agreement (2015) as it pertains to 'common but differentiated responsibilities and respective capabilities' (Vidigal and Venzke, 2022). While the CBAM may contribute to the EU's efforts of stemming climate change, the costs and who bears it require special attention.

1.2. Research question and contribution to the literature

This study seeks to dimension and estimate the economic impact of the EU CBAM on the SA steel and aluminium industries, including the loss of revenue which firms operating in SA may experience as a result of implementation. In so doing, this study contributes to the literature by estimating the potential impact of the CBAM on a single developing country and its largest exposed industry.

The study applies a mixed approach, leveraging the gravity model of trade to determine the elasticity of demand for a basket of goods most exposed to the EU. The econometric approach is complemented with semi-structured interviews with 21 stakeholders in the SA steel and aluminium value chain, in order to capture other threats, opportunities and the potential policy and industry response.

Applying the structural gravity model of trade, **this study estimates the implementation of the CBAM would result in a fall of direct revenue for SA exporters of between 6 and 9%. Had the CBAM already been in place in 2022, this would have equated to between $114 million to $185 million in lost sales for the year**. Stakeholder interviews highlight a range of additional threats to SA industry, including the risk of increased competition in domestic and alternate markets, as well as input supply shortages as global steel and aluminium markets adjust to reduced EU access. We provide a set of policy recommendations for both the EU and SA, which includes targeted exemptions for smaller developing countries, the introduction of relative carbon pricing, mobilisation of funding, and fostering an enabling environment for decarbonisation.

1.3. Outline of this study

The remainder of this paper is set out as follows: Section 2 describes the evolution of climate policy in the EU, including arguments around carbon leakage and the introduction of the CBAM. Section 3 sets out the mixed-method empirical approach used in this study to investigate the research question. Section 4 outlines the data used for both the gravity model and stakeholder interviews. Section 5 presents the results of the gravity model; while Section 6 presents that of stakeholder interviews. Section 7 provides a discussion on the CBAM in the context of climate justice and the geopolitics of the green industrial revolution, and provides a set of policy recommendations to address equity while maintaining ambition on climate action. Section 8 concludes with the key contribution to the literature, and suggestions for further research.

2. Background

2.1. The development of climate policy in the EU

The EU has generally been regarded as a leader in climate policy with a history of comprehensive legislative frameworks as early as the 1980s (Averchenkova et al, 2017).

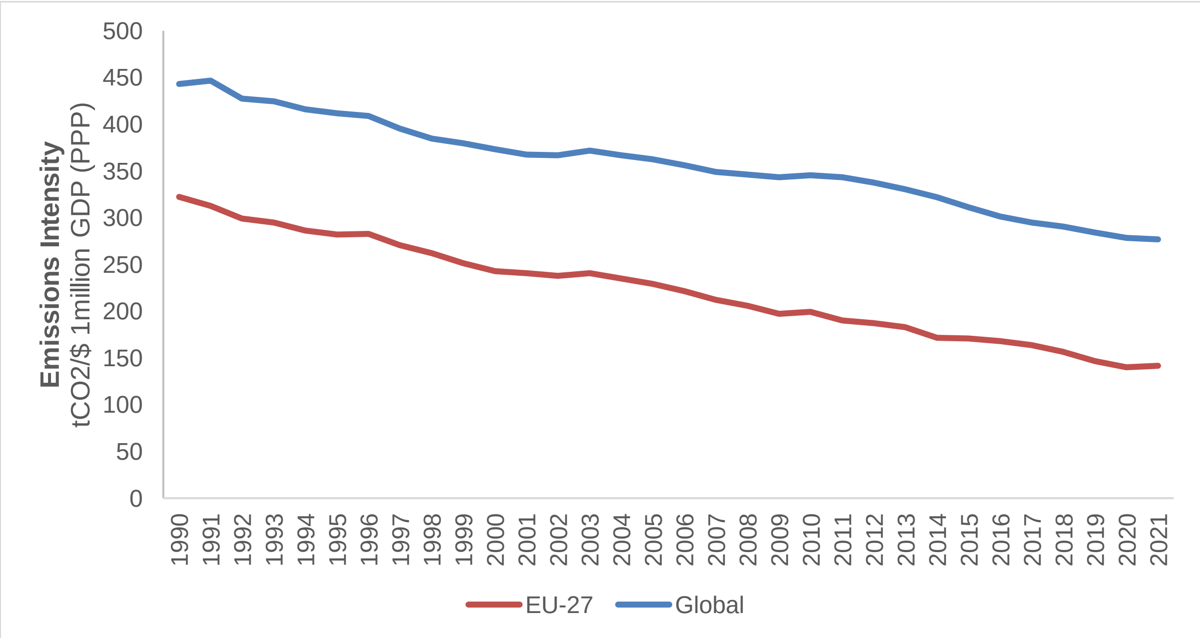
In 2005, the EU introduced the ETS, the world's first "large scale" emissions trading platform (Ellerman and Butchner, 2007, p. 66), as the "cornerstone" of its climate policy (EC, 2023a). The ETS introduced a cap-and-trade system within the EU, effectively putting a price on half the carbon emissions within the union, and establishing a market-based system for buying and selling emissions allowances (EUAs) (Martin et al, 2016). Over the period from 2003 to 2020, the ETS developed over three distinct phases, with an initial Phase I covering the period from 2003 to 2007, followed by Phase II over the period from 2008 to 2012; and Phase III from 2013 to 2020.

During Phase I and II, the ETS took a decentralised approach, whereby EU member states were entitled to set their own respective caps and allowances under national allocation plans (Ellerman et al, 2016). Initial directives applied to firms operating in sectors such as energy, including oil refineries; ferrous metal production; mineral industries (including cement, glass and ceramics); and pulp and paper (European Parliament, 2003). In Phase II, the ETS was extended to aviation emissions (Ellerman et al, 2016).

Starting in 2012, the EU introduced a further set of reforms for a Phase III, which sought to address some of the competitive distortions stemming from the initial decentralised approach (Ellerman et al, 2016); as well as addressing the surplus in EUAs resulting from poor economic performance in the wake of the 'great recession' (Laing et al, 2014). In particular, Phase III introduced (i) a single declining EU-wide cap on emissions; (ii) the adoption of an auctioning process for EUAs; (iii) further limits to the use of offsets as a means of abating emissions; and (iv) from 2013, extension to firms operating in chemical, including fertiliser; and aluminium sectors (Ellerman et al, 2016). The EU also adopted a set of Effort Sharing Regulations in 2018 for sectors not covered by the ETS, establishing a set of nationally determined targets for the reduction of GHGs by 2030 (EPRS, 2023).

The introduction and development of the ETS has indeed coincided with a reduction in GHG emissions (see Figure 1), with a majority of researchers finding a positive impact of the ETS on EU territorial emissions. Ellerman and Buchner (2008) find that the ETS has an immediate effect, with EU territorial emissions declining by between 50 and 100 $MtCO_2$ per year between 2005 and 2006, while Dechezleprêtre et al (2018) find the introduction of the ETS led to a 10% reduction in EU territorial emissions over the medium-term between 2005 and 2012.

Figure 1 EU-27 versus global emissions intensity



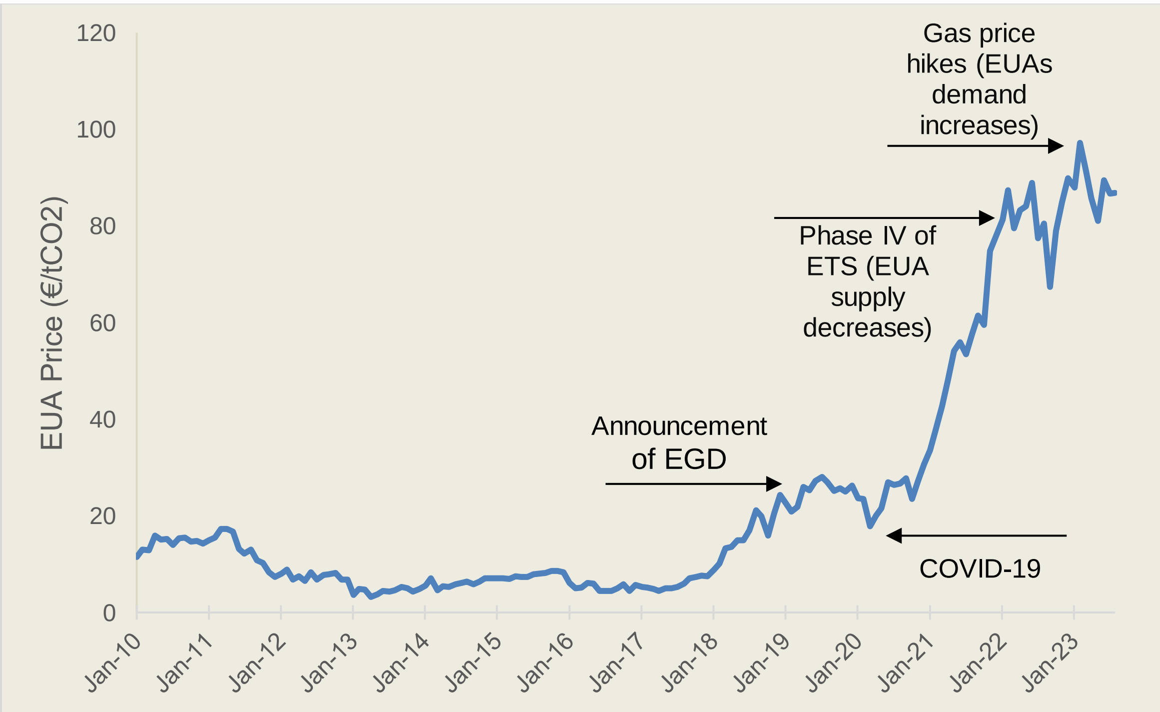
Source and notes: Ritchie et al, 2020; PPP GDP in constant 2017 dollars

Since 2019, the EU has significantly increased ambition to reduce territorial emissions with the announcement of the EGD, and the passing of the European Climate Law, which establishes (i) a binding target of climate neutrality by 2050; and (ii) an intermediate target of reducing emissions from their 1990 levels by 55% by 2030. To accompany this intermediate target, the EU has announced a package of intervention to support the near-term decarbonisation of the EU. Firstly, a new Phase IV for the ETS has been introduced, which includes a steepening decline in the EU-wide emissions cap, a phasing out of free allowances, and an extension to maritime shipping. Second, in order to mitigate the risk of 'carbon leakage', the EU will introduce a CBAM imposing a carbon price on the import of commodities in certain sectors.

Third, the EU will gradually phase out emissions from road transportation with an effective ban on CO_2 emitting vehicles by 2035 (EC, 2023d). Finally, a series of support funds for vulnerable member states as well as households across the EU will be provided, with additional annual funding equal to 1.8% of pre-covid levels of GDP (Wolf et al, 2021).

Increased climate ambition is highlighted in the EUA price, which has increased from roughly €24/ton in early 2020 to a monthly high of €97/ton in February 2023 (Bloomberg, 2023), with volatility of EUA price often reflecting macro and micro events (See Figure 2).

Figure 2 Historical EUA price



Source: Bloomberg (2023); Author's own annotation

2.2. Competitiveness and 'carbon leakage'

The development of climate legislation in the EU has been accompanied by increasing concerns about the competitiveness of domestic firms in regulated industries. Such concerns arise from the increasing ambition of the ETS, which forces regulated firms to invest in mitigation or purchase EUAs, both of which reduces profitability (Martin et al, 2016). Such competitiveness concerns increase further in the presence of asymmetric climate regulation between trading partners, giving rise to concerns about 'carbon leakage' (Dechezleprêtre and Sato, 2017).

Carbon leakage - reflecting the shift in carbon-intensive production from jurisdictions with more stringent climate regulations to those with less stringent ones - has been a large concern for regulators since the introduction of the EU ETS in 2005 (Eskander and Fankhauser, 2023; Evans et al, 2021). While a larger number of countries have initiated some form of carbon pricing, such initiatives only cover 23% of global emissions (World Bank, 2023a). The EU has argued that "[e]xperience gathered during the operation of the EU ETS has confirmed that sectors and subsectors are at risk of carbon leakage" (EC, 2019a). US regulators have equally argued against the imposition of domestic carbon regulation unless leakage is addressed (Winchester et al, 2011; Helm et al, 2012).

The actual evidence of carbon leakage is mixed. In an analysis of national climate legislation from 111 countries over the period from 1996 to 2018, Eskander and Fankhauser (2023) find "no evidence of trade-related carbon leakage" (p. 3). Other studies have concluded similarly (Martin et al, 2016; Dechezleprêtre and Sato, 2017). The EU itself recognises that "evidence of the existence of carbon leakage is not always conclusive" (2021a, p. 7); nonetheless, EU legislators have argued that the perception of carbon leakage "threatens to undermine popular support for climate agendas" (Blümel et al, 2021), and hence needs to be addressed in climate legislation.

2.3. Policy tools to mitigate 'carbon leakage'

Several policy recommendations have emerged in the literature to address carbon leakage, including (i) the use of free allowances or exemptions; (ii) the introduction of BCAs; as well as (iii) carbon consumption charges, climate excise duties, environmental standards; and green public procurement (Grubb et al, 2022). This study focuses on first two recommendations.

2.3.1. The use of free allowances as a mitigant for carbon leakage

In practice, the use of free allowances has been the more popular approach. Since the commencement of the ETS, free allowances for hard-to-abate sectors, including the manufacturing of steel, aluminium, fertiliser, cement, clothing and textiles, glass, pharmaceuticals, as well as certain mining industries have been provided (EC, 2019b). Steel and aluminium sectors are considered particularly challenging sectors to abate because of its long investment cycles, technical challenges and funding requirements (Bataille et al, 2021). Free allowances for these sectors have thus muted any cost increases from increased carbon pricing (Evans et al, 2021). SA also includes a set of allowances under the Carbon Act (Act 15 of 2019) which provides for effective rebates from the carbon tax in certain industries up to 90%, including the steel and aluminium sectors.

However, the use of free allowances is generally argued as incompatible with the pursuit of lower emissions, as it removes the incentive to decarbonise (Evans et al, 2021; Grubb et al, 2022). Furthermore, the exemption of certain industries from the ETS has opened the door for "large-scale lobbying and generated major inefficiencies", resulting in "market distortion" that subsidise more carbon intensive industries (Helm et al, 2012, p. 369).

While some researchers have argued that free allowances have served a necessary political compromise, spurring initial adoption and support from industries who may have otherwise rejected increasing climate regulation (Sato et al, 2022), more ambitious emissions reductions require the introduction of more appropriate measures to reduce leakage (EC, 2019c).

2.3.2. The use of BCAs as a mitigant for carbon leakage

The use of BCAs has thus emerged as an approach which offers a more appealing means of mitigating carbon leakage in the face of increasing ambition on reducing territorial and consumption emissions (Böhringer et al, 2012). BCAs are intended to equalise the carbon price applied between imports and domestic production, thus mitigating competitive pressures that emerge from trade with firms in countries with asymmetric climate policies (Grubb et al, 2022).

To accompany its increasing ambition, the EU has thus decided to introduce a BCA which it calls the CBAM, and to reduce its reliance on free allowances as a means of mitigating carbon leakage, phasing them out over the period to 2034. While the merits of BCAs have been debated for some time (Helm et al, 2012), the EU will become the first major trading bloc or country to introduce one. If successful in its implementation, the introduction of the CBAM may spur the adoption of similar mechanisms in other countries. At the time of this study, at least two US senators have tabled proposals for a US BCA (Smith, 2023); while the governments of the UK and Canada have each launched consultation processes on their own BCAs.

