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Know your opponent: Which countries might fight the European carbon border adjustment mechanism?

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ABSTRACT

The European Union (EU) plans to activate a carbon border adjustment mechanism (CBAM) in January 2023. This is meant to secure fair competition for European energy-intensive industries, incentivize countries both inside and outside the EU to cut emissions, and hinder carbon leakage from the EU. Early reactions from some large economies suggest that CBAM will encounter significant international opposition, especially from countries whose industry is dependent on fossil fuels. The purpose of this paper is to identify which countries are likely to resist CBAM most fiercely. This is done by creating a multidimensional CBAM Opposition Index based on the following indicators: trade with the EU, carbon intensity, litigiousness in the World Trade Organization (WTO), domestic public opinion on climate change, and capacity for innovation. The analysis indicates that the following countries are most likely to mount opposition to CBAM: Iran, Ukraine, the USA, the United Arab Emirates, Egypt, China, India, Kazakhstan, Russia, and Belarus. How the EU handles opposition from these countries will be decisive for the fate of CBAM. The index can serve as a tool for policymakers inside and outside the EU who need to negotiate over CBAM and want to anticipate the stances of other countries and understand their drivers.

1. Introduction

The EU Emissions Trading System (ETS) is the world's largest platform for trading greenhouse gas (GHG) emission allowances (Bayer and Aklin, 2020). In order to fulfill the Paris Agreement and reach the EU's emissions reduction target for 2030, the sectors covered by the ETS must reduce their emissions by 43% compared to 2005 levels (European Commission, 2018). To achieve this, the EU needs to further raise the price of ETS allowances (Joltreau and Sommerfeld, 2019). For many years, the price of emissions was allowed to remain low and some high-emitting sectors were granted free allowances (Clò et al., 2013; Hu et al., 2015). The number of available emissions allowances will be reduced and sectors previously exempted will have to start paying for their allowances (Hájek et al., 2019).

However, it is feared that the tightening of the ETS will render European energy-intensive industry uncompetitive (Joltreau and Sommerfeld, 2019; Kuik and Hofkes, 2010). The viability of tightening the ETS therefore hinges on the introduction of a mechanism to ensure that external producers selling energy-intensive goods to the EU do not pay a much lower price for their emissions than their European competitors.

The purposes of the EU's CBAM are: to ensure a level playing field for companies selling energy-intensive goods in the EU; to limit carbon leakage, that is to say, to prevent energy-intensive industries from moving elsewhere when the cost of emissions goes up in the EU (Kuik and Hofkes, 2010; Schinko et al., 2014); and to encourage other countries and economic blocs to introduce or tighten their carbon pricing (Eyland and Zaccour, 2014; Jakob, 2021; Li et al., 2013; Tavoni et al., 2011).

A detailed plan for the EU's CBAM was leaked in June 2021 and officially presented as a part of European Green Deal in July 2021 (European Commission, 2021a). The plan has "produced howls of protest from EU trade partners" (Fleming and Giles, 2021). This includes public criticism from major economies such as China, India, Japan, and the United States (BASIC, 2021; Hook, 2021). Some authors argue that the imposition of CBAM-like measures will be particularly challenging for developing countries (Zhang, 2010), above all for China due to the high share of energy-intensive industries in its exports (Li and Zhang, 2012).

Should the resistance mount, CBAM might be torpedoed. Opposition might come in the form of WTO litigation and retaliatory trade measures. While the EU and many researchers argue that CBAM is compatible with international trade law, the issue remains complex and

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it is likely CBAM will be challenged under international trade legislation (Black, 2017; Mehling et al., 2019; Porterfield, 2019).

CBAM will cover five sectors: aluminum, cement, electricity, fertilizers, and iron and steel. However, retaliatory trade measures will not necessarily be limited to these five sectors. They could instead target European interest groups that European policymakers are thought to be dependent upon. When the Trump administration imposed tariffs on Chinese exports to the US, the Chinese retaliation targeted American agricultural exports in the hope of undermining support from farmers who had voted for Donald Trump (Bown, 2021; Tankersley and Bradsher, 2018). CBAM could trigger a similar pattern of interaction.

CBAM could promote the decarbonization of energy supplies for industry both within the EU and among its trade partners. The five sectors covered by CBAM are all energy- and carbon-intensive. For example, global steel production relies heavily on the use of coal and coke (Zhang et al., 2021). Energy-efficient technologies and low-carbon energy sources for such industries have been discussed extensively in the literature (Song and Oh, 2015; Zhou et al., 2010). CBAM may accelerate the uptake of such solutions.

The EU's CBAM will have the greatest consequences for the countries that export most to the EU and whose goods have the highest carbon content due to relying on carbon-intensive energy sources (Chen and Zeckhauser, 2018). Those countries could mount fierce resistance. A first step towards handling such resistance is to identify which countries it is likely to come from. That is the purpose of this article. Once identified, European policymakers can try to analyze the interests of these counterparts, work out counterstrategies, adapt the design of CBAM, and/or engage them in dialogue.

There is a growing body of research on CBAM. It addresses a variety of aspects, such as carbon leakage (Böhringer et al., 2017; Mehling et al., 2019; Naegele and Zaklan, 2019), WTO rules (Balistreri et al., 2019; Kaufmann and Weber, 2011; Porterfield, 2019; Trachtman, 2017), the ability to induce global climate cooperation (Al Khourdajie and Finus, 2020; Farrahi Moghaddam et al., 2013; Hecht and Peters, 2019; Sanctuary, 2018), impacts on the domestic economy (Fouré et al., 2016; McKibbin et al., 2018), design issues (Cosbey et al., 2019; Kortum and Weisbach, 2017), and possible impacts on non-EU countries (Tagliapietra and Wolff, 2021; Tang et al., 2015; Zhong and Pei, 2021). However, we found no existing study which has sought to identify potential antagonists to the EU CBAM related sectors using multidimensional criteria.