2.4. The introduction and mechanisms of the EU CBAM

First announced as part of the broader EGD in 2019, the EC began solicitation of feedback on potential mechanisms for the CBAM in March 2020 (Evans et al, 2021). In July 2021, the EU announced its '*Fit for 55'* package, including a fully-fleshed proposal for the CBAM amongst other policy instruments geared towards the intermediate target of a 55% reduction in emissions from 1990 levels by 2030 (EPRS, 2023). In December 2022, the EU Parliament adopted the legislation for the CBAM, and in May 2023 the final regulations on the architecture were published. Further sets of implementing legislation have been published for public comment and are expected to be finalised ahead of the implementation date on 1 October 2023.

Under its current framing, the CBAM will be phased in with an initial period of reporting between October 2023 and December 2025. First duties will be levied in 2026 to coincide with an accelerated phasing out of free allowances. The CBAM will be applied to imports from 'third countries', being all those outside of the EU and EFTA; and, in its first phase, will apply to imports of across six sectors, namely: aluminium, cement, electricity, fertiliser, hydrogen and iron and steel (EC, 2023c). In 2022, the EU imported $141 billion of CBAM regulated products from third countries (see Table 1).

Table 1 Source of CBAM regulated products imported by EU countries, 2022

USD billions	Aluminium	Cement	Electricity	Fertilizer	Iron and Steel	ALL CBAM Products
EU	54.1	2.5	69.4	15.9	198.3	**340.2**
EFTA	11.0	0.0	17.9	0.6	6.1	**35.6**
All Third Countries	**29.4**	**1.3**	**9.9**	**14.3**	**85.8**	**140.7**
US	0.8	0.2	0.0	0.9	3.2	**5.0**
India	2.3	0.0	0.0	0.0	7.1	**9.5**
China	4.9	0.0	0.0	0.3	16.7	**22.0**
Russia	3.0	0.0	0.7	3.1	6.5	**13.2**
Turkiye	4.0	0.4	0.2	0.5	9.7	**14.7**
Africa	3.5	0.2	0.1	5.3	3.3	**12.4**
Other Third Countries	10.9	0.5	8.9	4.2	39.3	**63.8**
TOTAL	**94.5**	**3.9**	**97.2**	**30.7**	**290.2**	**516.5**

Source: Compiled by author using TradeMap (2023); EU import data; hydrogen excluded since negligible amounts imported to date

The EU has indicated that in subsequent phases, the CBAM may be extended to other hard-to-abate sectors, or indeed all imports (EC, 2021a). While direct and indirect emissions[2] have to be reported on all regulated products, duties will apply only to direct emissions for aluminium, hydrogen and iron and steel; while for cement, electricity and fertiliser both direct and indirect emissions will attract duties. CBAM duties will be priced according to the prevailing EUA price under the ETS, and will cover CO_2 emissions across all regulated sectors, as well as other GHGs for certain sectors, being nitrous oxide for fertiliser and perfluorochemicals for aluminium. Importantly, any eligible carbon taxes paid in the country of origin, may be used to offset the CBAM duty applied in the EU (EC, 2023c).

2.5. Criticisms of the EU CBAM and compatibility with the WTO

The CBAM has not been without its criticism, with commentators and foreign ministers calling it "unilateral" (Ensor, 2023) and "green protectionism" (Hancock, 2022). EU legislators have however argued that the mechanism serves as an "effective, legitimate and fair" tool to address carbon leakage, compliant with the rules of the WTO (Blümel et al, 2021).

Whether the CBAM is indeed compliant with WTO rules has become a hotly debated issue, with much of the literature focusing on three areas of concern. Firstly, it has been argued that the CBAM contravenes the 'most favoured nation' provisions which prevents countries from discriminating between 'like' imported products (Hufbauer et al, 2022). Secondly, it has been argued that imposing additional duties for the CBAM would exceed the WTO defined 'bound rates' which typically limit the import duties which any country may impose to pre-defined levels (Bacchus, 2021; ACF, 2023). Third, it has been argued that since the phasing out of free

[2] Direct emissions refer to those emissions which stem from the production process itself (also known as Scope 1), while indirect emissions refer to those which stems from the generation of the electricity used in the production process (Scope 2).

allowances is gradual and introduction of the CBAM immediate, EU firms will initially enjoy both protections simultaneously creating a more favourable business environment for domestic industries covered by the CBAM. This arguably contravenes rules that imported goods be treated no less favourably than domestic goods (Bacchus, 2021; African Group, 2023).

Notwithstanding these arguments, the EU is expected to raise a defence in terms of Article XX of the GATT, which allows for domestic mechanisms deemed “necessary to protect human, animal or plant life or health” (ACF, 2023).

While these debates are not new (Helm et al, 2012) they are likely to intensify with the introduction of the CBAM and other BCAs introduced by other countries. Any litigation in terms of the WTO will not be resolved quickly, and may take years, both to establish the harm and to argue the outcomes through the necessary appellate channels (Hufbauer et al, 2022).

The matter of the CBAM is likely to be tabled at multilateral forums, and may become a feature of COP28 or the forthcoming WTO Ministerial Conference (MC13). In July 2023, the African Group of countries at the WTO circulated a series of communiques on the implementation of BCAs and other trade-related environmental measures, arguing the disproportionately adverse impacts they may have on developing countries, thus undermining tenets of the Paris Agreement (2015) like CBDR and sovereignty with respect to NDCs. The Africa Group (2023) further argued that the implementation of BCAs impedes the development of developing countries, by constraining the opportunity for global value chains to serve as a path of what Baldwin (2016) describes as economic ‘convergence’, while contributing little to the fight against climate change.

The WTO itself has recognised that the introduction of BCAs could lead to "trade tensions" (WTO, 2022, p. 83). As a result, the WTO (2022) has argued that economic costs resulting from the implementation of BCAs need to be fairly shared, and aligned to the principle of CBDR. Measurement of impact is thus an important aspect of understanding the policy implications of BCAs.

2.6. Previous impact studies of the EU CBAM

Impact studies on the potential effects of the EU CBAM have to-date focused on three areas of concern, namely the potential effects on (i) carbon leakage in the EU; (ii) EU and global emissions; and (iii) the economies of EU trading partners.

2.6.1. Impact studies on carbon leakage

Consistent with the mixed evidence on carbon leakage itself, the estimated effect of the CBAM on such competitive challenges is itself mixed. The study with the most pronounced effect is that of the EU, which estimates the CBAM could reduce carbon leakage by nearly one-third by 2030 (EPRD, 2023). Other independent studies show a less pronounced effect, for example Branger and Quirion (2014), which in a meta-analysis of 25 studies, find that BCAs reduce leakage by 6 percentage points. Other studies find only partial effects, with a potential material impact on leakage for iron and steel production, but less so for other sectors, including cement (Kuik and Hofkes, 2010).

2.6.2. Impact studies on EU and global emissions

Most studies estimate the impact of the CBAM on global emissions to be negligible, while many estimate that the CBAM will likely result in an increase in EU territorial emissions, and a decline in other parts of the world, as production in emission-intensive activities shifts to the EU at the expense of production in the rest of the world. Winchester et al (2011) estimate a 0.6% fall in global emissions from the imposition of BCAs, while Korpar et al (2023) estimate an increase in EU emissions of 0.24%, with global emissions declining 0.08%. The ACF (2023) estimate that a carbon price of €87 per ton, the introduction of the CBAM increases EU emissions by 0.51%, with emissions declining in Africa (0.19%), India (0.25%), China (0.22%) and the rest of the world (0.11%)

Nonetheless, the EU has estimated more positive effects with a reduction in EU territorial emissions of 13.8%, and a 0.3% reduction in global emissions, through the introduction of the CBAM coupled with other measures contained within the EGD (EPRD, 2023).

2.6.3. Economic impact studies on EU trading partners

A number of economic impact studies estimate that the introduction of the CBAM will have an adverse effect on the economies of EU trading partners, with a larger cost on trading partners who are unable to decarbonise quickly (Böhringer et al, 2012; Eicke et al, 2021). These effects are estimated to be more pronounced for middle- and lower-income countries, as a result of reduced ability to diversify exports (Beaufils et al, 2023); and may be greater in regions of the world with historically carbon-intensive economies, most prominently African and Middle East countries (Zimmer and Holzhausen, 2020). The impact of such effects is estimated to widen inequality between the Global South and North in terms of both GDP and welfare (Xiaobei et al, 2022). Regional studies on the African continent find a near 1% fall in aggregate GDP for the continent at a €87/ton carbon price, with more pronounced effects in more export oriented countries (AFC, 2023).

The loss of export potential is estimated to be a key driver of the adverse economic impact of the CBAM. UNCTAD (2021) estimates a decline in exports to the EU of up to 5.6% in a scenario where an $88/ton carbon tax prevails, creating a loss in real incomes for developing countries of $10.2 billion offset by a gain of $2 billion in the developed world. These potential losses are compounded by the significant role which the EU plays as the largest market for regulated goods, accounting for more than 30% of imports for globally traded products regulated by the CBAM (see Table 2).

Table 2 Global markets for CBAM regulated products, 2022

USD billions	Aluminium	Cement	Electricity	Fertilizer	Iron and Steel	ALL CBAM Products
EU	94	4	97	31	290	**516**
Other Europe *	15	1	17	5	41	**79**
Africa	5	3	2	10	32	**51**
Asia **	67	5	6	39	271	**388**
North America	50	3	5	14	131	**203**
South America ***	6	1	3	24	34	**68**
RoW	3	0	0	4	10	**18**
TOTAL	**241**	**17**	**130**	**127**	**809**	**1,324**

Source: compiled by author from TradeMap (2023) data
Notes: * includes Russia; ** includes Turkiye; *** includes Caribbean countries

This loss of export potential may impact some industries more prominently than others, and may result losses across the value-chain of firms, investors, suppliers and customers. BCG (2020) estimates that profit amongst global flat-rolled steel producers could decline 40% if just a $30/ton CBAM duty is introduced.

2.6.4. Economic impact studies on SA

Only a handful of studies have been conducted with a specific focus on SA. Using a CGE model, Xiaobei et al (2022) estimate that in a scenario where direct emissions attract a duty at a carbon price of $75/ton, iron and steel exports to the EU could decline by 30.5% from a 2030 baseline, making it one of the most exposed countries in this sector after Kazakhstan and Ukraine.

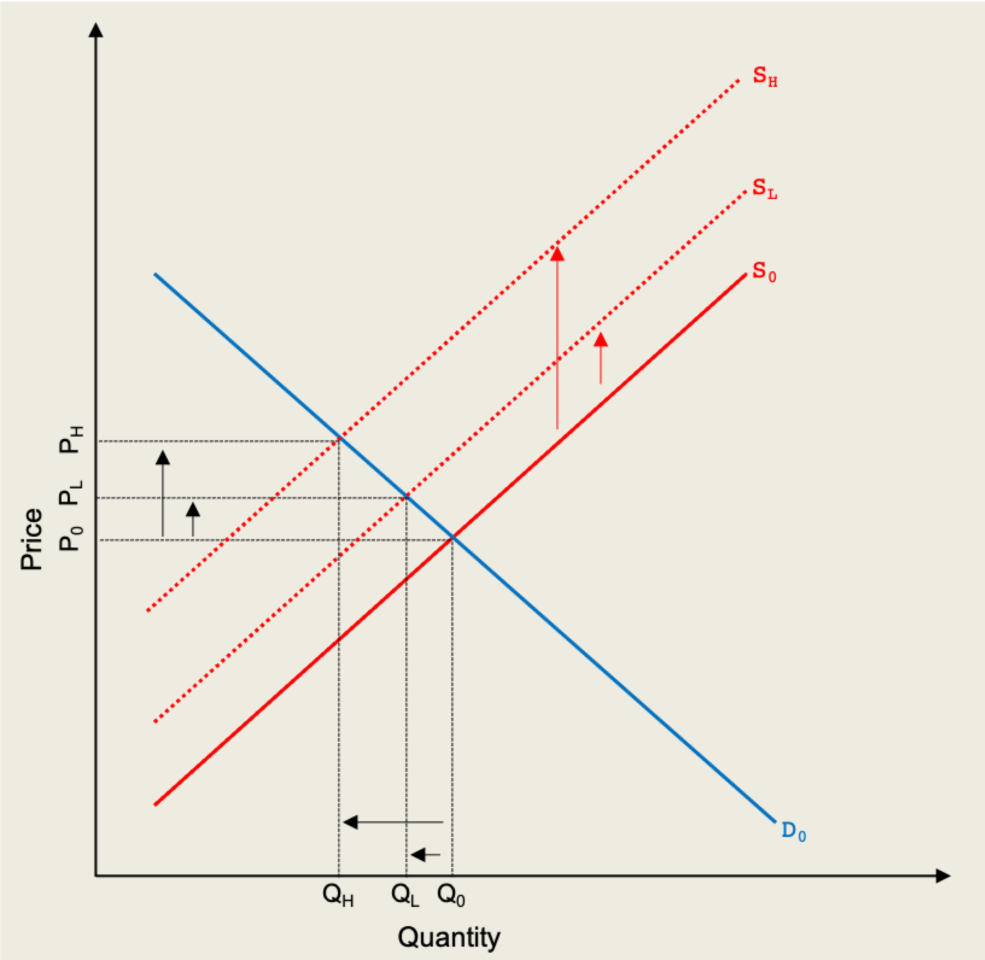
3. Empirical Approach

This study seeks to dimension and estimate the impact of the EU CBAM on the SA steel and aluminium industries, and to further highlight a set of policy recommendations for both the EU and SA which can alleviate any adverse effects which may arise from the implementation of the CBAM, while maintaining ambition on decarbonisation.

SA has been selected, as the largest exporter of commodities covered by the CBAM in Sub-Saharan Africa. The steel and aluminium value-chains have been selected, since they represent the largest export of commodities regulated by the EU CBAM. (While addressed in part, an exhaustive discussion of steel and aluminium decarbonisation plans is however beyond the scope of this study). While SA is chosen as a specific case, it is done with the recognition that the country represents an illustrative example of how other African and developing countries may be impacted by the CBAM. The focus on a developing country is further deemed appropriate because of the limited solution set and funding available to such countries.

The primary hypothesis of this study is that the imposition of the CBAM is likely to result in a loss of exports from SA to the EU for steel and aluminium. This loss of exports is expected to result from the effective price increase which EU importers are likely to face as a result of the imposition of CBAM duties (see Figure 3).

Figure 3 Illustrative supply and demand response for commodities regulated by CBAM



Source and notes: Author's own. Assumes regulated commodities are normal goods. D_0 reflects the demand curve for a regulated commodity and is assumed to be agnostic of any CBAM duty. S_0 reflects the supply of the regulated commodity before the imposition of the CBAM. Q_0 and P_0 are the resultant price and quantity supplied. S_L reflects the upward shift in the supply curve for low-emission suppliers which are now subject to the CBAM. Q_L and P_L are the resultant price and quantity supplied for low-emissions suppliers due to the CBAM. S_H reflects the upward shift in the supply curve for high-emission suppliers which are now subject to the CBAM. Q_H and P_H are the resultant price and quantity supplied as a result of the CBAM. Figure 3 highlights how higher emissions producers will be subject to higher duties, and hence expected to suffer a reduction in the demand equal to the difference between Q_H and Q_0.

While the CBAM will apply to all third countries, the impact on each country will differ based on (i) the emissions profile of production; (ii) how exposed their exports are to the EU; and (iii) how readily exported commodities can be substituted. Throughout this paper, this loss of exports to the EU is referred to as the 'direct effect'.

A secondary hypothesis of this study is that the imposition of the CBAM will result in a set of international trade and investment dynamics which could result in a loss of exports to other parts of the world for firms operating in SA, and/or an increase in imports to SA. These dynamics are expected to result from a shift in trading patterns as exporters higher up on the emissions profile seek alternate markets other than the EU for their goods. Throughout this paper, these changing global patterns are referred to as the 'indirect effects'.

To capture the contextual nuances in the SA steel and aluminium, and to test the potential impact of both the primary and secondary hypotheses, this study applies a mixed-methods approach. First, an econometric model is developed using the gravity model of trade to estimate the value of SA exports that may be at risk of diversion due to the imposition of the CBAM. Second, a series of interviews with stakeholders in the SA steel and aluminium industries are conducted which seeks to expand on the econometric modelling and sense-check the expected 'direct effects', while further unearthing some of 'indirect effects' which may arise through the implementation of the CBAM.