2. Methods

2.1. Selection of countries

We carried out an initial delimitation of potential CBAM opponent countries using two criteria. First, we identified countries which export products to the EU in any of the five sectors covered by the current iteration of CBAM: aluminum, cement, electricity, fertilizers, and iron and steel. The export data were extracted from the UN Comtrade Database using Combined Nomenclature codes from the leaked CBAM document (European Commission, 2021b). A detailed data source description is provided in Section 2.3.

As a second criterion, among these countries we chose the top 50 destinations for exports *from* the EU (not limited to the five CBAM sectors). The rationale behind this was that, should the launch of CBAM trigger a trade war, the EU will be most sensitive to actions by the countries to which the EU exports its own goods. Accordingly, these are potential opponents *of importance.* Two of the 50 countries—Iraq and Panama—were later omitted from our analysis due to lack of data.

2.2. Index construction steps

For the purpose of identifying which countries are likely to be most antagonistic towards CBAM, we constructed a composite index following the state-of-the-art approach to index construction (Becker et al., 2017; Freudenberg, 2003). The index was constructed in four steps: selection of index subdimensions; data normalization; weighting and aggregation; and robustness check and sensitivity analysis (Nardo and Saisana, 2008; Saltelli, 2007). The obtained index was rescaled from 1 to 100, where 100 signifies the highest potential opposition to CBAM and 1 the lowest. The data were collected and analyzed using Stata 16.1. The complete dataset is available in the open access repository Mendeley Data (Sabyrbekov and Overland, 2021).

2.2.1. Choosing index subdimensions

The selection of subdimensions for the index was based on a review of the academic literature on CBAM. In addition, we sought to ensure that each subdimension represented a distinct aspect of the likelihood of opposing CBAM and that they did not overlap. To check this, we ran a correlation analysis of the selected subdimensions.

The overall selection of subdimensions was guided by considerations about exposure and adaptability. Exposure consists of CBAM-applicable exports to the EU and the carbon intensity of the economy of the exporting country. Adaptability consists of the technological capacity measured in terms of patent applications; track-record of WTO litigiousness measured in terms of the number of initiated WTO disputes; and domestic public opinion on climate change. In the next paragraphs, we describe the five subdimensions and their relationship to CBAM.

(1) *Trade*: This subdimension consists of two parts: (a) the exports of countries to the EU in the five sectors covered by CBAM and (b) the size of EU exports to these countries. The former is measured in terms of the share of the CBAM-applicable sectors in total exports to the EU. Clearly, the implementation of CBAM will have a higher impact on countries that export more of the CBAM-applicable products to the EU market. The second is EU exports to a given country as a share of total EU exports. The higher the share of EU exports to a country, the more vulnerable is the EU to trade retaliation from that country. Since retaliation against CBAM may be asymmetric, we take into consideration all EU exports and do not limit this indicator to the five CBAM-applicable sectors.

(2) *Carbon intensity:* CBAM-related fees will be highest for the goods with the highest carbon content. Thus, we included the carbon intensity of the economy of the trade partners exporting to the EU. Ideally, this would be based upon the specific carbon intensity of each CBAM-applicable sector or good exported to EU, but such data are unavailable for many countries. However, the carbon intensity of a country's whole economy represents a reasonable approximation of sectoral carbon intensity since the sector is embedded in the national economy and its environmental regulations.

(3) *Track record of confrontation in WTO/quarrelsomeness*: There is an ongoing discussion in the literature as to whether or not CBAM is in conformation with WTO rules (Cottier et al., 2014; Kaufmann and Weber, 2011; Ladly, 2012; Trachtman, 2017). As an indicator of the risk that countries will challenge CBAM in the WTO, we used the number of past WTO disputes they initiated between 1995 and 2018.

(4) *Climate change opinion:* This subdimension represents public concern about climate change. In countries where the population is climate sceptic or at least not worried about climate change, the government may be more inclined to challenge the EU over CBAM. In countries with a high level of public concern about climate change, governments may be less inclined to fight against CBAM, as they might lack domestic support.

(5) *Innovation capacity:* The development and implementation of new technologies is key to the decarbonization. A strong capacity for innovation can therefore make it easier for a country to adapt its economy to international decarbonization trends. This

subdimension is measured in terms of the total number of patent applications per 100,000 inhabitants from 1995 to 2019.

To ensure the robustness of the analysis and maximize the policy angles, we developed five different versions of the index (Table 1). The multiple the versions are also useful for identifying the specific reasons why a specific country might oppose to the CBAM.

2.2.2. Normalization

For each subdimension we normalized the data using maximum and minimum values, in accordance with Formula 1:

$$I_c = \frac{x_c - min(x)}{\max(x) - min(x)} \quad (1)$$

where I_c is the subdimension for country c, x_c is the value of the variable x, and $\max(x)$ and $min(x)$ are the maximum and minimum values. The resulting normalized values are between 0 and 1.

2.2.3. Weighting and aggregation

Since no evidence in the literature suggests a hierarchical relationship, we used equal weighting for all subdimensions. Before aggregation, we made sure that for all subdimensions, a higher score indicates greater opposition to CBAM. To achieve this, we subtracted 1 from the normalized values of patent applications and climate concern because these two subdimensions in their raw data format are negatively associated with the likelihood of opposition to CBAM.

2.2.4. Robustness check and sensitivity analysis

To check the robustness of the obtained index, we used a different normalization technique drawing on Cherchye et al. (2008) and Saisana et al. (2005). While the minimum-maximum technique may be sensitive to outliers, a z-score based normalization approach solves this issue by using standard deviation (Formula 2).

$$ZI_c = \frac{x - \mu_x}{\sigma} \quad (2)$$

where ZI_c is a z-score normalized subdimension, μ_x is the mean value of the subdimension, and σ is the standard deviation.

The resulting z-score based index was compared with the min-max based index to see if there were any changes in country rankings. As a secondary check, we also ran a correlation assessment between the two versions of the index.

Finally, we performed a sensitivity analysis by dropping one variable at a time in the final aggregated index while making sure that all remaining subdimensions had equal weight in the overall index. This also allowed us to construct five different versions of the index (see Section 3.2). We used visualization at every step to spot irregularities.

2.3. Data description

All data are from 2019, except the data on WTO disputes and innovation capacity. The WTO disputes indicator includes the total number of disputes initiated by the countries between 1995 and 2018. Innovation capacity is a long-term process, so we used the total number of patent applications from 1995 to 2019. Detailed descriptions of the data and sources are provided in Table 2.

3. Results

3.1. Descriptive data

Table 3 provides summary statistics for each subdimension. The countries varied significantly in terms of the share of CBAM-applicable goods in their total exports to the EU, with the five largest being the

Table 2
Selected subdimensions and data sources.

Indicator	Measurement unit	Data source and availability	Rationale
(1a) Share of the five CBAM-applicable sectors in total exports to the EU	Share	United Nations Comtrade Database	High exports of CBAM-applicable products to the EU imply high costs generated by CBAM, and a correspondingly higher level of opposition from EU trade partners.
(1b) Share of EU exports to the country in total EU exports	Share	United Nations Comtrade Database	If a country retaliates, the greater the EU exports to this country, the more damage to the EU.
(2) Carbon intensity of the economy	Greenhouse gas emissions (metric tons) per USD of GDP	Calculated using CO2 emissions data from the Global Carbon Budget (Friedlingstein et al., 2020) and GDP (2010 constant USD) from the World Development Indicators of the World Bank.	Higher carbon intensity means higher emissions cost. Thus, opposition is likely to be stiffer.
(3) Track record of WTO litigiousness	Number of initiated appeals between 1995 and 2018	WTO Dispute Settlement (WTO, 2021).	The more WTO disputes a country has been involved in, the more likely it is to oppose CBAM in the WTO.
(4) Climate change opinion	Share of respondents who see climate change as a very serious or somewhat serious threat	The Lloyd's Register Foundation (Gallup, 2019). All samples are probability-based and nationally representative of the resident adult population.	Higher domestic public concern about climate change may make it more difficult for governments to engage in protracted conflict over CBAM.
(5) Innovation capacity	Total number of patent applications by residents from 1995 to 2019 per 100,000 people	World Intellectual Property Organization Data (WIPO, 2021) and population size from the World Development Indicators of the World Bank.	Countries with higher levels of innovation may be better positioned to adjust their industry and exports to CBAM.

Table 1
Five versions of the CBAM Opposition Index.

Index version	Trade		Carbon intensity	WTO appeals	Climate change awareness	
	EU exports to trade partner	Exports to EU in five sectors				Innovation capacity
I	X	X	X	X	X	X
II	X	X	X	X	X	
III	X	X	X	X		
IV	X	X	X			
V	X	X		X		

Table 3
Summary statistics of the subdimensions.

Variable	Mean	Std. dev.	Min	Max
Exports to the EU in the five CBAM-applicable sectors as a share of total exports to the EU	2.91	4.34	0.0004	14.37
Share of EU exports to the country in total EU exports	1.58	3.41	0.14	21.71
CO2 emissions in kg per USD of GDP	0.65	0.38	0.11	1.65
Total number of initiated WTO disputes 1995–2018	9	19	0	124
Share of respondents who see climate change as a threat	0.74	0.13	0.49	0.95
Number of patent applications per 100,000 inhabitants	376	1200	0	6296

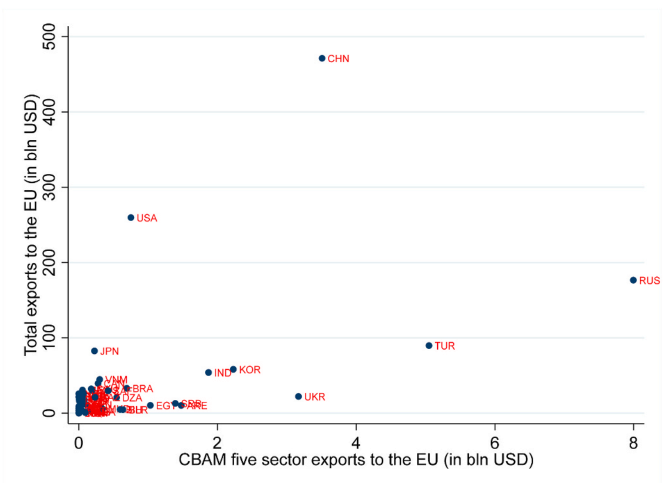

Fig. 1. Exports to the EU in the five CBAM-applicable sectors plotted against total exports to the EU.

United Arab Emirates (14%), Ukraine (14%), Belarus (13%), Bosnia and Herzegovina (12%), and Iran (12%). The five smallest exporters of CBAM relevant goods to the EU were Kuwait, Nigeria, Bangladesh, Peru, and Senegal.