3.1. Gravity model estimation

3.1.1. Theoretical grounding of the Gravity Model of International Trade

To measure the potential direct effects of the CBAM, this study leverages the gravity model of international trade. Some prior studies have instead used CGE models to measure these impacts, however there is a risk that assumptions regarding market structure embedded within the CGE framework may undermine the validity of the results (Piermatini and Teh, 2005). A gravity model is thus preferred because of the ability to tailor and specify the dataset to the question at hand.

3.1.1.1. Early history of the gravity model

The gravity model is often referred to as a "workhorse" of international trade, largely as a result of its intuitive nature, theoretical underpinning, and flexibility in the face of various policy questions (Head and Mayer, 2014).

Tinbergen (1962) laid out the origins of the gravity model as an intuitive framing of international trade, based on a logical extension of Newton's gravitational model, where bilateral trade between two countries can be modelled as directly proportional to the 'mass' of the respective economies (as measured by GNP or GDP); and indirectly proportional to the distance between these countries. This 'intuitive' form of the model thus takes the following form:

$$X_{ij} = \frac{Y_i^a Y_j^b}{D_{ij}^c}$$

where X_{ij} is the monetary value of trade between the country *i* and country *j*;

Y_i and Y_j is the GDP of the exporting country *i* and importing country *j* respectively;

D_{ij} is the distance between the two countries; and

a, *b* and c reflect the factor by which each of the variables impact final trade (Tinbergen, 1962).

The 'intuitive' form is often written as the natural log of the expressions as follows:

$$log(X_{ij}) \ = \ a.logY_i + b.logY_j - c.logD_{ij} + \epsilon$$

While the gravity model has proved exceptionally robust in empirical studies, it was initially criticised for its lack of theoretical underpinning (Head and Mayer, 2014). Anderson (1979) provided the first noted attempt at grounding the gravity model in a theoretical framework, though it was later criticised as being "too complex to be part of [the] everyday toolkit" (Head and Mayer, 2024, p. 135). A further criticism of the 'intuitive' framework is that it lacks the ability to model trade between two countries as part of a dynamic system, whereby trading costs between countries *i* and *j* may also be impacted by trade between countries *i* and *h* (Shepherd et al, 2019).

3.1.1.2. The development of a 'structural' gravity model

The 'structural' gravity model or "gravity with gravitas" framework of Anderson and Van Wincoop (2003) provided the first widely accepted theoretical grounding of the gravity model, addressing some of the limitations of earlier models, by expanding the set of terms to capture more complex trade dynamics.

Anderson and Van Wincoop (2003) introduced a set of now widely used 'multilateral resistance terms', providing a measure of the ease of market access for the importer and exporter respectively, thus extending the gravity model as follows:

$$logX_{ij}^{k} = a.logY_{i}^{k} + b.logE_{j}^{k} - c.logY^{k} + (1-\sigma_{k})(logD_{ij}^{k} - log\Pi_{i}^{k} - logP_{j}^{k})\ ;$$

$$\Pi_{i}^{k} = \sum_{j=1}^{C} \left(\frac{D_{ij}^{k}}{P_{j}^{k}}\right)^{(1-\sigma)} \frac{E_{j}^{k}}{Y^{k}}\ ;\ \text{and}$$

$$P_{j}^{k} = \sum_{i=1}^{C} \left(\frac{D_{ij}^{k}}{\Pi_{i}^{k}}\right)^{(1-\sigma)} \frac{Y_{i}^{k}}{Y^{k}}\ .$$

where for any good *k*:

E_{j}^{k} is the expenditure in country *j* (the importer);

Y_{i}^{k} is the output in country *i* (the exporter);

Π_i^k is exporter's multilateral resistance term, capturing the interaction between exports from country *i* to all other countries;

P_j^k is importer's multilateral resistance term captures the interaction between imports to country *j* from all other countries;

σ_k is the elasticity of substitution; and

Y^k is further defined as global output of good *k* (Shepherd et al, 2019).

3.1.1.3. Recent developments and application to BCAs

The 'gravity with gravitas' framework remains the core form of the model commonly used in the literature, and is applicable to general trade between two countries, as well as trade in individual commodities (Yotov et al, 2016). A smaller number of studies have applied the gravity model to determine the potential impact of a BCA or the CBAM in particular. Larch and Wanner (2017) extend the structural gravity of trade by introducing a production function in the form of a Cobb-Douglas function in order to introduce emission intensity of production and estimate welfare and emission effects where several BCAs are introduced. Korpar et al (2023) leverage the framework established by Larch and Wanner (2017) to assess the specific impact of the CBAM. Both these studies were conducted at an earlier stage of development of the CBAM and at a level of aggregation which does not necessarily reflect the specific product sets covered by the regulations.

3.1.2. Model framework for this study

This study seeks to contribute to the literature by focusing the analysis on exports from a particular country and sector likely to be impacted by the CBAM, following the recommendations of Yotov et al (2016).

Firstly, panel data is used, with intervals of three years. Panel data has been found in prior studies to improve the estimation efficiency, while the use of three-year intervals follows Olivero and Yotov (2012) who find that such modifications allow for better assessment of the gradual adjustments in patterns of trade in response to trade policy. Second, this study includes time-varying exporter fixed effects in order to capture the unobservable multilateral resistance terms as well as any observable and unobservable country-specific dynamics in the global steel and aluminium markets (Yotov et al, 2016). Third, following Santos Silva and Tenreyro (2006), this study includes an estimation using the Poisson Pseudo Maximum Likelihood (PPML) estimator, which has been found to perform better in the presence of heteroscedasticity, and further allows for estimation where there is a proliferation of zero trade observations.

Finally, following Yotov et al (2016), in addition to the use of time-varying exporter fixed effects this study proxies for the unobservable multilateral resistance terms through the introduction of remoteness indices, such that:

P_j^k can be approximated by a remoteness index for an importer *j*, expressed as:

$$P_j^k \sim REM_j = \frac{\sum_j \quad D_{ij}}{\frac{E_j}{Y}}$$; and

Π_i^k can equally be approximated by a remoteness index for an exporter *i*, expressed as:

$$\Pi_i^k \sim REM_i = \frac{\sum_i \quad D_{ij}}{\frac{Y_i}{Y}}$$

Consistent with other studies this study includes variables which have been shown to have significant coefficients in the literature, provided in summary in Table 3.

Table 3 List of variables included in the gravity model

Variable Name	Description
X_{ij}^k	Exports of good *k* from country *i* to the EU
GDP_j	EU GDP
GDP_i	GDP of exporting countries *i*
D_{ij}	The distance between country *i* and *j*
EU	A dummy variable for exporters that are from the EU
CONT	A dummy variable for exporters that share a land border with the EU
LANG	A dummy variable for exporters that share a common major language with countries in the EU
COL	A dummy variable for exporters that were once colonies of EU countries
RTA_{ij}	A dummy variable for exporters that are party to a RTAs with the EU
TRQ_{ij}^k	A dummy variable for any good k from any exporter i which is subject to a TRQ in the EU

Following Yotov et al (2016) and using instruction for coding in R from Shepherd et al (2019), this study uses a set of four gravity equations as estimated for each of the regulated commodities as follows:

(1) $logX_{ij}^k = logGDP_j \ + logGDP_i \ - logD_{ij} + EU + CONT + LANG + COL + RTA_{ij} + TRQ_{ij}^k$

(2) $logX_{ij}^k = logGDP_j \ + logGDP_i \ - logD_{ij} + logREM_i + logREM_j + EU + CONT + LANG + COL + RTA_{ij} + TRQ_{ij}^k$

(3) $logX_{ij}^k = logGDP_j \ + logGDP_i \ - logD_{ij} + FE_i^k + EU + CONT + LANG + COL + RTA_{ij} + TRQ_{ij}^k$

(4) $X_{ij}^k = EXP[GDP_j \ + GDP_i \ - D_{ij} + FE_i^k + EU + CONT + LANG + COL + RTA_{ij} + TRQ_{ij}^k]$

Equation (1) represents the gravity equation in its most standard form using GDP for both the importer and exporter as proxies for consumption and production of good *k*. Equation (2) includes the remoteness indices for the importer and exporter; while equation (3) includes the exporter-fixed-effects. The inclusion of Equation (2) and (3) thus serve to introduce the approximations for the multilateral resistance term consistent with structural gravity. Equation (4) includes the form of the equation using the PPML approach advocated by much of the recent literature.

Following Yotov et al (2016), this study develops a separate set of the aforementioned equations for each of the commodities in-scope of the research question, those being Primary Steel (covered under the tariff heading 72) and Aluminium (tariff heading 76). The set of equations for Primary Steel are henceforth referred to as Model 1; while those for Aluminium are henceforth referred to as Model 2.

While SA does export some commodities under tariff heading 73 (also regulated by the CBAM), it is relatively small and hence is out of scope of this study. Agglomerated iron ore (under tariff code 2601.12), which is also covered by the CBAM, is also excluded from the main study following feedback from stakeholder interviews that the specific market structure may limit the applicability of the gravity model for this commodity.

3.1.3. Introducing the CBAM into the Gravity Model of Trade

The 'structural' gravity model is essentially a demand function for any importer (country *j*), for any good *k* from any exporter (country *i*), written as a function of exogenous trading costs captured by the distance variable as a proxy (Yotov et al, 2016). To accommodate the inclusion of the CBAM, one can thus extend the 'iceberg' formulation, which assumes that in order for 1 unit of goods to arrive at the destination, the exporter needs to send 1 unit, plus an amount equal to the trade friction anticipated en route (Anderson and Van Wincoop, 2003). The CBAM adds to the trading costs and can thus be seen as extending the distance. This study thus imposes the CBAM duty as an adjustment to distance to determine the potential loss of revenue, whereby the distance variable is shocked by the proportion by which the CBAM duty is expected to exceed the CIF price.

Another option would be to include the CBAM as an additional tariff. However, several commodities in scope for this study enter the EU without any applied tariff regardless of exporter, and hence would not return any significant coefficient without risk of bias. Through an extension of the 'gravity with gravitas' model, Larch and Wanner (2017) introduce BCA by extending the endowment framework to include a production function into which energy usage and emission intensity can be included; and further adding a set of BCAs with an initial tariff of zero (note, there are no historical examples of BCAs). This study avoids this approach since derivation of an estimator, based on a historical dataset with a constant value may be biased.

3.1.4. Data limitation and strategic choices

While this study closely follows the literature, strategic choices have been made to account for some of the limitations in the data.

Firstly, the use of intra-national and international trade flows is often recommended (Yotov et al, 2016), however data on intra-national flows is not consistently available. To proxy for intra-national trade, this study treats the EU as a single bloc for the purposes of imports, however distinguishes between EU countries for the purposes of exports to the EU. Since the EU is a net-importer of each commodity (and the majority of the larger exporters are net-exporters), this is deemed an appropriate proxy.

Secondly, this study does not include importer-fixed-effects since it covers only a single importer (the EU) treated as a singular importing bloc. The importer-fixed-effects are thus included in the constant term in the equation.

Thirdly, the study further does not include a tariff term given that the models have been designed at a level of aggregation where tariffs cannot be applied accurately. (This study has been designed aggregating at the two-digit tariff heading, while customs duties are usually applied at a level of disaggregated six-digit tariff codes.) While some studies apply an average or weighted-average tariff, this study avoid this, given the risk of bias due to hidden counterfactual actions taken in response to tariff structures and other trading costs (Yotov et al, 2016).

Finally, this study uses the distance coefficient as a proxy to capture the potential trade response to the CBAM. It differs from other studies which impose their own proxies to estimate the effect. All such proxies result from the lack of data, given that no country or trading bloc has imposed a BCA. Stakeholder interviews are used inter alia to validate the results.

3.2. Stakeholder Interviews

To deepen the contextual understanding of dynamics in SA steel and aluminium value chains, this study includes a series of semi-structured interviews with stakeholders in SA. Interviews were conducted (i) to validate the potential direct effects which may result from the implementation of the CBAM; and (ii) to explore potential indirect effects not captured by the econometric analysis.

3.2.1. Theoretical framework and interview method

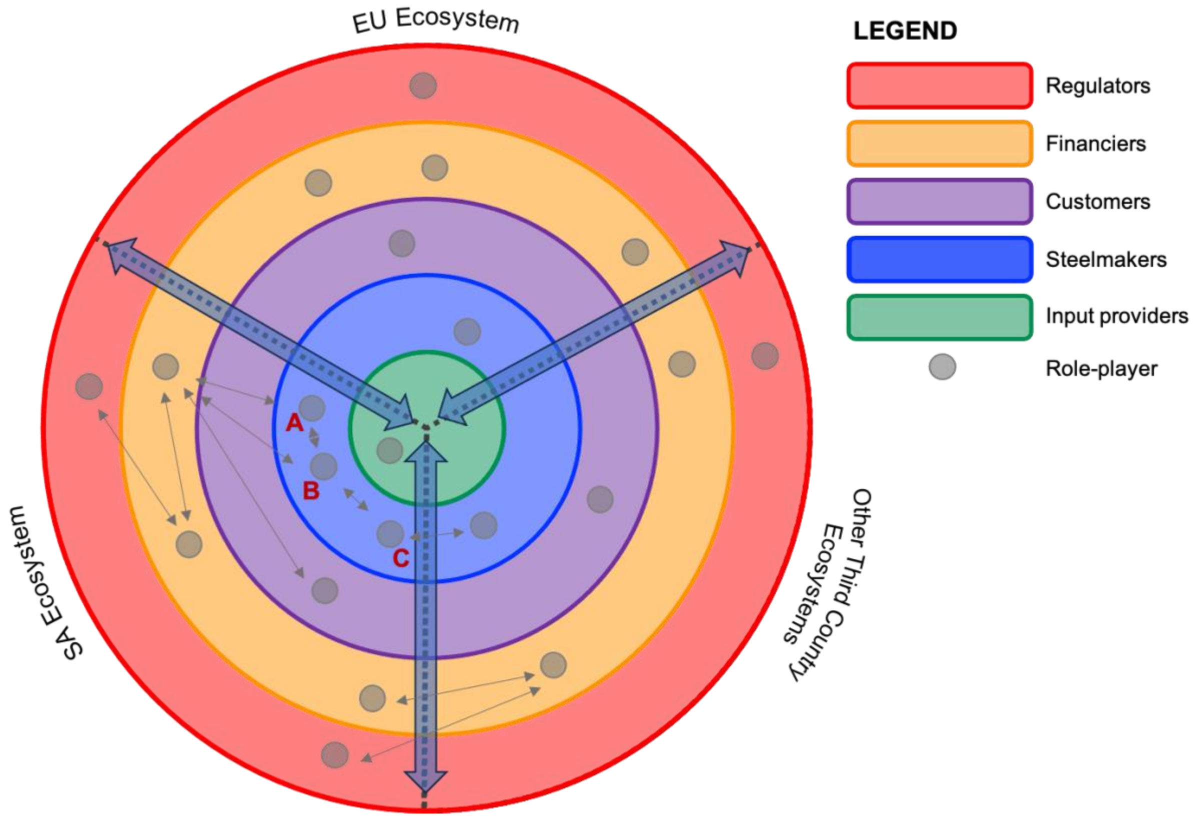
While the research question has been informed by the primary and secondary hypothesis, interviews with stakeholders followed an inductive approach. Stakeholders were selected from five different groupings expected to play an important role in SA's response to the CBAM, being (i) producers, (ii) business federations, (iii) banks, (iv) researchers and (v) policymakers.

Interviews were underpinned by a theoretical framing that stakeholders operate within a dynamic system, and that responses to policy evolve through several rounds of interaction between actors. As such, the framing has been influenced by the literature on 'complexity' (Barbrook-Johnson and Carrick, 2022). The use of interviews to complement the econometric model thus recognises that such modelling may only be effective at estimating first order direct effects. Actors within the system are likely to adapt their behaviour in response to their own estimations of such first order effects, as well later-order indirect effects.