The top five export destinations for EU goods were the USA (21%), China (11%), Russia (4%), Turkey (4%), and Japan (3%). At the bottom of the list of the EU's 50 main trade partners, with less than 1% of EU exports combined, were Senegal, Jordan, Bangladesh, Albania, and Moldova.

EU trade partners vary in terms of the volumes of their total exports to the EU in the five CBAM sectors. China and the USA are the largest overall exporters to the EU, while Russia and Turkey have the largest exports to the EU in the five sectors. Fig. 1 plots the exports of countries to the EU in the five CBAM sectors against their total exports to the EU.

The carbon intensity indicator ranged from 0.11 to 1.65 kg per USD of GDP. The most carbon intensive economies among the EU's 50 main trade partners in 2019 were Ukraine (1.65), Iran (1.60), Kazakhstan (1.47), Bosnia and Herzegovina (1.28), and Vietnam (1.23). The least carbon intensive were Israel (0.21), Brazil (0.20), New Zealand (0.19), Japan (0.18), and Singapore (0.11). Fig. 2 plots the exports of countries to the EU in the five CBAM sectors against their carbon intensities.

Countries with a high share of CBAM-applicable exports to the EU and with high carbon intensity of GDP include Ukraine, Iran, Bahrain, Belarus, and Serbia (see Fig. 2). Countries such as Kazakhstan, Pakistan, South Africa, and Vietnam have a low share of exports to the EU but high carbon intensity.

The United States initiated the largest number of WTO appeals between 1995 and 2018 (see Fig. 3). Most other countries had much

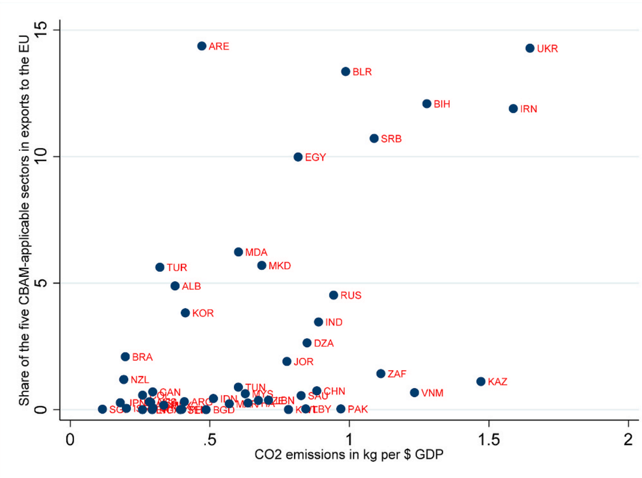

Fig. 2. Exports to the EU in the five CBAM-applicable sectors as a share of total exports to the EU plotted against carbon intensity of GDP at country level.

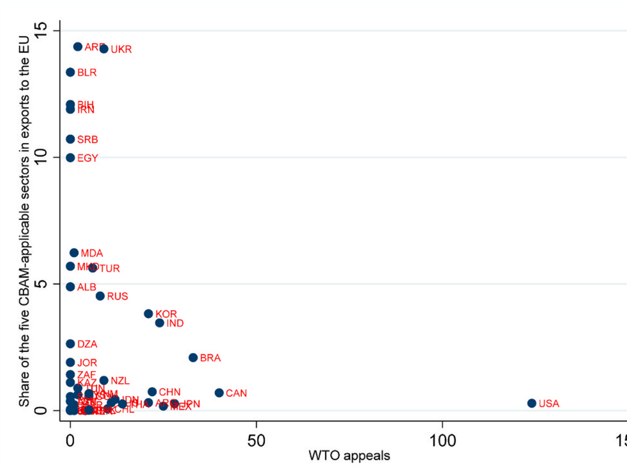

Fig. 3. Exports to the EU in the five CBAM-applicable sectors as a share of total exports to the EU plotted against the number of WTO appeals 1995–2018.

smaller numbers, but Brazil and Canada also initiated numerous appeals.

The level of public concern about climate change was highest in Chile (95%), followed by Korea (94%), Japan (94%), Singapore (91%) and Peru (90%). The lowest levels of climate change concern were registered in the United Arab Emirates (49%), Libya (50%), Saudi Arabia (52%), Indonesia (54%), and Bangladesh (55%) (see Fig. 4 for details).

3.2. CBAM Opposition Index

3.2.1. Main index

The main version of the composite index ranges from 100 for Iran to 1 for Japan. The top ten potential opponents of the EU's CBAM are thus Iran, Ukraine, USA, United Arab Emirates, Egypt, China, India, Kazakhstan, Russia, and Belarus. Some other major economies, such as, Saudi Arabia, Indonesia, and South Africa are among the top 16. The full index ranking table can be found in Table A.1 in the appendix and is presentedvisually in Figs. 5 and 6. The full rankings for all countries and all index versions are presented in Tables A.1-A.5 in the appendices.

3.2.2. Index without innovation capacity

We see that technological capacity also plays an important role in the

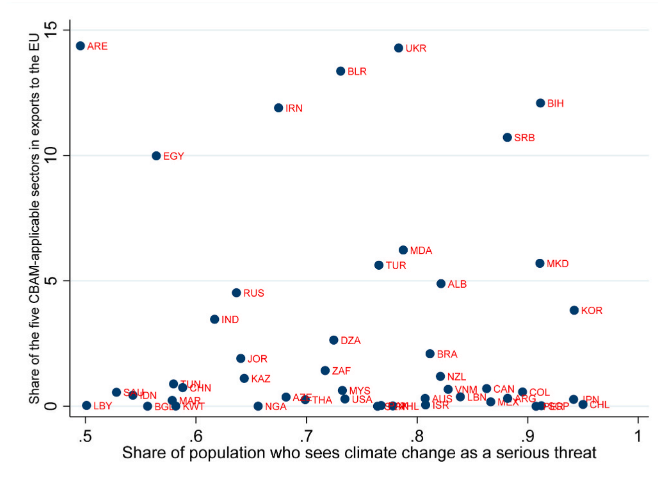

Fig. 4. Share of exports to the EU in the five CBAM-applicable sectors plotted against the share of the population who see climate change as a serious threat.

index, mediating the impacts of the other components. If we exclude the innovative capacity subdimension, the United States moves up to first place. Japan and Korea move up as well but remain at the lower end of the scale (see Fig. 7). This means that any attempt to anticipate the reaction of these countries to CBAM will depend on whether or not one thinks the countries will see that their capacity for innovation will enable them to handle the higher cost of GHG emissions well and benefit from the markets for green technologies that CBAM will help expand.

3.2.3. *Index with trade, carbon intensity and WTO disputes*

In the version of the index with three dimensions—trade, carbon intensity, and WTO disputes—the USA, Ukraine, Iran, Bosnia and Herzegovina, and Belarus are at the top (see Fig. 8). The top ten also include China and India (eighth and tenth place, respectively). Singapore, Israel, Peru, Nigeria, and Colombia have the lowest scores.

3.2.4. *Index with trade and carbon intensity*

This version of the index has only two subdimensions: trade with the EU and carbon intensity (see Fig. 9). The top three countries are Ukraine, Iran, and Bosnia and Herzegovina.

3.2.5. *Index with trade and WTO disputes*

In an even simpler index version with the trade and WTO disputes dimensions only, the top CBAM opponents are Bosnia and Herzegovina, Iran, Belarus, the UAE and the USA (see Fig. 10).

The different versions of the index show similar patterns with some exceptions (see Fig. 11). The main index includes WTO appeals and thus considers the likelihood that opposition to CBAM will manifest itself in the use of international trade agreements. Iran, Ukraine, the USA and the United Arab Emirates are important opponents in all versions.

The index versions can serve a variety of purposes, depending on the focus of the analysis. The simplest version, with trade and carbon intensity only, shows which countries are most exposed, while the version which includes innovative capacity attests to adaptivity.

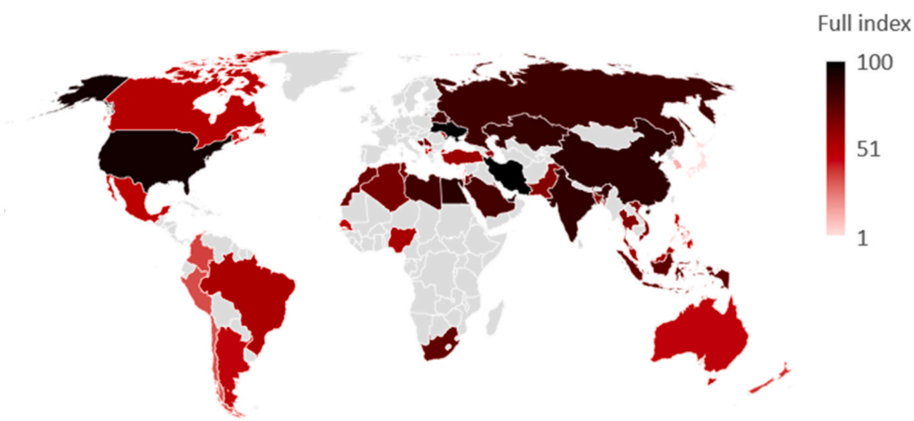

Fig. 5. CBAM Opposition Index plotted on the world map.

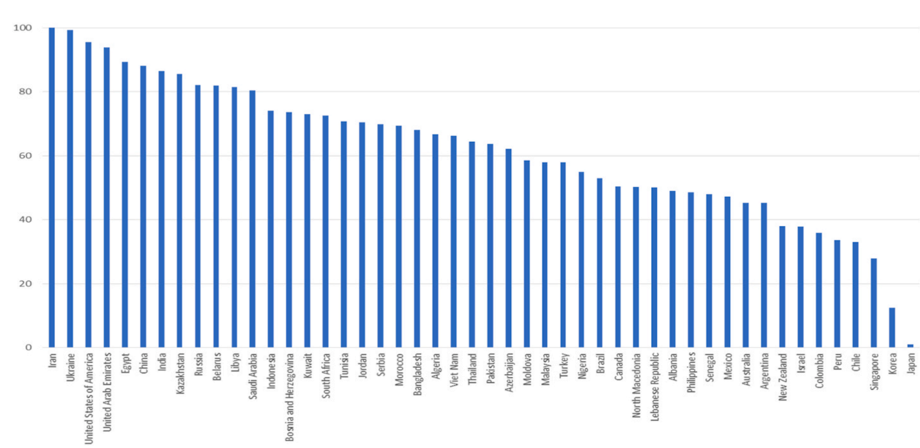

Fig. 6. CBAM Opposition Index, main version with all dimensions.