Figure 4 provides a simple schematic framing of this complex and interacting ecosystem for steelmakers, which would analogously apply to aluminium producers as well. Interviewees were sourced from across the SA ecosystem for both product groupings.

Semi-structured interviews were conducted, with a series of 'question-prompts' to help guide the conversation and to create a common set of response areas, without wanting to be too specific (see Annexure A). While respondents were advised of the broad study design (see Annexure B), no specific questionnaire was circulated ahead of the interview. In each case, time was left to ensure that other views that respondents deemed important were reflected.

Figure 4 Simplified schematic of global steelmaking ecosystem



Source: Author's own.

The schematic provides a simplified framing of the global steelmaking ecosystem. For simplicity, it splits out the EU ecosystem from the SA and other third country ecosystems, all of which combine to make up the global ecosystem. The size of the wedge does not represent the relative size of the ecosystems. Within each ecosystem a network of role-players, consisting of input providers (like iron ore and scrap metal providers), steelmakers, customers, financiers (e.g., commercials banks and investors), and regulators interact, with decisions by one party having ripple effects through the value-chain (represented by larger blue arrows). For example, a decision by regulators to provide subsidies to input providers, may trigger private sector investment, which drives capacity increases, and potentially lower prices for steelmakers and ultimately customers. Improved financial performance of firms may increase tax receipts which increase fiscal flows to regulators. In addition, actions by role-players in one ecosystem can spill over into another ecosystem, through the level of exposure that one role-player may have to another. The schematic illustrates the exposure to that a role-player may have to another ecosystem. For example, Roleplayer A is an illustrative steelmaker operating in the SA ecosystem which is more exposed to the EU ecosystem. This exposure may result inter alia from sales to EU customers, purchases from EU input providers or funding from EU financiers. Roleplayer C is more exposed to Other Third Countries; while Roleplayer B is more insulated from other ecosystems. Roleplayers A and C may expect to be more influenced by decisions made in the neighbouring ecosystem including regulatory action in those systems which impact on nodes of influence. While Roleplayer B may be less exposed initially, it may become more exposed over time through domino effects and competitive dynamics within the SA or global ecosystems, illustrated by the arrows in the schematic.

For interviews with respondents within the producer and business federation stakeholder groups, question-prompts sought to address seven areas of interest which were believed to be of importance, including (i) fluency with the CBAM legislation (ii) exposure to the EU; (iii) relative emissions profile; (iv) how their market may be impacted by direct and indirect effects;

(v) self-assessment of risk; (vi) decarbonisation plans, including technical and financial feasibility; and (vi) policy recommendations.

For interviews with respondents within the banking stakeholder group, question-prompts sought to address six areas of interest including (i) fluency with the CBAM legislation; (ii) exposure to affected industries; (iii) credit and investment view of sectors; (iv) how such sectors may be impacted by direct and indirect effects; (v) views on sources of finance for the transition; and (vi) policy recommendations.

For interviews with respondents within the research stakeholder groups, question-prompts sought to address three additional areas of interest, including (i) how exposed SA is to the CBAM; (ii) how compatible the CBAM is with multilateral frameworks like the WTO and UNFCCC; and (iii) policy recommendations.

For interviews with respondents within the policymaker stakeholder groups, question-prompts sought to address three areas of interest including (i) fluency with the CBAM legislation; (ii) perceived risk of CBAM to SA; and (iii) any potential policy response.

3.2.2. Method of data analysis

This study uses thematic analysis for the purpose of analysing data from stakeholder interviews given the structure and flexibility of the framework, and is influenced by the work of Braun and Clarke (2006). In particular, this study follows a more latent approach to thematising the responses, and is thus more descriptive with respect to interview responses. The study followed the six steps outlined by Braun and Clarke (2006) as captured in Table 4.

Table 4 Braun and Clarke's (2006) Six Phases of Thematic Analysis

Phase	Description of the process
1. Familiarizing yourself with your data	Transcribing interviews and noting initial ideas
2. Generating initial codes	Grouping initial quotes into broad areas of response
3. Searching for themes	Condensing response areas into core themes
4. Reviewing themes	Generating a thematic map of responses
5. Defining and naming themes	Refining themes
6. Producing the report	Extracting core quotes to illustrate themes

Source: adapted from Braun and Clarke (2006)

Initial coding was undertaken based on the content of the response, with salient quotes grouped based on broad explanatory concepts. For example, where the response dealt with the substance of the fairness of the CBAM, it was grouped with other such comments from respondents. A sentiment analysis was conducted to further categorise responses as either positive, neutral or negative.

Themes were thus aggregated based on the initial coding and sentiment of the responses, based on the proliferation of such responses across the different interviews. Where novel responses from interviewees served to illustrate salient points that had not been previously made, they were included as well. The results of Phase 4 is captured in Figure 7 Thematic map of stakeholder responses, while Phases 5 and 6 are described in Section 6 of this paper.

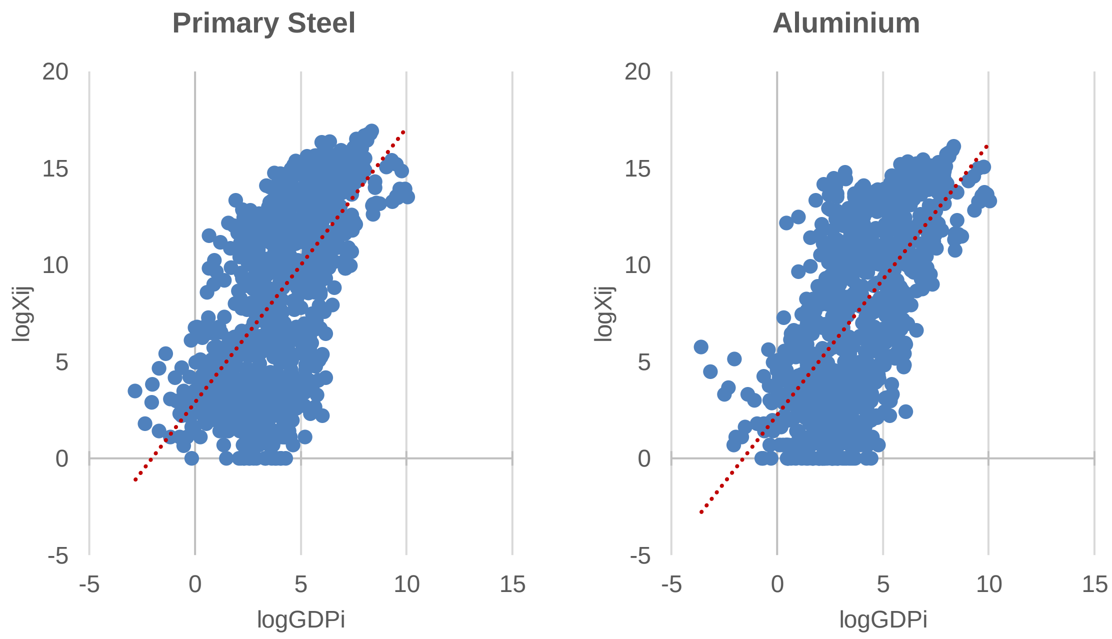
4. Data applied in study

4.1. Gravity model estimation

For the gravity model estimation, this study follows the recommendations of Yotov et al (2016) and Shepherd et al (2019) with respect to data sources, which is consistent with much of the literature.

Data on trade, including US-dollar value, quantity (in tons) and price is sourced from TradeMap (2023), while data on GDP is sourced from the IMF (2023). Nominal data and EU mirror-data is used as recommended by Yotov et al (2016). Figure 5 provides a plot of the relationship between trade with the EU and exporter GDP.

Figure 5 Scatter plot of trade exports to the EU and exporter GDP



Note: R^2 for Primary Steel is 64.8%; and for Aluminium is 65.2%. Trade flows measured in natural log of $000's, while GDP is measured in natural log of $'millions.

For each commodity, all observed imports for regulated commodities from any country to the EU over the period from 2003 to 2022 are included; with the exception of countries for which the IMF does not measure and report GDP. In practice, only smaller exporters are excluded, thus reducing the risk of bias in the models. These small exporters account for a cumulative 0.15% of total exports to the EU for Primary Steel and 0.02% for Aluminium over the twenty-year observation period. Thus, for Primary Steel, 189 exporting countries are included in the model from a possible 216 countries; while for Aluminium 190 countries are included in the model from a possible 217.

Observations for each of the ten variables indicated in Section 3.1.2 are taken for a twenty-year period from 2003 to 2022, being the full extent of data publicly available from TradeMap (2023), applying a three-year interval as recommended by Oliviera and Yotov (2012). As such, only seven annual observations for 2003, 2006, 2009, 2012, 2015, 2018 and 2021 are included. While this is the recommended approach, it is noted that the effect of the Ukraine-Russia conflict is not included in the data, which may impact the potential impact of the CBAM as it is implemented over the period from 2026.

Model 1 for Primary Steel thus has a theoretical maximum number of 13,130 data points from 1,313 observations; while Model 2 for Aluminium has a theoretical maximum number of 13,200 data points from 1,320 observations. Observations with zero-trade flows or missing data are removed from the dataset before estimating the models in Equations (1) to (3). Zero-trade flows are included for Equation (4).

Given that exports of aluminium and steel make up the majority of SA's exports to the EU covered by the CBAM (see Table 5), this study builds two commodity-specific models using the structural gravity model of trade, being (i) Primary Steel; and (ii) Aluminium. SA exports of pig iron, ferromanganese, ferrochromium, flat steel and stainless steel are covered under Model 1 (Primary Steel); while wrought aluminium and aluminium sheets are covered under Model 2 (Aluminium).

Only those commodities which are exported by SA firms within tariff headings 72 and 76, and which specifically covered in the regulations (EC, 2023c) are included. In particular for both Primary Steel and Aluminium, scrap metals, covered under tariff codes 7204 and 7602 respectively are excluded. For Primary Steel, while not all ferro-alloys are regulated by CBAM, we include the entire tariff line at the four-digit level for ease of computation.

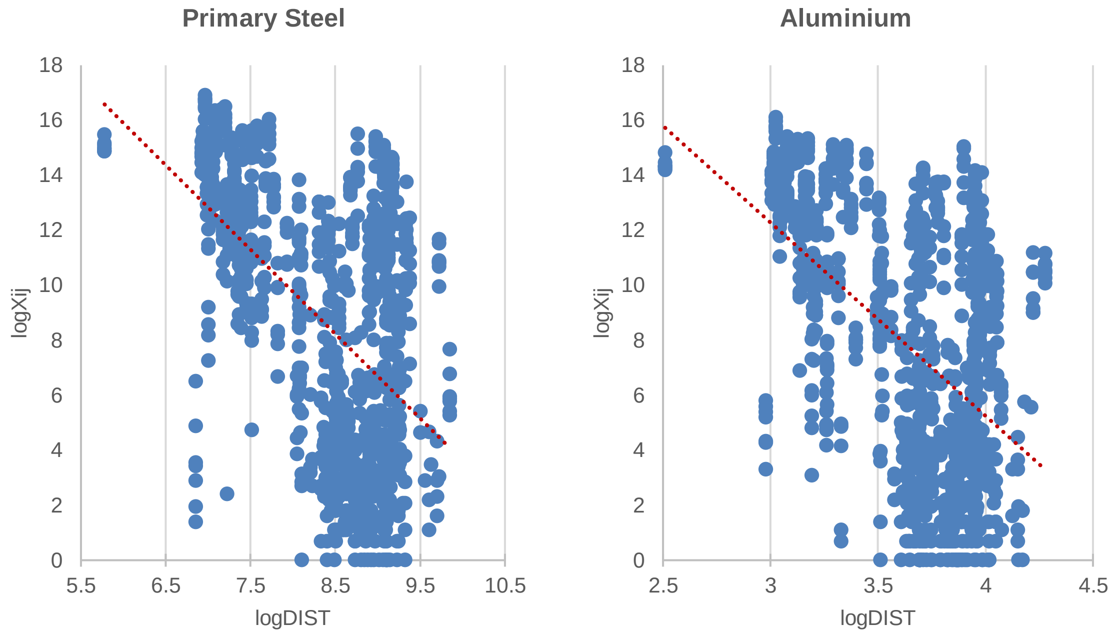
Table 5 SA's largest exports to the EU covered by the CBAM

HS Code	Description	Export to EU ($'millions) (2022)	SA export rank to EU (non-EU)
260112	Agglomerated iron ore	95.7	7th
720110	Non-alloy pig iron	172.8	3rd
720219	Ferromanganese (<=2% carbon)	95.0	2nd
720241	Ferrochromium (>4% carbon)	361.2	1st
721049	Zinc-coated flat steel	142.5	8th
7219	Flat-rolled stainless steel	442.1	5th
760110	Non-alloy wrought aluminium	530.6	5th
760612	Extruded sheets of aluminium alloys	241.9	4th
	Commodities covered in study	**2,064.2**	**4th**
	Other CBAM products not covered by study	200.3	
	TOTAL	**2,264.5**	

Source: TradeMap (2023); EU import data

Distance data is sourced from the CEPII database (Conte et al, 2022). In the case of countries from outside the EU, distance is measured in kilometres between the capital city of the exporter and Brussels. In the case of exporters from the EU, distance is measured as the average between the capital of the specific EU country and all other EU countries. Figure 6 provides a plot of distance between trading partners and trade flows

Figure 6 Scatter plot of trade exports to the EU and distance



Note: Correlation for Primary Steel is -53.6%; and for Aluminium is -53.1%. Trade flows measured in natural log of $000's, while distance is measured in natural log of kilometres.

Data on colonial ties and common language is also sourced from CEPII. Contiguous borders are determined through observation using World Bank (2023d) and refer only to those in continental Europe, excluding those shared with overseas territories of EU states. Data on RTAs is sourced from the EC (2023e), while TRQs are sourced from the EC (2022). The TRQ prevails irrespective of any RTA which may be in force[3].

Emissions data is sourced from a range of publications, including company reporting, World Steel Association (2022), International Stainless Steel Federation (ISSF) (2022) and the IPCC Guidelines for National Greenhouse Gas Inventories (2006), using direct emissions to determine the CBAM duty applied. Domestic SA carbon prices as well as any available free allowances for steel and aluminium production are published in the relevant SA legislation.

[3] An exemption was in place for certain Sub-Saharan African countries (including South Africa) until July 2022.

4.2. Stakeholder interviews

Stakeholders were selected from five different groupings expected to play an important role in SA's response to the CBAM, being (i) producers, (ii) business federations, (iii) banks, (iv) researchers and (v) policymakers.

First, seven of the largest producers of commodities regulated by the CBAM were selected for interviews. Given SA's exposure to the legislation through commodities like iron ore, ferroalloys, pig iron, primary steel, stainless steel, aluminium smelting and aluminium extrusion, at least one large producer of each commodity was selected for interviews. Amongst steel producers, the study also targeted producers with different production processes, including BOF and EAF.

Second, a set of three major business federations were selectedd to include both a broader view of the sector, and to capture those views and experiences of smaller members within those federations which may differ from those of the larger producers.

Third, a set of four banks active in the SA steel and aluminium, including both commercial and public finance institutions, were selected to ascertain a view on how financiers to the sector estimate the potential impact of the CBAM, and to further dimension the scale and sources of capital required to affect a green transition in the sectors and SA more broadly.

Fourth, a set of three researchers from SA universities and 'think-tanks' were selected to investigate the industrial and trade policy impact of the CBAM, and to gather research and academic positions on SA's risks and opportunities.

Finally, five policymakers from SA government departments responsible for response measures to the CBAM were selected, were selected to understand the policy position being adopted in SA. In total, 21 interviews were conducted throughout July 2023, the details of which are included in Table 6.