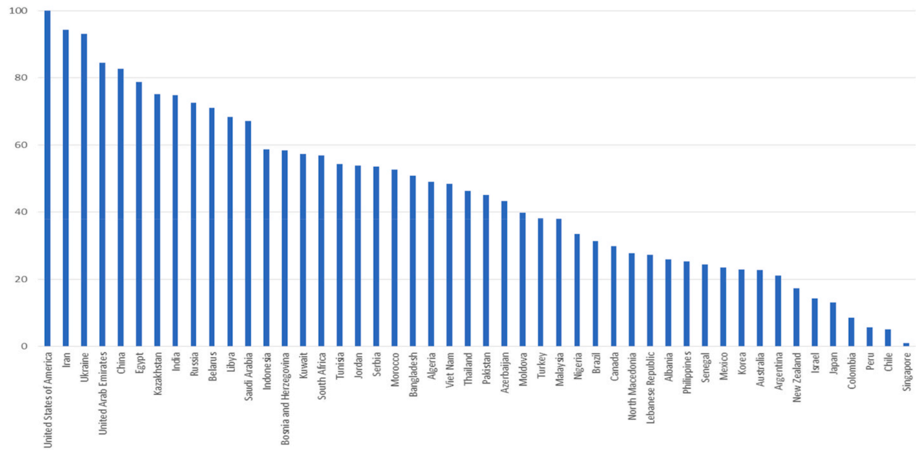

Fig. 7. CBAM Opposition Index with innovation capacity/patent applications dimension omitted.

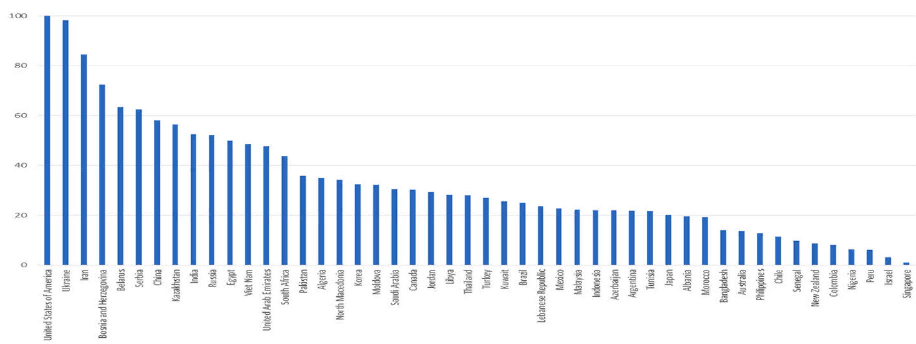

Fig. 8. CBAM Opposition Index based on trade, carbon intensity and WTO appeals dimensions only.

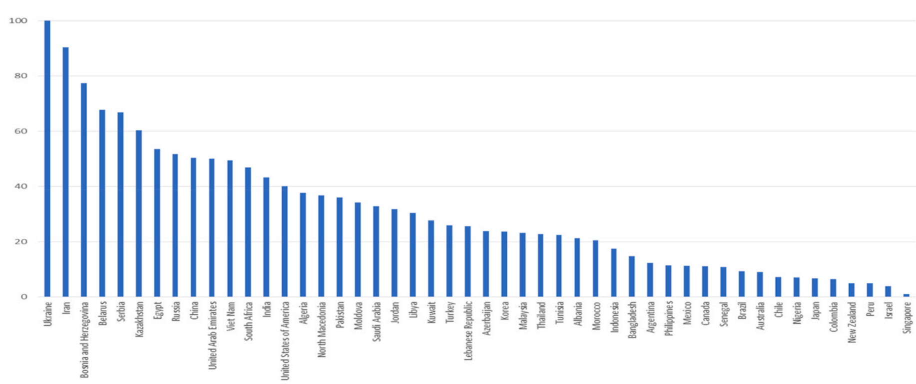

Fig. 9. Index based on the trade and carbon intensity dimensions only.

4. Conclusion and policy implications

The early reactions of other countries indicate that the EU's CBAM will encounter some resistance. This study has used a multidimensional index to assess which countries are most likely to become the greatest opponents of CBAM. The index can serve as a useful tool for policymakers inside and outside the EU who need to negotiate over CBAM and want to anticipate the stances of other countries and understand their drivers.

The CBAM Opposition Index shows that the greatest opponents are likely to be Iran, Ukraine, the USA, the United Arab Emirates, Egypt, China, India, Kazakhstan, Russia, and Belarus. A high share of CBAM-exposed exports to the EU along with high carbon intensity and low levels of technological innovation entail that CBAM will be a major issue for these countries. Our findings also suggest that large economies such as the USA, Russia, China, and India are likely to use the WTO platform to oppose CBAM based upon their prior history of dispute initiation. In finalizing the design of CBAM, the EU may need to take into account the interests of these countries, or prepare to face off with them in the WTO.

Our analysis also indicates that CBAM opposition in Ukraine, Bosnia and Herzegovina, Serbia, and Vietnam may be largely driven by the carbon intensity of their energy supply. To soften the impact of CBAM in such countries, the EU and other interested actors could offer support for their decarbonization, for example through technology transfers.

In smaller developing economies such as Algeria, Bangladesh, and Morocco, lower innovation capacity plays a bigger role as a potential driver of CBAM opposition. To soften the impact of CBAM in such countries, the EU and other interested actors could offer to support the

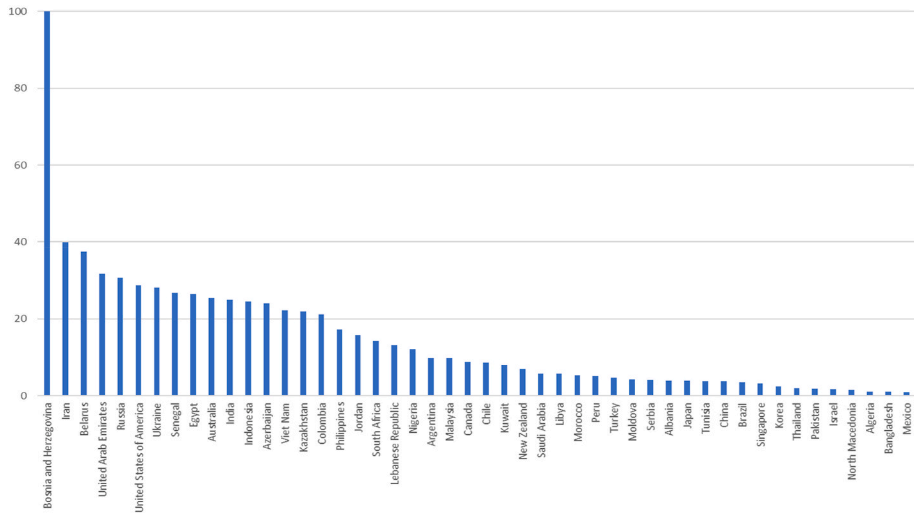

Fig. 10. Index with trade and WTO disputes dimensions only.

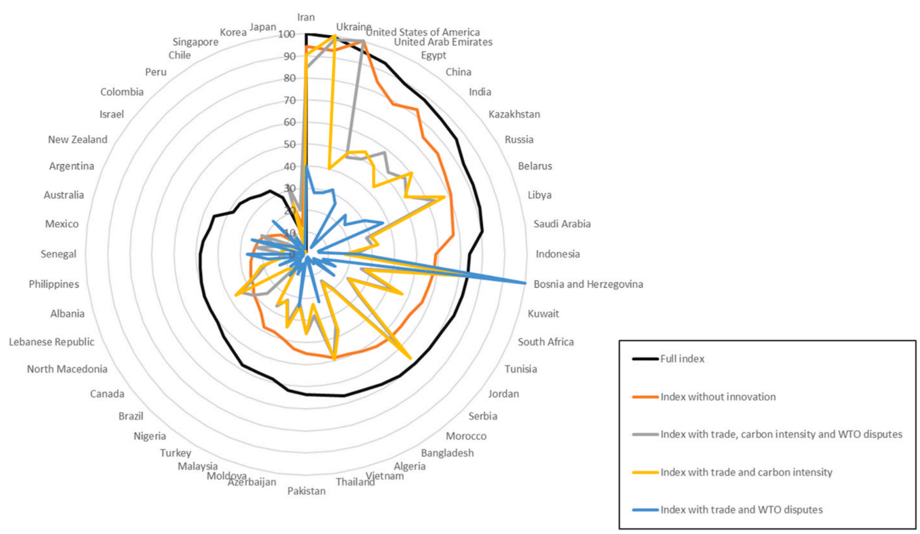

Fig. 11. Different versions of the index, sorted by the full index.

development of greater capacity for innovation.

On the one hand, the index can be useful for the EU in understanding how CBAM will be opposed and how to approach opponents. On the other hand, it can also be useful for countries that oppose CBAM and wish to identify potential allies.

Japan is one of the most interesting countries in the context of the CBAM Opposition Index. In the main version of the index, it is the country ranked as least likely to oppose the CBAM. One of the reasons for this is that Japan is the top-ranked country on the innovation/patents indicator. But when we omitted this indicator in the sensitivity analysis, Japan moved up only four places from the bottom and it is placed low in all five versions of the index. This indicates that Japan does not have much to lose from CBAM, and little to gain from opposing it. However, in the real world, Japan is one of the countries that has spoken out most loudly against CBAM. This fits with the trend in Japanese policy in which it moved away from the pro-climate position it held in the 1990s, but our index indicates that there could be scope for Japan to change its position again. As the EU's fifth largest trade partner, the world's third largest economy and a highly export-dependent country, Japan will be an important interlocutor for the EU as it tries to implement CBAM.

Another implication of our findings is that coordination with the China and/or USA will be very important for the viability of the EU's CBAM. China and the USA are the largest economies and most powerful countries among the potential opponents. If one or both of them can be won over, it will be more difficult for other countries to resist.

CRediT authorship contribution statement

Indra Overland: Conceptualization, Funding acquisition, Methodology, Project administration, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Rahat Sabyrbekov:** Methodology, Data curation, Formal analysis, Calculations, Investigation, Methodology, Visualization, Writing – original draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data are publicly available and the sources are listed in the article.

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6. Appendices

Table A.1
Full index version with list of all countries

Ranking	Country	Full index
1.	Iran	100
2.	Ukraine	99
3.	USA	96
4.	United Arab Emirates	94
5.	Egypt	89
6.	China	88
7.	India	86
8.	Kazakhstan	86
9.	Russia	82
10.	Belarus	82
11.	Libya	81
12.	Saudi Arabia	80
13.	Indonesia	74
14.	Bosnia and Herzegovina	74
15.	Kuwait	73
16.	South Africa	73
17.	Tunisia	71
18.	Jordan	70
19.	Serbia	70
20.	Morocco	69
21.	Bangladesh	68
22.	Algeria	67
23.	Vietnam	66
24.	Thailand	64
25.	Pakistan	64
26.	Azerbaijan	62
27.	Moldova	59
28.	Malaysia	58
29.	Turkey	58
30.	Nigeria	55
31.	Brazil	53
32.	Canada	50
33.	North Macedonia	50
34.	Lebanon	50
35.	Albania	49
36.	Philippines	49
37.	Senegal	48
38.	Mexico	47
39.	Australia	45
40.	Argentina	45
41.	New Zealand	38
42.	Israel	38
43.	Colombia	36
44.	Peru	34
45.	Chile	33
46.	Singapore	28
47.	Korea	12
48.	Japan	1