Table 6 Details of Stakeholder Interviews

Respondent	Designation	Organisation / Sector	Grouping	Interview Date	Interview Length (min)
#1	Senior executive ***	SA integrated steelmaker	Producer	10.07.23	57
#2	Senior executive	Global integrated steelmaker **	Producer	26.07.23	~45
#3	Senior executive ***	Global aluminium smelter **	Producer	19.07.23	~45
#4	Senior executive	SA Aluminium extruder	Producer	27.07.23	49
#5	Senior executive ***	SA iron ore producer	Producer	14.07.23	65
#6	Senior executive ***	SA ferrochromium producer	Producer	18.07.23	57
#7	Senior executive	SA Iron and steel producers	Federation	13.07.23	55
#8	Senior executive	SA Downstream steel producers	Federation	13.07.23	63
#9	Senior executive	SA Stainless steel producers	Federation	27.07.23	53
#10	Sector coverage	SA Public Finance Institution	Bank	07.07.23	58
#11	Sector coverage	SA Commercial Bank	Bank	12.07.23 *	52
#12	Economic analyst	SA Commercial Bank	Bank	11.07.23	51
#13	Climate risk modeller	Global Commercial Bank	Bank	13.02.23	37
#14	Senior Lecturer	SA University	Research	12.07.23	51
#15	Professor	SA University	Research	14.07.23	57
#16	Research	Think tank	Research	10.07.23	47
#17	Cabinet Minister	SA Government	Policymaker	28.07.23	55
#18	Director ***	SA Government (tax policy)	Policymaker	18.07.23	50
#19	Director	SA Government (ind. Policy)	Policymaker	27.07.23	49
#20	UNFCCC Rep.	SA Government	Policymaker	11.07.23	56
#21	WTO Rep.	SA Government	Policymaker	27.07.23	52

Notes: * interview conducted in-person rather than Zoom platform; ** interview not recorded (interview length estimated ~); *** multiple participants on the interview platform (Additional participants: #1 - 1; #3 - 3; #5 - 1; #6 - 3; #18 -1)

Interviews were conducted and recorded on the Zoom virtual platform (with the exception of one), and ranged between 37 and 65 minutes per interview with a total of more than 9 hours of recorded stakeholder responses.

In two cases, respondents asked not to be recorded, while in other cases respondents were joined by other stakeholders within their organisations (see Table 6). While this study includes any salient remarks made by additional respondents, it is only done if corroborated by the main respondent.

Table 7 Summary Statistics for Stakeholder Interviews

Summary Statistics	
Total number of interviews	21
Total number of unique participants	30
Number of recorded interviews	19
Total minutes of recorded interviews	1,014
Average recorded interview time (mins)	53
Total minutes of recorded respondent contributions *	545
Average recorded respondent contribution per interview (mins)	28

Note: * refers to total speaking time for respondents, excluding prompts from interviewer and dead-air

5. Results of gravity model estimation

5.1. Gravity estimates for Primary Steel

As detailed in Section 3.1.2, this study applies four model specifications to obtain a range of estimates for the explanatory variables. Each of the results for the four estimation models for Primary Steel (see Table 8) provide a significant and satisfactory fit. Further in each case, the distance variable, which serves as the proxy for trading cost (and over which the CBAM effect is applied) has the traditional negative sign and is significant at the 95% confidence interval, with a range of between 0.8 and 1.28 depending on the estimation method.

Table 8 Gravity Estimates for Model 1: Primary Steel

Variable	Equation (1): OLS	Equation (2): OLS w/ Remoteness Indices	Equation (3): OLS w/ Fixed Effects	Equation (4): PPML w/ Fixed Effects
Constant	19.59**	46.17**	N/A	22.04**
$logGDP_i$	1.15**	1.15**	0.3352	0.00**
$logGDP_j$	-0.96	-0.12	1.25**	0.01**
$logD_{ij}$	**-0.82****	**-0.80****	**-1.22****	**-1.28****
$logREM_i$	-	-0.10	-	-
$logREM_j$	-	-3.94	-	-
FE_i	No	No	Yes	Yes
EU	4.12**	4.13**	1.42**	2.28**
CONT	2.66**	2.65**	-1.54**	-0.17
COL	0.44**	0.43**	-0.05*	-0.67**
LANG	-1.38**	-1.37**	8.97	-1.58**
RTA	0.48	0.53	0.03	0.47
TRQ	0.17	0.53	0.19	-0.23
Observations	**943**	**943**	**943**	**1313**
Adjusted R^2	**0.64**	**0.64**	**0.89**	**0.66**
p-value	**< 2.2e-16**	**< 2.2e-16**	**N/A**	**< 2.2e-16**

Note: Signif. codes: ** $p < 0.05$
Following Shepherd et al (2019), equations (1) - (3) are estimated in R using an ordinary least squares methodology, using the estimatr package and the lm_robust function, while equation (4) is estimated in R using the PPML methodology, using the gravity package and the ppml function.

Increasing GDP for exporters (captured by $logGDP_i$) has a positive impact on imports into the EU where fixed effects are excluded, accounting for a 1.1% increase in exports for every 1% increase in nominal GDP. In the presence of exporter-fixed-effects, this relationship falls to 0.3% and is no longer significant at the 95% confidence interval. This may suggest that steel production is not necessarily part of every country's industrial strategy, even where GDP is increasing.

Increasing EU GDP (captured by $logGDP_j$) has a negative impact on EU imports where exporter-fixed effects and remoteness is excluded, though with an estimate which is not significant at a 95% confidence interval. EU GDP has a positive impact where export-fixed-effects are included accounting for a 1.25% increase in imports for every 1% increase in EU GDP. This is consistent with the literature.

Across each model there is a very strong EU effect, with an increase in exports of between 1.4 and 4.1% for countries in the EU when controlling for other variables. This is unsurprising given the values in Table 1 and consistent with gravity literature. A similar effect, though not as pronounced, is present for contiguous countries which are not part of the EU, like Turkey and the Ukraine, though this effect is reversed when accounting for specific exporter-fixed-effects. The EU effect appears to fall in the presence of remoteness indices; however, this is likely a result of the multicollinearity as defined, and hence we caution against too much interpretation (see Table 12.

5.2. Gravity estimates for Aluminium

For Aluminium, a similar relationship between exporter-GDP and exports to the EU is observed with a 1.1% increase in exports for every 1% increase in GDP (see Table 9). In the presence of exporter-fixed-effects, the relationship becomes smaller and no longer significant at the 95% confidence interval. A potential interpretation of this estimate is that beyond exporter capabilities, export GDP is unable to explain additional propensity to export to the EU despite correlation between exporter GDP and exports to the EU.

As with Primary Steel, there is an inverse relationship between EU GDP and EU imports, for which we posit the same interpretation as for Aluminium. Though this relationship is less pronounced and even changes direction when exporter-fixed-effects are taken into consideration.

Table 9 Gravity Estimates for Model 2: Aluminium

Variable	Equation (1): OLS	Equation (2): OLS w/ Remoteness Indices	Equation (3): OLS w/ Fixed Effects	Equation (4): PPML w/ Fixed Effects
Constant	20.42**	64.55**	N/A	18.11**
$logGDP_i$	1.10**	1.11**	0.29	0.00
$logGDP_j$	-1.30**	0.23	0.64	0.00
$logD_{ij}$	**-0.58****	**-0.54****	**0.06**	**-0.92****
$logREM_i$	-	-0.21	-	-
$logREM_j$	-	-6.67**	-	-
FE_i	No	No	Yes	Yes
EU	4.27**	4.25**	1.14**	2.37**
CONT	2.50**	2.48**	11.58**	0.70**
COL	-0.26	-0.25	0.97	-1.02
LANG	-0.82	-0.81	5.98**	-0.63
RTA	-0.08	-0.00	0.04	0.01
TRQ	N/A	N/A	N/A	N/A
Observations	**1029**	**1029**	**1029**	**1320**
Adjusted R^2	**0.63**	**0.64**	**0.91**	**0.69**
p-value	**< 2.2e-16**	**< 2.2e-16**	**N/A**	**< 2.2e-16**

Note: Signif. codes: ** $p < 0.05$
Following Shepherd et al (2019), equations (1) - (3) are estimated in R using an ordinary least squares methodology, using the estimatr package and the lm_robust function, while equation (4) is estimated in R using the PPML methodology, using the gravity package and the ppml function.

Distance has its traditional inverse relationship and is significant, other than in the presence of fixed effects. The relationship is less pronounced than for Primary Steel, with a 0.54 - 0.92% decrease in imports for every 1% increase in distance.

As with Primary Steel, we observe a strong EU- and contiguous-effect for exports to the EU. We further note a significant inverse relationship between the EU's inward multilateral resistance term, measured by the remoteness index. The presence of multicollinearity between the resistance term and EU GDP may however undermine the validity of these estimates (see Table 12).

5.3. Obtaining estimates of direct impact of EU CBAM

The imposition of CBAM duties will (all else equal) raise the cost of importing regulated products from third countries into the EU, and thus trigger a demand response (see Figure 3). To determine this response, this study applies the carbon intensity of exports to determine the potential CBAM duty which may be applied as follows:

(5) $CBAM_i^k = \frac{I_i^k \times (ETS_{EU} - CP_i)}{p_{ij}^k}$

Where $CBAM_i^k$ is the CBAM duty to be applied on good *k* imported from country *i*;

I_i^k is the emissions-intensity of production in tCO_2e per ton of good *k* in country *i*;

ETS_{EU} is the prevailing EUA price in the EU;

CP_i is the carbon price in country *i*; and

p_{ij}^k is the CIF price per ton of good *k* exported from country *i* as landed in country *j*.

Following Korpar et al (2023) and World Bank (2023c), this study applies an EUA price of \$100 per tCO_2e to determine the CBAM duty, the results of which are captured in Table 10.

Table 10 Implied duties for CBAM regulated commodities exported by SA to the EU

HS Code	Description	(A) 2022 CIF price ($ / ton)	(B) CO_2e emissions (per ton)	(C) Implied CBAM duty (%)
720110	Non-alloy pig iron	$482	1.35**	**~25%**
720219	Ferro-manganese	$2,493	1.3 - 1.5**	**~5%**
720241	Ferro-chromium	$1,391	1.3**	**~10%**
721049	Zinc-coated flat steel	$1,295	2.7*	**~20%**
7219	Flat-rolled stainless steel	$3,535	0.4***	**~1%**
760110	Non-alloy wrought aluminium	$3,121	1.7**	**~5%**
760612	Sheets of aluminium alloys	$4,818	0.5*	**~5%**

Source: (A) 2022 CIF Price from TradeMap based on EU Reporting; (B) *Company Reports; **IPCC (2006); ***ISSF (2022) (C) Application of Equation (5) based on on $100/tCO2e EUA price

To determine the potential impact of the CBAM duty, the distance coefficient from the relevant model is used to impute the elasticity of demand and applied as follows:

$$(6)\ \Delta X_{ij}^{k} = \beta_{ij}^{k} \times \left(\frac{CBAM_{i}^{k}}{p_{ij}^{k}}\right)$$

Where ΔX_{ij}^{k} is the change in exports of good k from country i to country j; and

β_{ij}^{k} is the elasticity of demand for good k from country i to the EU estimated in Sections 5.1 and 5.2.

For commodities falling under the tariff heading 72 corresponding to Primary Steel, the elasticity range of 0.8 to 1.28 is applied from Model 1. For commodities falling under the tariff heading 76 corresponding to Aluminium, the elasticity range of 0.54 to 0.92 is applied from Model 2.

For illustrative purposes, the CBAM duty is applied in the 2022 calendar-year to determine what the fall in demand for SA exports would have been had the CBAM been in place at this stage (see Table 11).

Table 11 Change in demand for SA exports to the EU from implementation of CBAM

HS Code	Description	2022 Exports ($'M)	Demand Elasticity	Applied CBAM duty (%)	Change in demand ($'M)
720110	Non-alloy pig iron	172.8	0.8 - 1.28	~25%	**-34.6 to - 55.3**
720219	Ferro-manganese	95.0	0.8 - 1.28	~5%	**-3.8 to - 6.1**
720241	Ferro-chromium	361.2	0.8 - 1.28	~10%	**-28.9 to - 46.2**
721049	Zinc-coated flat steel	142.5	0.8 - 1.28	~20%	**-22.8 to - 36.5**
7219	Flat-rolled stainless steel	442.1	0.8 - 1.28	~1%	**-3.5 to - 5.7**
760110	Non-alloy wrought aluminium	530.6	0.54 - 0.92	~5%	**-14.3 to - 24.4**
760612	Sheets of aluminium alloys	241.9	0.54 - 0.92	~5%	**-6.5 to - 11.1**
	TOTAL	**1986.1**			**-114 to - 185**

Notes: -ve sign on change in demand reflects a fall in demand

Applying the above methodology, this study estimates that SA exports to the EU would have fallen by $114 million to $185 million had the CBAM been in effect in 2022, equivalent to between 6 and 9% of exports of commodities covered.

5.4. Robustness and validation

To validate the results, the expected change in demand as a result of the CBAM has been shared with respondents to this study, who are major producers in the SA steel and aluminium value chains. This is deemed appropriate given that many of the producers have their own internal economic teams who have engaged in modelling work to assess the potential impact of the CBAM on their business. Respondents representing 32% of exports by value have positively affirmed the estimated change in demand; while 68% of exports failed to respond in time for submission.

To inform the quality of the model, a multicollinearity heatmap (see Table 12) is developed to determine correlation of main variables in the model. Other than the remoteness indices, which by definition are a function of distance and GDP, there is limited evidence of multicollinearity.

Table 12 Multicollinearity heatmap

	GDPi	GDPj	DIST	REMik	REMjk	EU	CONT	LANG	COLONY	RTA	TRQ
GDPi	100%	6%	-3%	-12%	6%	4%	1%	-3%	-2%	-3%	6%
GDPj	6%	100%	1%	3%	76%	0%	0%	1%	0%	18%	62%
DIST	-3%	1%	100%	93%	1%	-54%	-34%	5%	13%	6%	11%
REMik	-12%	3%	93%	100%	5%	-54%	-33%	17%	22%	6%	11%
REMjk	6%	76%	1%	5%	100%	0%	0%	1%	0%	20%	50%
EU	4%	0%	-54%	-54%	0%	100%	-1%	26%	-9%	-18%	-22%
CONT	1%	0%	-34%	-33%	0%	-1%	100%	-11%	-16%	21%	1%
LANG	-3%	1%	5%	17%	1%	26%	-11%	100%	36%	12%	-8%
COLONY	-2%	0%	13%	22%	0%	-9%	-16%	36%	100%	-5%	2%
RTA	-3%	18%	6%	6%	20%	-18%	21%	12%	-5%	100%	20%
TRQ	4%	62%	11%	11%	50%	-22%	1%	-8%	2%	20%	100%

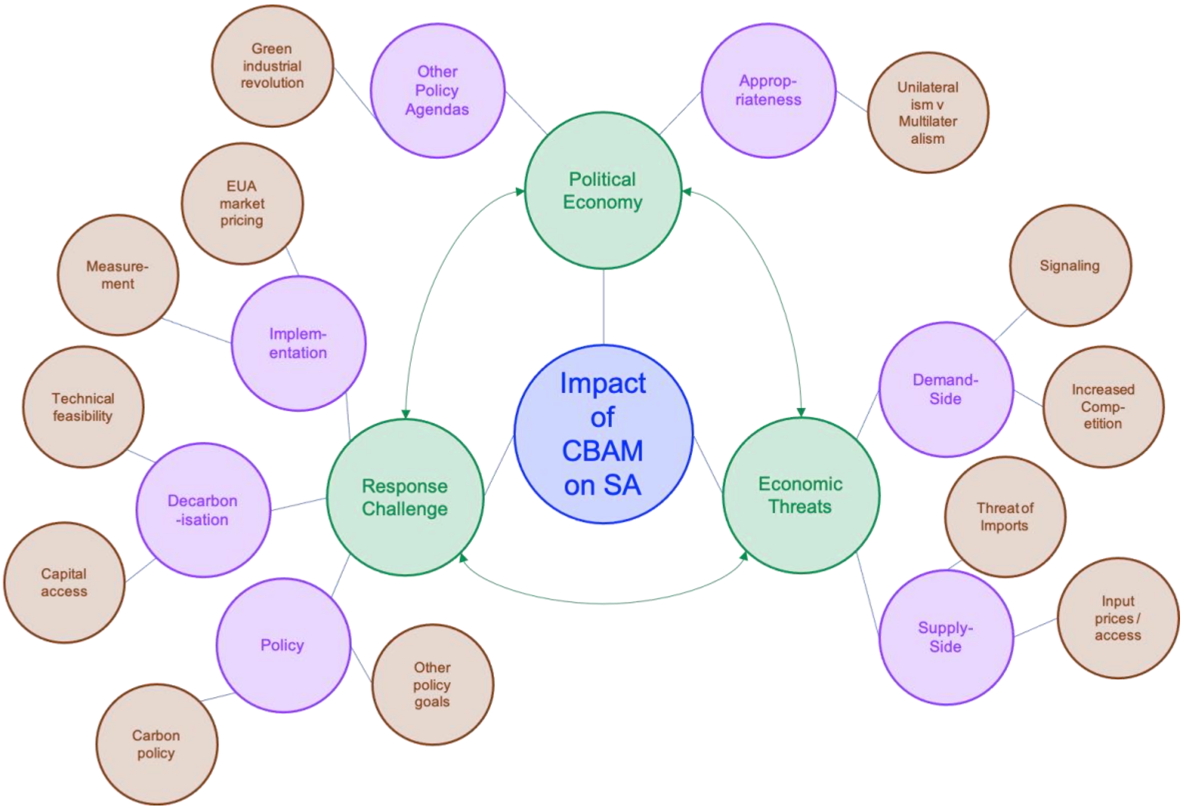
Note: the correlation between REM_i and REM_j and distance is notably since they are derived as a function thereof

6. Results of stakeholder interviews

From the stakeholder interviews several themes have emerged, which relate to the core research question of dimensioning and estimating the impact of the EU CBAM on the SA steel and aluminium industries. The network of themes has been illustrated in Figure 7.