Table A.2
Index version without innovation capacity

Ranking	Country	Index without innovation
1.	USA	100
2.	Iran	94
3.	Ukraine	93
4.	United Arab Emirates	85
5.	China	83
6.	Egypt	79
7.	Kazakhstan	75
8.	India	75
9.	Russia	73
10.	Belarus	71

(*continued on next page*)

Table A.2 (*continued*)

Ranking	Country	Index without innovation
11.	Libya	68
12.	Saudi Arabia	67
13.	Indonesia	59
14.	Bosnia and Herzegovina	58
15.	Kuwait	57
16.	South Africa	57
17.	Tunisia	54
18.	Jordan	54
19.	Serbia	54
20.	Morocco	53
21.	Bangladesh	51
22.	Algeria	49
23.	Vietnam	48
24.	Thailand	46
25.	Pakistan	45
26.	Azerbaijan	43
27.	Moldova	40
28.	Turkey	38
29.	Malaysia	38
30.	Nigeria	34
31.	Brazil	31
32.	Canada	30
33.	North Macedonia	28
34.	Lebanon	27
35.	Albania	26
36.	Philippines	25
37.	Senegal	24
38.	Mexico	24
39.	Korea	23
40.	Australia	23
41.	Argentina	21
42.	New Zealand	17
43.	Israel	14
44.	Japan	13
45.	Colombia	9
46.	Peru	6
47.	Chile	5
48.	Singapore	1

Table A.3
Index with trade, carbon intensity and WTO disputes

Ranking	Country	Index with trade, carbon intensity and WTO disputes
1.	USA	100
2.	Ukraine	98
3.	Iran	85
4.	Bosnia and Herzegovina	72
5.	Belarus	63
6.	Serbia	62
7.	China	58
8.	Kazakhstan	56
9.	India	52
10.	Russia	52
11.	Egypt	50
12.	Vietnam	49
13.	United Arab Emirates	48
14.	South Africa	44
15.	Pakistan	36
16.	Algeria	35
17.	North Macedonia	34
18.	Korea	32
19.	Moldova	32
20.	Saudi Arabia	30
21.	Canada	30
22.	Jordan	29
23.	Libya	28
24.	Thailand	28
25.	Turkey	27
26.	Kuwait	26
27.	Brazil	25
28.	Lebanon	24
29.	Mexico	23

(*continued on next page*)

Table A.3 (*continued*)

Ranking	Country	Index with trade, carbon intensity and WTO disputes
30.	Malaysia	22
31.	Indonesia	22
32.	Azerbaijan	22
33.	Argentina	22
34.	Tunisia	22
35.	Japan	20
36.	Albania	20
37.	Morocco	19
38.	Bangladesh	14
39.	Australia	14
40.	Philippines	13
41.	Chile	11
42.	Senegal	10
43.	New Zealand	9
44.	Colombia	8
45.	Nigeria	6
46.	Peru	6
47.	Israel	3
48.	Singapore	1

Table A.4
Index with trade and carbon intensity

Ranking	Country	Index with trade and carbon intensity
1.	Ukraine	100
2.	Iran	90
3.	Bosnia and Herzegovina	77
4.	Belarus	68
5.	Serbia	67
6.	Kazakhstan	60
7.	Egypt	53
8.	Russia	52
9.	China	50
10.	United Arab Emirates	50
11.	Vietnam	49
12.	South Africa	47
13.	India	43
14.	USA	40
15.	Algeria	38
16.	North Macedonia	37
17.	Pakistan	36
18.	Moldova	34
19.	Saudi Arabia	33
20.	Jordan	32
21.	Libya	30
22.	Kuwait	28
23.	Turkey	26
24.	Lebanon	26
25.	Azerbaijan	24
26.	Korea	24
27.	Malaysia	23
28.	Thailand	23
29.	Tunisia	22
30.	Albania	21
31.	Morocco	20
32.	Indonesia	17
33.	Bangladesh	15
34.	Argentina	12
35.	Philippines	11
36.	Mexico	11
37.	Canada	11
38.	Senegal	11
39.	Brazil	9
40.	Australia	9
41.	Chile	7
42.	Nigeria	7
43.	Japan	7
44.	Colombia	6
45.	New Zealand	5
46.	Peru	5
47.	Israel	4
48.	Singapore	1

Table A.5
Index with trade and WTO disputes

Ranking	Country	Index with trade and WTO disputes
1.	Bosnia and Herzegovina	100
2.	Iran	40
3.	Belarus	37
4.	United Arab Emirates	32
5.	Russia	31
6.	USA	29
7.	Ukraine	28
8.	Senegal	27
9.	Egypt	26
10.	Australia	25
11.	India	25
12.	Indonesia	24
13.	Azerbaijan	24
14.	Vietnam	22
15.	Kazakhstan	22
16.	Colombia	21
17.	Philippines	17
18.	Jordan	16
19.	South Africa	14
20.	Lebanon	13
21.	Nigeria	12
22.	Argentina	10
23.	Malaysia	10
24.	Canada	9
25.	Chile	9
26.	Kuwait	8
27.	New Zealand	7
28.	Saudi Arabia	6
29.	Libya	6
30.	Morocco	5
31.	Peru	5
32.	Turkey	5
33.	Moldova	4
34.	Serbia	4
35.	Albania	4
36.	Japan	4
37.	Tunisia	4
38.	China	4
39.	Brazil	4
40.	Singapore	3
41.	Korea	2
42.	Thailand	2
43.	Pakistan	2
44.	Israel	2
45.	North Macedonia	2
46.	Algeria	1
47.	Bangladesh	1
48.	Mexico	1

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