At a high level, stakeholder responses can be grouped into three Level I themes, being (i) the political economy of the CBAM; (ii) the economic threats of the CBAM; and (iii) the response challenge for firms and policymakers.

Figure 7 Thematic map of stakeholder responses



Source: author's own. Level I are in green and closest to the centre. Level II themes are in magenta. Level III are in brown and in the out most ring of the thematic map.

The three Level I themes can be further decomposed into respective sets of Level II themes, which are again decomposed into Level III themes, discussed in detail in the sections below. While these themes are distinct in character, they can interact with each other. For example, views on the economic threats of the CBAM interact with the broader political economy, including the broader competitive landscape of the green industrial revolution, and may thus have an impact on how policymakers and firms choose to respond to the CBAM.

6.1. The political economy of the EU CBAM

The political economy of the EU CBAM was a consistent and pervasive theme throughout stakeholder responses. The Level I political economy theme can be further decomposed into two underlying Level II themes, being (i) other political agendas; and (ii) fairness and appropriateness of the CBAM in the context of global treaties.

6.1.1. Other policy agendas

Respondents reflected that the EU CBAM ought to be seen in a broader economic context, which goes beyond ambition on climate. For example, stakeholder responses drew comparison between the CBAM and the IRA, and the fight for global relevance in the broader green industrial revolution. Stakeholder responses which illustrate this theme are captured in Table 13.

Table 13 Selected stakeholder responses for 'other policy agendas' theme

Stakeholder grouping	Select Quotes
Policymaker	"We've seen over the last number of years the rise of a new green industrial policy. In the US, it relies on the IRA. In the EU, the tendency is for green protectionism, using climate as an instrument for shielding industries and securing a competitive advantage for those industries."
Research	"it looks like [the US and EU] are entering a mode of more active industrial policy aligned to their own interests and the world rules be damned, we'll sort that out in 20 years, or we'll rewrite them, or we'll just not correlate the forums and we'll wait and see."
Policymaker	"the IRA will probably have a more significant impact than the CBAM."
Bank	"We mustn't overlook the fact that the EU is trying to get jobs and income and profits for the EU. The stated support for sustainability and climate is only part of the picture. There are very strong commercial goals here and I think a lot of people overlook that."

Source: Stakeholder interviews; quotes not attributed to specific stakeholders by request of participants

6.1.2. The fairness and appropriateness of CBAM

Stakeholder responses further reflected upon the tension between the CBAM and the global consensus on climate action. Respondents generally reflect that the implementation of CBAM is an unfair act of unilateralism which is in contrast to the "spirit" if not indeed the text of global treaties. Stakeholder responses which illustrate this theme are captured in Table 14.

Table 14 Selected stakeholder responses for 'fairness and appropriateness of CBAM' theme

Stakeholder grouping	Select Quotes
Policymaker	"Europe has taken more than two centuries to develop a strong and quite competitive economy. But that economy was based on massive carbon emission. And now, having secured that advantage, it wants to say we will impose standards on others who are now starting their industrialization."
Policymaker	"the deep irony in the post-colonial period [is that] we are being penalised for the colonial structure that has been foisted on our economies in an earlier age."
Policymaker	"t[he CBAM] encroaches on [the] sovereignty of countries"
Policymaker	"the [Paris Agreement] allow[s] countries to look at their own circumstances and implement it in accordance [with] their own development needs."
Policymaker	"in terms of the UNFCCC, it was about a just transition, not just any transition. You have to take into account the need to transition, but also the need for sustainable development."
Researcher	"[the EU] haven't even tried sufficiently and meaningfully to consult. There is an obligation that if you impose a measure that may have a negative impact on other countries, you should consult."
Policymaker	"[the CBAM risks creating a polarisation] of those who support the EU position and those who are opposed to it and it breaks down a necessary global consensus on climate change.
Policymaker	"Many of the countries who are now proposing the CBAM opposed [labour clauses] even though it was [based on] the same logic [as carbon leakage]... it was rejected because it was argued, even by developed countries that the level of development across the world was such that if you had to impose similar labour standards across the world you would leave large parts of the world in deep poverty because they would not be able to industrialise."
Bank	"we're getting European regulators are going to be now affecting the design of our African electric grids, which are already built on colonial imperialist foundations and have been through any number of other iterations before that and likely to lead to some bizarre outcomes."

Source: Stakeholder interviews; quotes not attributed to specific stakeholders by request of participants

6.2. The economic threat of the EU CBAM

The economic threat of the EU CBAM was a further consistent theme which emerged from stakeholder responses. Stakeholders argued that the economic effects may extend beyond the direct loss of revenue within the EU, and may include a set of other demand-side and supply-side impacts which are decomposed as a set of Level II themes.

6.2.1. Other demand-side effects of EU CBAM

6.2.1.1. Increased competition in alternate markets

Stakeholder responses highlighted that the demand-side impact of the EU CBAM may spill over into other geographies which serve as export markets for SA steel and aluminium, increasing competition in these markets. Such effects occur because as EU demand for imported steel and aluminium contracts (as estimated by the econometric part of this study), exporters are forced to find alternate markets. Stakeholder responses reflect that such alternate markets are likely to be those with less stringent climate regulation, most notably the African continent, which may undermine SA exporters attempts to exploit opportunities across the continent. Stakeholder responses which illustrate this theme are captured in Table 15.

Table 15 Selected stakeholder responses for 'increased competition in alternate markets' theme

Stakeholder grouping	Select Quotes
Bank	"you have a lot of production that needs to find a new home."
Federation	"Because of limitations of carbon limitations and the involvement with regard to greening the industry, more and more of the steel producers worldwide are aiming for destinations that are not so strict on the carbon side as Europe is, for example."
Policymaker	"Because the more lucrative market of the EU cannot be accessed, we may well see either much lower prices which will come quite close to dumped product or even dumping of product as companies and countries try to get rid of what will now be excess production."
Federation	"Indian mills are [going to be] very active in Africa, the Chinese mills are very active in Africa, the Southeast Asian malls are very active in Africa, your Brazilian mills are very active in Africa"

Source: Stakeholder interviews; quotes not attributed to specific stakeholders by request of participants

6.2.1.2. Signalling effects through emissions reporting

Stakeholder responses highlighted that further demand-side risks may emerge from the reporting of emissions. Notwithstanding that for many commodities CBAM duties will be levied from 2026 based on direct emissions only, the required reporting Scope 2 is likely to send an early signal that SA production is ‘dirtier’, potentially redirecting EU imports away from SA even before any duties are levied.

Table 16 Selected stakeholder responses for ‘signalling effect’ theme

Stakeholder grouping	Select Quotes
Producer	"The issue is that we are going to see the effects even before the CBAM comes into effect. Because if you are not able to trace your carbon emissions and are transparent about the content of your carbon emissions in your exports, then because the importers in the EU have to pay the CBAM what they will do, is to look at shifting sourcing from those who are able to report and are already gearing themselves in terms of adhering to the CBAM once it is implemented."

Source: Stakeholder interviews; quotes not attributed to specific stakeholders by request of participants

6.2.2. Supply-side effects of EU CBAM

6.2.2.1. Competition for scrap metal

Increased competition for scrap metal is expected to result from increased investment in EAF technology as an intermediate step in greening the industry. EAF production, which has a lower carbon footprint than traditional BOF technology (World Steel Association, 2022), uses scrap metal as a core input (Lee and Sohn, 2014). As investment in such technology increases, demand for scrap as an input increases. This is likely to put SA producers at a disadvantage because of higher international prices and the lower generation of scrap in SA. It was also noted that the CBAM does not apply to the import of scrap steel and aluminium. Stakeholder responses which illustrate this theme are captured in Table 17.

Table 17 Selected stakeholder responses for ‘competition for scrap metal’ theme

Stakeholder grouping	Select Quotes
Producer	“You're going to lose the export potential of scrap. And that will change the dynamics and the costing in the world, the pricing of scrap relative to iron ore"
Federation	"I think global demand for scrap will definitely increase as more and more mills will actually divert into trying to become more greener."

Federation	"many countries are currently embarking on trade restrictions on scrap. India has blocked the exports of scrap, China has blocked the exports of scrap. They are importing scrap. It's as Europe is doing importing, but you cannot export from there."

Source: Stakeholder interviews; quotes not attributed to specific stakeholders by request of participants

6.2.2.2. Risk of increased steel and aluminium imports into SA

In addition, the same competitive dynamics which are discussed in Section 6.2.1.1 above may position SA an attractive alternate market for other third countries, thus increasing domestic competition for SA steel and aluminium producers. Stakeholder responses which illustrate this theme are captured in Table 18.

Table 18 Selected stakeholder responses for 'risk of increased imports' theme

Stakeholder grouping	Select Quotes
Policymaker	"[SA] is a very trade exposed economy. Trade as a percentage of [SA's] GDP is materially higher than many peer countries… so the diversion of trade is likely to be one significant consequence of CBAM [for SA]."
Bank	"A lot of the covered products are ones where we're actually not super competitive, we're not the lowest cost producer globally. So I think that the incoming imports being at a lower price point are a threat"
Federation	"South Africa will be at higher risk of imports, given how active Chinese, Indian and Brazilian mills are on the African continent"

Source: Stakeholder interviews; quotes not attributed to specific stakeholders by request of participants

6.3. Response challenges for firms and policymakers in SA

Stakeholder responses highlight response challenges which emerge for both firms and policymakers, being the challenge of (i) implementation; (ii) decarbonisation; and (iii) policy.

6.3.1. Implementation challenges

6.3.1.1. Measurement of emissions

The measurement of emissions is likely to be challenging for smaller firms in the SA steel and aluminium value chain. Further, while the CBAM allows for default values to be used where emissions data is missing, this may result in some 'adverse selection' whereby high emission producers prefer not to report so as to lower their duties through use of the default values. Stakeholder responses which illustrate this theme are captured in Table 19.

Table 19 Selected stakeholder responses for 'measurement of emissions' theme

Stakeholder grouping	Select Quotes
Researcher	"[SA doesn't] have the kind of state budget [the EU has] to collect all the data that a process like this needs. [The EU has] a competitive advantage when it comes to administrative heavy processes like this."
Bank	"an administrative burden arise[s] with the implementation of the CBAM for local industries [because of] the data that would be required."
Bank	"Businesses are reluctant to invest too much time in it because they know it's going to change"
Bank	"And there's a safe default in just like not reporting anything because then the use says you use new norms. Exactly. Yeah. So cool, right. Probably you're going to be more fossil fuel intensive than the EU, so you can default down."

Source: Stakeholder interviews; quotes not attributed to specific stakeholders by request of participants

6.3.1.2. Linking duties to a market mechanism

Where most import duties are set as fixed percentage of the value of imports, the CBAM duty will be dynamic, linked to the price of EUAs sold in weekly auctions under the ETS. This may lead to volatility in import duties, given that EUA prices themselves have been historically volatile (see Figure 2). Stakeholders expressed concerns of increased uncertainty for importers and exporters. Gaming of the system may further lead to unexpected and perverse outcomes. Stakeholder responses which illustrate this theme are captured in Table 20.

Table 20 Selected stakeholder responses for 'linking duties to market mechanism' theme

Stakeholder grouping	Select Quotes
Producer	"When you're competing on price because it's imported, your lead time is much longer."
Bank	"The CBAM references to the price of the ETS, and that's a market mechanism. Very few tariffs are not like fixed percentages."
Bank	"You've got to tailor your trade barrier relative to the price of carbon in the EU"

Bank	"The CBAM in effect is a derivative market in that it's linked to the ETs, but it's a derivative market where you can never convert into the underlying, so the price is referenced to that, but you never consume emissions from that cap within the EU".

Source: Stakeholder interviews; quotes not attributed to specific stakeholders by request of participants

6.3.2. Decarbonisation challenges

6.3.2.1. Technical feasibility

Stakeholders argued that in terms of direct emissions, SA steel and aluminium producers are in line with global medians. Nonetheless, respondents highlighted that where possible investments are being made in processes which can improve direct emissions profiles.

SA producers are however at a disadvantage in terms of indirect emissions given SA's reliance on coal-fired generation. While responses highlight increased investment in own-generation renewable energy, limitation exist because of, inter alia, the need for continuous operations, which are incompatible with the intermittency of renewables. Stakeholder responses which illustrate this theme are captured in Table 21.

Table 21 Selected stakeholder responses for 'technical feasibility' theme

Stakeholder grouping	Select Quotes
Federation	"But also the intermittency of that energy profile, given the load that they demand, solar can't really match that, right? So what you then found out in this survey is that 60% of investment into alternative energy sources were actually into [diesel generators]."
Researcher	"[the industry] can't do it alone because we don't have the resources, the finance, because it would require huge financial adjustments, the adjustments, but also new technologies."

Source: Stakeholder interviews; quotes not attributed to specific stakeholders by request of participants

6.3.2.2. Access to capital

Some respondents argued that the largest impediment to decarbonisation lay in access to capital, rather than technical limitations. Capital is expected to be constrained from both public and private resources, risking a set-back for SA firms. Stakeholder responses which illustrate this theme are captured in Table 22.

Table 22 Selected stakeholder responses for 'access to capital' theme

Stakeholder grouping	Select Quotes
Bank	"on a standalone basis [steelmakers] would not be able to support [the required investment] from a credit perspective."
Bank	"Capital, I think for me I see it as the biggest challenge because on the technical and the technology side, as I said, I think we have the technology and technical capabilities."
Policymaker	"capital required for [the] shift is significant and would need to be financed in the private sector."
Bank	"governments around the world take all the [investment attractiveness] out of [the steel industry] by just supporting it directly through subsidies or indirectly through some sort of state support."
Bank	"the steel market itself is not like a globally competitive market; it's very heavily impacted by subsidies and trade agreements."
Researcher	""The Paris climate finance discussion, very important because that's really about changing the whole architecture of finance and wood system because in the current system, there's absolutely no way the additional finance can be obtained to fund the transition."

Source: Stakeholder interviews; quotes not attributed to specific stakeholders by request of participants

6.3.3. Policy challenges

6.3.3.1. The interaction of other policy goals with climate action

Stakeholder responses highlighted that climate action in SA ought to be appropriately prioritised alongside other policy goals. While every respondent affirmed the importance of climate action, some argued that SA's specific developmental needs, including high unemployment, required special consideration. Stakeholders further argued that the CBAM compounds other challenges already faced by firms. Stakeholder responses which illustrate this theme are captured in Table 23.

Table 23 Selected stakeholder responses for 'interaction with other policy goals' theme

Stakeholder grouping	Select Quotes
Producer	"inefficiencies at our ports and the logistics to get it to port, are becoming significant barriers to export."
Producer	"whatever [competitiveness] was built in factory is undone by just getting it to port."
Producer	"We have a renewable resource base that far exceeds most other countries and can be exploited far more cheaply."
Federation	"the CBAM is just an unwelcome additional challenge that the industry now has to face on top of all of the other challenges. And it's hard to say how much of if the industry was in a healthy space, could it absorb some of the imposed cost of the CBAM."

Source: Stakeholder interviews; quotes not attributed to specific stakeholders by request of participants

6.3.3.2. Ability to implement more stringent carbon policy

While the CBAM allows importers to offset any eligible carbon tax paid in the country of origin to reduce the duty, the ability to increase carbon taxes in SA is limited by both economic and institutional capacity. Some respondents argued the existing SA carbon tax, which is expected to nearly double by the time CBAM comes into effect (SA Govt, 2023), already puts a significant burden on SA firms, and raises domestic concerns of competitiveness. It was further argued that increasing carbon taxes necessitated an SA BCA, however institutional capacity to do remains limited. Stakeholder responses which illustrate this theme are captured in Table 24.

Table 24 Selected stakeholder responses for 'ability to implement more stringent carbon policy' theme

Stakeholder grouping	Select Quotes
Federation	"the taxes on the developing countries are unbearable and we will actually lose quite a lot of traction."
Policymaker	"we have had quite significant challenges even with introducing those tax rates in as much as they may not be as high, as arguably they could be. But we have to look at the South African context and us as a developing country. Yes, we are one of the high emitting countries, but we also are a developing country. And so, we have to sort of juggle those two realities in our policy approach."
Policymaker	"There was some discussion of a domestic BCA. However, there were issues with regards to how do you administer that, do we have enough data to implement that, et cetera. And from those discussions, then we finally decided on the Trade Exposure allowance as part of the carbon tax design."

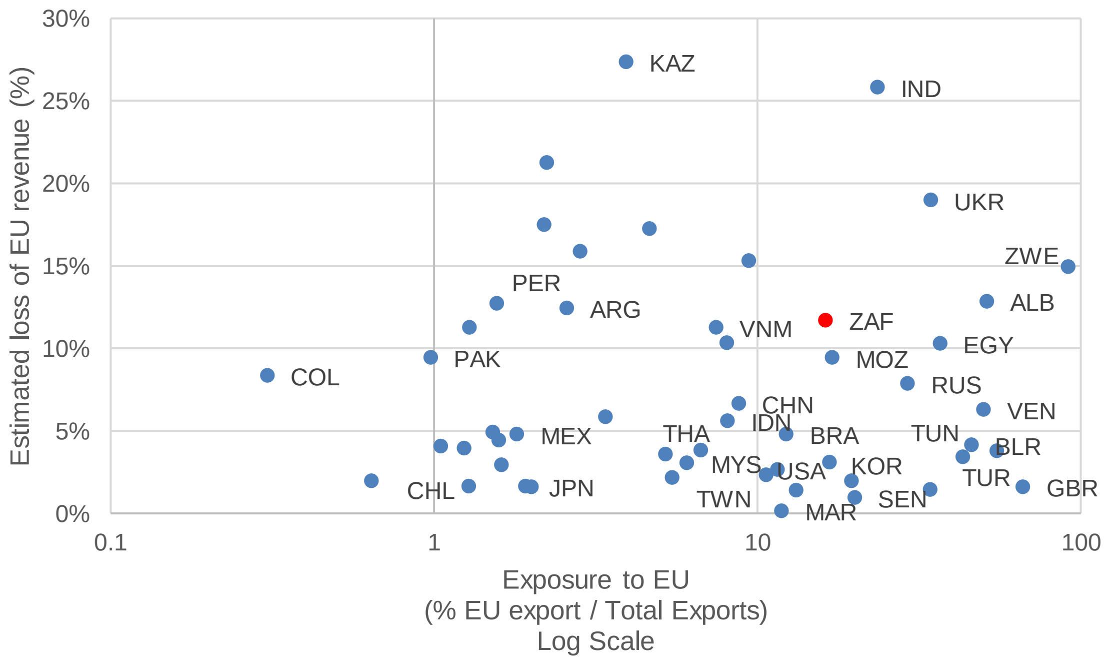
Source: Stakeholder interviews; quotes not attributed to specific stakeholders by request of participants

7. Discussion

The results of the quantitative and qualitative parts of this study illustrate the pervasive extent to which the EU CBAM is likely to impact SA. It further highlights the extent to which the response from SA firms may be limited by access to capital and their reliance on the SA energy grid. Policymakers may be limited too in terms of policy space and competing priorities. We argue that SA provides an illustrative example of how other developing, resource-intensive countries may be impacted.

The results from Model 1 and 2 in Sections 5.1 and 5.2 can be extended to other third countries which export regulated products to the EU, and can thus be used as an estimator of how the CBAM will impact trade. Using the World Bank (2023c) 'Relative CBAM Exposure Index', an estimate for a group of countries in the steel sector is provided as illustrated in Figure 8.

Figure 8 Third Country estimate for lost revenue and exposure to the EU, Iron and Steel



Notes: assumes the higher end of elasticity range of 1.28, using data on emissions and exposure to EU from World Bank (2023c). Estimates for SA (ZAF) differ to those obtained in Table 11 due to different focus of data set on Iron and Steel across tariff headings 26, 72 and 73

The need for urgency in climate action is indeed clear. However, a careful balancing of the risks and opportunities of the climate policy is required. The pursuit of net-zero must be consistent with other sustainable development objectives in order for it to be credible (Fankhauser et al, 2022). If the CBAM only serves to shift the burden of decarbonisation from developed to developing countries without the necessary financial and technical support, it is arguably a regressive policy, and one which may only serve to deepen fractures in the global rules-based system. Figure 8 illustrated how several third countries, many of which are developing, may losses through the implementation of the CBAM.

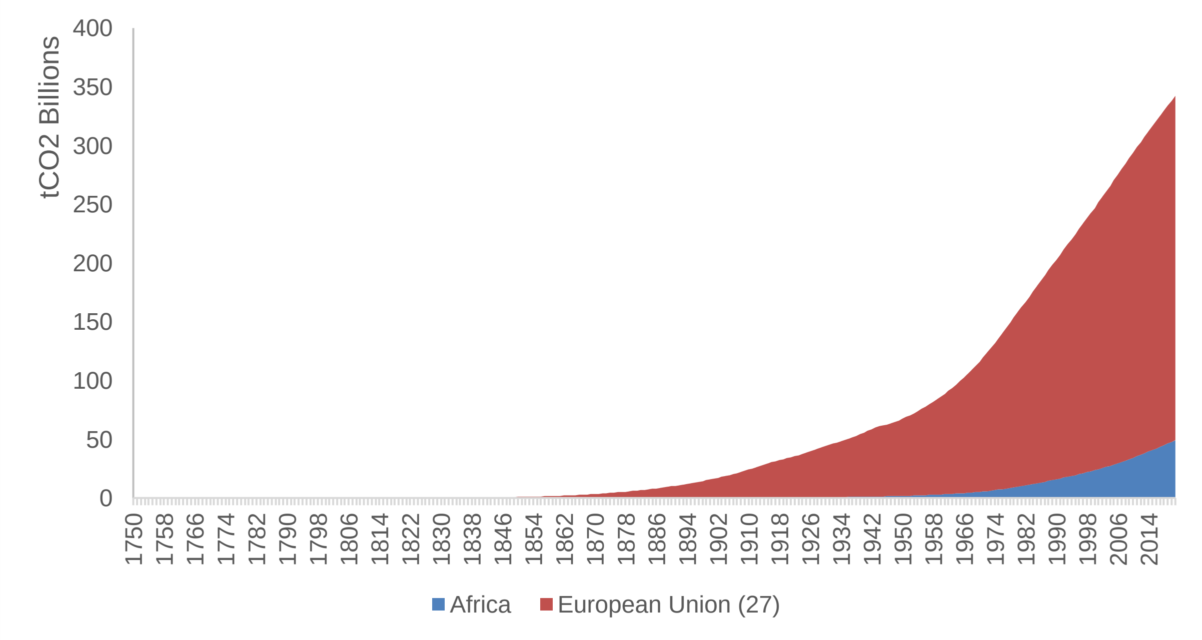
The introduction of the CBAM and the cost to EU trading partners thus gives rise to an important set of necessarily nuanced debates and discussions about fairness in the pursuit of climate action. This section of the paper thus attempts to contextualise these debates, and finally to conclude with a set of policy recommendations which can give effect to the need for action, while addressing concerns of competitiveness, and providing the necessary space for developing countries.

7.1. Climate justice and the CBAM

The implementation of the CBAM must be positioned within the context of fairness and climate justice for it to be seen as a credible tool in the fight against climate change. While it may be uncomfortable, engaging with the historical source of climate change, including culpability and responsibility is critical. Cumulative historic emissions in the EU far exceed those in Africa by a ratio of nearly six-to-one (see Figure 9). The very first carbon emissions from the 'dark satanic mills' (Blake, 1808) of the early industrial revolution still contribute to climate change today, continuing to cast their long shadow. Moreover, these emissions occurred at a time when much of the African continent was still subject to a European led trans-Atlantic slave trade.

The political scars left by the partition of the continent at the 1884 Berlin Conference – an extractive exercise which positioned the African continent as a source of resources in order to fuel the European industrial revolution (Craven, 2015) – painfully remain.

Figure 9 Cumulative historic CO_2 emissions



Source: Ritchie et al, 2020

Moreover, historical structures of globalism and systems of exploitation, including “racial capitalism and colonialism” exacerbate climate injustices in the developing world today (Sultana, 2022, p. 120). Engagement with historical emissions should not been as an obfuscation of responsibility for the Global South. Rather it should be seen as an appreciation of the intersectionality of climate justice. Recognition of historic imbalances have been built into global agreements on climate change, including the Paris Agreement (2015), which was developed using the principle of CBDR.

Implementation of the CBAM has been argued (by scholars and participants to this study) as a contravention of the CBDR principal, since its effect is to impose a singular carbon price on every country which seeks to maintain its access to the EU market. Given the size of the EU as a market for commodities regulated by the CBAM (see Table 2), this effect will be far reaching.

The CBAM may also serve to undermine agreements like the EU-SADC Economic Partnership Agreement, which sought to create a better integration of African manufacturing into European supply chains. Since the CBAM does not cover basic commodities, it may render beneficiation of these products in Africa uneconomical, prompting producers to export the lower value raw material. For example, chromium ore is not subject to the CBAM, while beneficiated ferrochromium is. At higher CBAM duties it may be more economical to export unprocessed chromium, rather than the processed ferrochromium which would attract a duty. This would result in a transfer of welfare and jobs from Africa to the EU.

The potential losses, which this study estimates, risks impeding the ability of global value chains to act as a pathway of economic convergence cutting off a vital source of growth and development. The CBAM thus risks being one of a proliferation of climate policies which contribute to ‘climate injustice’ is so far that it does not account for historical emissions (Khosla et al, 2023).

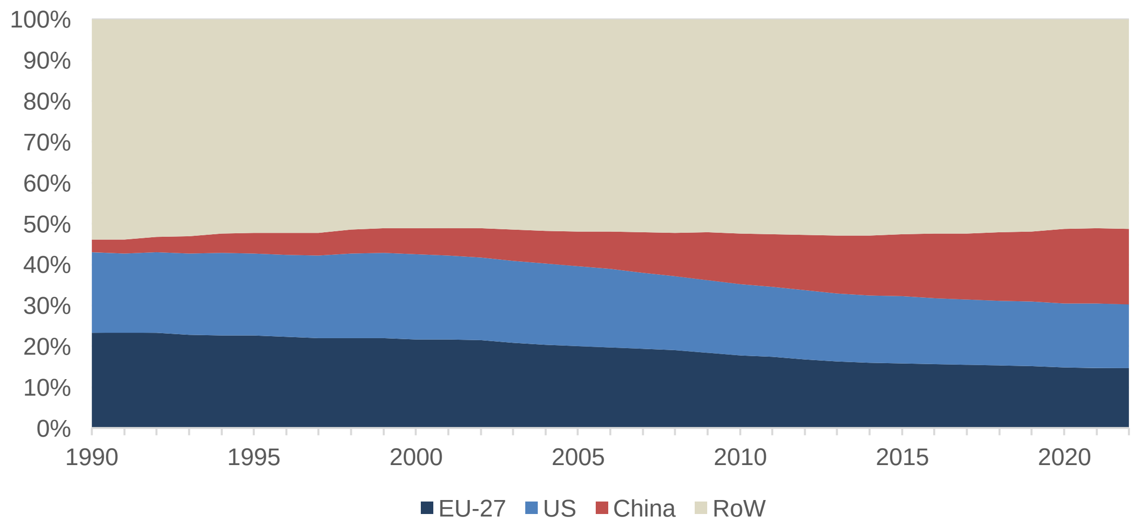
7.2. The geopolitics of the green industrial revolution

With the increasing global ambition of countries and firms to reach net zero, accompanied by the massive investment required, scholars now recognise the emergence of the green industrial revolution as a new and distinct phase in the world’s economic structure (Clarke and Cooke, 2014). This phase will encompass significant changes in how energy is produced and delivered to households and businesses, and will further be complemented by shifts in the technology and consumer habits generating new industrial opportunities.

Countries and firms around the world are thus positioning themselves to take advantage of this opportunity, no doubt seeking to be on the right side of the likely Schumpeterian process of 'creative destructive' which will create winners and losers (Bowen and Fankhauser, 2011). Schumpeterian growth is inherently chaotic as an evolutionary struggle for survival plays out between incumbent and novel technologies, and its perhaps through this lens that the EGD, IRA and other climate policy should be viewed, as participants to this study have argued.

The green transition is expected to change the geopolitics of energy, and indeed the world over, the 21st century. During the last three decades, the EU and US have both lost ground in terms economic output, with an increasing share of output emanating from China (see Figure 10). While for much of the period, the three blocs have constituted half on global GDP (constant PPP), there has been a relative transfer of wealth from the US and EU to China. Scholars have argued, China's advance in renewable energy supply chains since 2011 (IEA, 2022) has further threatened the EU and US' global competitive position (Allan et al, 2021).

Figure 10 Share of global GDP (PPP, constant 2017 USD)



Source: World Bank (2023b)

Embedded within the geopolitics of the green industrial revolution is a fight for relevance in the sectors which will most enable the green transition. Respondents argued that the EU and US are seeking economic relevance as much as climate ambition with the implementation of the respective EGD and IRA.

In the tensions between these large global players emerges a risk that the developing world is either left behind or used as cannon fodder; the proverbial 'grass that is trampled as elephants fight'. As scholars have argued climate policy must serve to address inequity rather than widen it for it be just (Fankhauser et al, 2022). Where participants to study argued that the developing world was casualty of the first industrial revolutions, the green industrial revolutions should be rooted in an attempt address equity and bring balance to the world order as much as it brings balance to nature and climate.

7.3. CBAM and financing the green transition

Many participants to this study reflected that access to capital, not technology, may be the greatest inhibitor to a transition in the steel and aluminium industries. Capital, however, has not been forthcoming. It is estimated that African countries require $277 billion annually to finance just the NDCs submitted, while only 10% of this flowed in 2020 (CPI, 2022). The CBAM may well compound this problem given the need to go faster than previously planned in order to maintain EU market access.

The steel and aluminium sectors are generally regarded as hard-to-abate sectors given the technology and investment required (Bataille et, 2021). Achieving commercially viable operations consistent with net-zero emissions by 2050, is estimated to require up $11 billion per annum for steel (MPP, 2022a) and as much as $570 billion cumulatively for aluminium by

2050 (MPP, 2022b). However, as respondents to this study have argued (including those in the banking sector) commercial funding for the sector will be hard to raise, putting pressure on state budgets and public finance institutions.

The EU is mobilising significant state resources within its borders, with Germany alone reported to have earmarked $220 billion in funding until 2026 (Reuters, 2022). Given fiscal vulnerabilities in much of the developing world, respondents to this study reflected that state funding in developing countries is unlikely to be available, and that significant external financing is thus required. The $8.5 billion Just Energy Transition finance provided to SA by a group of wealthier countries in 2020 may be a good start, but arguably a deeper set of concessional terms are needed to generate the desired transitions. Failure to do so risks asset-stranding (Semieniuk et al, 2021) in the developing world and a widening of global inequalities.

7.4. Policy recommendations

The implementation of the CBAM is likely to have significant and adverse effects on developing countries, which when overlaid against the limited policy space in these countries, requires a more accommodating stance from the EU. Policy recommendations in this section thus seek to balance the impact on developing countries, while still creating the appropriate architecture for an ambitious and just transition to lower carbon technologies and infrastructure.

7.4.1. EU policy recommendations

Following Mealy et al (2023), equity clauses can serve to limit the widening of global inequalities which a CBAM may render. Three recommendations thus emerge as a result of this study, namely (i) the need for a targeted set of developing country exemptions; (ii) the introduction of relative carbon pricing; and (iii) the mobilisation of funding for developing countries.

7.4.1.1. Exemptions from the CBAM

This author recommends the exemption of countries which on aggregate do not represent a significant portion of the EU import basket. Economies with extensive investment in fossil fuel-related infrastructure may find themselves with more difficult trade-offs to make in respect of renewable energy investment. These trade-offs are even more challenging when one overlays other developmental challenges like high unemployment and inequality, particularly for African countries (Mulugetta et al, 2022).

Table 1 highlights the relatively small proportion of EU imports constituted by African exporters for CBAM regulated products (excluding electricity[4]), representing 9% of the total import basket from ‘third countries’.

Exempting African countries and other developing nations with similar profiles would likely not lead to substantial competitive pressure in the EU, and thus not contribute significantly to carbon leakage. Furthermore, it would help to root the measure within a framework of fairness which support a more ‘equitable’ journey towards net-zero.

There is also precedent under the GATT, in respect of safeguard measures whereby developing countries are exempt if their share of imports is below 3% (WTO, 2023b). Such a threshold may provide a helpful benchmark for an appropriate CBAM exemption.

[4] Electricity is excluded because of its limited trade beyond contiguous land borders.

7.4.1.2. Relative carbon pricing

The CBAM allows importers to offset any carbon taxes paid in the country of origin from any duty payable in the EU. In so doing, the EU sets a single carbon price which must be paid (either at the EU border or in jurisdiction of production) irrespective of domestic circumstances for all exporters wanting to maintain access.

This author recommends that any duty payable in the EU should reflect carbon taxes paid based on relative measures like PPP rather than absolute levels. Coupled with the exemptions referred to in 7.4.1.1, this approach would be consistent with the principles of CBDR and further give effect to the concepts of “equity” and “sustainable development” contained within Article 4.1 of the Paris Agreement (2015) (Khosla et al, 2023).

7.4.1.3. Mobilisation of funding

The decarbonisation of energy and production processes in developing countries will require significant funding, much of which will not be available in the form of private and commercial bank funding. Furthermore, debt-funded energy transition plans may be unhelpful for developing countries from a credit perspective given the already high debt burden (Fitch, 2022).

The EC (2023f) has estimated that the CBAM may raise as much as €1.5 billion (2018 prices) per year, which when taken with the expected revenues from the auction of EUAs may generate as much €36 billion annually. The use of funds however has not been made clear, other than to indicate that member states may hold 25% of these resources for state budgets.

This author recommends that a portion of these revenues are provided to developing countries on deeply concessional terms, with incentives for decarbonisation, thus enabling an appropriate and just transition.

7.4.2. SA policy recommendations

While the aforementioned recommendations would serve to address some of the equity issues which a CBAM may raise for developing countries, by the CBDR principle, developing countries have their own role to play in ensuring appropriate climate action. Several recommendations for SA thus emerge from this study, which focus on creating an enabling environment for the green transition without imposing significant additional costs on the SA fiscus or operating firms. These recommendations include: (i) fiscal support for green investment; (ii) increased urgency with respect to renewable energy and other green energy; and (iii) investment in network industries.

7.4.2.1. Fiscal support for green investment

The introduction of the CBAM is likely to raise competitive risks for exposed SA industries. Some commentators have argued that a steepening increase in carbon taxes in SA can limit the impact of the CBAM in the EU and further raise revenues for decarbonisation in SA (Maimele, 2023). However, this author cautions against this approach, as it may overburden domestic industry, further driving uncompetitiveness.

Instead, this author recommends further support policies which may provide an enabling environment for decarbonisation, including income tax holidays for firms investing in green technologies. Such tax holidays would not detract from the fiscus as the counterfactual is that no investment happens, thus depriving the fiscus of revenue in either case. This may require a break from traditional tax policy, and ring fencing of carbon and other such revenues to be channelled towards the green transition. Such policies may further mitigate against carbon leakage and other competitiveness risks for firms operating in SA. Where possible, targeted subsidies for green R&D may be mobilised through allocations already available for grants across government departments.

7.4.2.2. Increased urgency with respect to renewables and other green energy

This author recommends a rapid and further liberalisation of the energy market in SA in order to foster investment in lower carbon energy solutions, including the necessary regulatory framework for the development of green hydrogen in SA. This may include finalisation of the legislation around wheeling arrangements and the development of green energy industrial parks, positioned closer to major industrial centres. We further recommend the development of clean energy certification, which can verify the use of renewable energy in firms' production processes thus lowering Scope 2 emissions.

7.4.2.3. Investment in network industries

This author recommends investment in network industries like port, rail and road infrastructure in order to improve the competitiveness of firms operating in SA. Doing so can serve to improve the overall competitiveness of exports, thereby offsetting some of the cost increases which the CBAM may impose.

Investment in network industries can further support increased competitiveness for SA firms seeking access to alternate markets. Investment in network industries across the African continent can further support the development of regional value chains, giving effect to the AFCFTA.

8. Conclusion

Measuring the impact of climate policy on the most vulnerable parts of world is an important element of achieving climate action aligned to equity and sustainable development. The implementation of the CBAM is likely to have deep and far reaching implications for global value chains. While the current focus is on six sectors, it is clear that the ultimate expectations are for the regulations to be extended to nearly all EU imports. In the absence of measures to address potential inequity, the introduction of the CBAM risks polarising an increasingly divided world, creating long-lasting divisions which may ultimately undermine the global consensus on climate action.

Within the context, this study makes important contributions to the literature. First, it contributes to the measurement of impact by using the ‘workhorse’ gravity model of trade to estimate the potential direct effects of the CBAM on steel and aluminium exports from firms operating in SA to the EU. This study estimates that the implementation of the CBAM would result in a fall in direct revenue of between 6 and 9% for SA exporters. Had the CBAM already been in place in 2022, this would have equated to between $114 million to $185 million in lost sales for the year. If such losses were to manifest for SA firms it would be catastrophic. This study provides a further illustration of the direct effect for firms operating in the steel sectors of other third countries.

Second, this study includes an extensive set of interviews with 21 stakeholders who play considerable roles in the development of the SA steel and aluminium industry to dimension not yet measurable indirect effects. Interviews served to highlight the dynamic structures of the global steel and aluminium markets, and the uncertain and challenging context into which the CBAM is overlaid. Risks are far reaching and potentially large with disruptions in exports to others markets and constrained access to input materials expected.

Third, this study provides a set of policy recommendations which can serve to maintain the ambition on climate action while providing the policy space necessary for developing countries. At the time of this study, global average temperatures have reached their highest on record. The “safe operating space for humanity” is quickly disappearing (Rockström et al, 2009). The EU’s ambition to decarbonise along the targets outlined in the European Climate Law should thus be seen as a welcomed endeavour. However, the principles of CBDR must be adhered to if the transition is to be just and equitable. The analysis of SA as a developing country - albeit larger - should thus be seen as an exemplar of how other developing countries may be similarly at risk, and how more needs to be done to ensure the CBAM and other such ambitious climate policy does not simply shift the pains of transition to the Global South.

Finally, while the CBAM presents many threats to the SA economy, it presents opportunities for decisive action and financial mobilisation in support of a green transition in SA. Climate policy will serve to crystallise transition risks for all economies. In so doing, there is an understanding that paying the immediate transitions cost can mitigate the much higher physical costs which will come with inaction.

8.1. Limitations and suggestions for further research

Limitations for the specification of the gravity model used in this study have been reflected in Section 3.1.4 of this paper. The effects of the Ukraine-Russia conflict are also not present in the dataset, the impact of which may serve to alter trade patterns not yet captured by the econometric modelling. The use of the gravity model itself presents a limitation as a static snapshot based on a reference scenario. In some cases, a CGE framework may perform better, assuming that market structure can be appropriately defined. The use of agent-based modelling may also be more effective, however would require an appropriate mapping of the nodes of the system including the force and direction of interaction. Further stakeholder interviews and workshops may serve this purpose.

Stakeholder interviews focus solely on the SA ecosystem. A more inclusive study covering stakeholders from the EU as well as other third countries may provide a more conclusive mapping of the potential impact of the CBAM more broadly. There are also likely to be nuances which emerge when other sectors are included. While this study has not focused on other regulated sectors, learnings suggest that even though a third country may not export significant volumes of the regulated commodity to the EU, the global market adjustments may still impact. Further studies should thus consider these dynamics.

Finally, there is inherent uncertainty in both the modelling and stakeholder responses because of the novelty of BCAs. The next few years are likely to be a source of great learning as the CBAM comes into implementation, and as firms and third countries respond.

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Annexures

Annexure A: Question-prompts for stakeholder interviews

1. How exposed is [company name / sector] to the EU market?
2. How price sensitive are exports to the EU, and does [company name / sector] expect that the imposition of the CBAM will impact exports to the EU? Where does the imposition of the CBAM rank in terms of global risks to [company name / sector]'s business?
3. How does [company name / sector] rank on the global emissions profile for steel / aluminium production in terms of both Scope 1 and 2 emissions?
4. How does [company name / sector] expect the imposition of the CBAM to impact the global steel / aluminium market? How may it impact on the global scrap market?
5. Is there a risk of greater imports into South Africa as a result? What about the African market more generally?
6. What actions is [company name / sector] taking to reduce the emissions intensity of production? How much can be achieved through own gen?
7. What support would [company name / sector] be looking to from Government to navigate the risks imposed by the CBAM.

Annexure B: Research Project Summary circulated to interviewees ahead of interviews

The potential impact of the EU Carbon Border Adjustment Mechanism on iron and steel exports to the EU: A South African case study

Introduction

This research project seeks to investigate the potential impact of the EU carbon border adjustment mechanism on the export of iron and steel to the EU. The study has two components, namely: (i) an econometric analysis, which seeks to model the flow of iron and steel to the EU from the 20 to 30 largest exporting countries; and (ii) a case study of South Africa, being one of the largest exporting countries of iron and steel to the EU.

As part of the case study, we will seek to speak to range of policymakers, academics, iron and steel producers, associations of iron and steel producers, and financiers to better understand how the EU CBAM may impact on the South African iron and steel industry, and further how certain stakeholders may respond. Your participation in this study thus provides helpful insights into the South African iron and steel industry and the potential dynamics of the EU CBAM regulations.

This document briefly sets out the background to the CBAM and the purpose of this research. **Annexure […]** to this document includes the consent forms which you are requested to sign and return via email ahead of our scheduled interview to […].

Background

On 10 May 2023, the European Parliament voted in favour of the implementation of a carbon border adjustment mechanism (CBAM), which will have the effect of imposing an import tariff on in-scope goods imported into the EU, proportional to the direct (and sometimes indirect) greenhouse gas emissions from the production of such goods.

The CBAM will take effect on 1 October 2023, with a reporting requirement for importers for the 2024 and 2025 calendar years. From 2026, importers of in-scope goods will be required to purchase CBAM certificates equivalent to the in-scope greenhouse gas emissions associated with the production of such goods. The price of CBAM certificates will be set equivalent to the weekly auctions on the EU emissions trading scheme (ETS). At the same time, the EU will over the period from 2026 to 2030, phase out free allocations under the EU ETS for production of certain goods in territory.

The CBAM will be applied to six product areas as a start, namely: (i) iron and steel; (ii) aluminium; (iii) cement; (iv) fertiliser; (v) electricity; and (vi) hydrogen. Importers of in-scope goods may set-off against any CBAM obligation, any emissions taxes collected in the country of origin. As such, to the extent that the country of origin has emissions taxes at least equivalent to the prevailing cost of the CBAM certificate, no further CBAM import tariff is required.

Purpose of this research

The purpose of this research is to understand how the implementation of the EU CBAM is likely to impact countries exporting iron and steel to the EU. In particular, we seek to understand how sensitive exports from countries subject to the CBAM are likely to be to the imposition of a carbon tax, and how exports of iron and steel are likely to change as a result of the CBAM when controlling for factors like GDP and costs associated with trade.

This study focuses on the iron and steel industry as the largest sector by value subject to the CBAM regulations. The research further focuses on the South African ecosystem as a case study of how stakeholders from a single country may be impacted, and further how they may respond. As part of this research, we will engage with a collection of policymakers, academics, producers of iron and steel, associations of producers of iron and steel, and financiers.

This study thus seeks to add to the emerging literature on the EU CBAM by (i) focusing on a specific sector, that being the iron and steel industry; (ii) introducing an econometric framework to evaluate the sensitivity of exports to the carbon border tax; and (iii) engaging a wide array of stakeholders from a country likely to be impacted by the CBAM, that being South Africa.

Your contribution to the research project is thus critical to understanding how stakeholders in the South African iron and industry may be impacted and how they may respond to the implementation of the EU CBAM. Your personal name will not be used in any publications, reports or presentations on the research, however a reference to the organisation and your role in the organisation may be used to provide context, should you consent to its inclusion.

END

Annexure C: Consent Form

Central University Research Ethics Committee (CUREC) approval reference: […]

Study: The potential impact of the EU Carbon Border Adjustment Mechanism on iron and steel exports to the EU: A South African case study

Purpose of Study: to understand how stakeholders in the South African iron and steel industry may be impacted by the implementation of the EU Carbon Border Adjustment Mechanism; and how they may respond.

	Please initial each box if you agree with the statement
I confirm that I have read and understand the information sheet version for the above research. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
I understand that my participation is voluntary and that I am free to withdraw at any point until 31 July 2023, without giving any reason.	
I understand who will have access to personal data provided, how the data will be stored and what will happen to the data at the end of the project.	
I understand that I will not be personally named in any publications, reports or presentations, but that references may be made to the organisation which I represent and the title which I hold.	
Use of quotations: Please indicate your preference (select *one* option): a) I do not wish to be quoted. **or**	
b) I agree to the use of quotations in research outputs if I am not identifiable. **or**	
c) I agree to the use of direct quotations, attributed to my name, in research outputs.	

I give permission for you to contact me again to clarify information.

	☐
I understand how to raise a concern or make a complaint.	☐
I agree to take part.	☐
Optional: I agree that my personal contact details can be retained in a secure database so that the researchers can contact me about future studies.	YES / NO

Name of participant	**Date**	**Signature**