Addressing climate change through unilateral action

The implications of adopting a European Union-wide Border Carbon Adjustment

Egle Kareckaite

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Abstract

In the European Union's (EU) Emissions Trading Scheme (ETS), free allocation of emissions allowances to avoid carbon leakage has resulted in a distorted pricing signal and a failure to reduce emissions in the most polluting industries. A Border Carbon Adjustment (BCA), a mechanism which would apply a tariff to imported goods based on their embedded carbon content, has been suggested as a solution. Various concerns have been raised regarding the potential EU-wide BCA, including its questionable compatibility with trade law, limited effectiveness in reducing carbon leakage and the tendency to shift the burden of climate change mitigation from industrialised to developing countries. In this thesis, I undertake a systematic literature review to identify the implications of adopting an EU-wide BCA. The findings are evaluated against three criteria: feasibility, effectiveness, and fairness. Regarding feasibility, the analysis finds that while it is theoretically possible to design a BCA compatible with the World Trade Organisation (WTO) rules, it is still likely to get challenged by at least some of the EU's trade partners. Regarding effectiveness, a BCA has the capacity to reduce carbon leakage, but cannot eliminate it if introduced unilaterally by the EU. Regarding fairness, a BCA is found to shift the burden of climate change mitigation towards developing countries. The negative distributional impact of the BCA can be mitigated by using the revenue to fund climate change and clean technology initiatives in developing countries. Overall, the findings raise questions regarding the trade-offs between the BCA's feasibility, effectiveness and fairness as well as the possibility of designing truly effective market mechanisms under the existing WTO rules.

Keywords: carbon border tax, carbon leakage, carbon pricing, World Trade Organisation, common but differentiated responsibilities, market mechanism

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And you are right. It will be.

Contents

List of abbreviations

BAT	Best available technology
BCA	Border carbon adjustment
BRIC	Brazil, Russia, India and China
CBDR&RC	Common but differentiated responsibilities and respective capabilities
CDM	Clean Development Mechanism
EITE	Emissions-intensive and trade-exposed
ETS	Emissions Trading Scheme
EU	European Union
EUA	European Union emissions allowance
GATT	General Agreement on Tariffs and Trade
GHG	Greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
LDC	Least-developed country
LIC	Low-income country
NDC	Nationally determined contribution
SCM	Agreement on Subsidies and Countervailing Measures
UNFCCC	United Nations Framework Convention on Climate Change
WTO	World Trade Organisation

"In this world nothing can be said to be certain, except death and taxes."

Benjamin Franklin in a letter to Jean-Baptiste Leroy, 1789[1]

[1] The quote was retrieved from the following source: Pirie, M. (2019, November 13). Death and taxes. *Adam Smith Institute.* https://www.adamsmith.org/blog/death-and-taxes

1. Introduction

Recent decades have seen a proliferation of market mechanisms as the principal tool for climate change mitigation. The reasoning for this trend has been that climate change is different from other environmental problems due to its global character, where neither greenhouse gas (GHG) emissions nor the damage they cause can be contained within national boundaries (Evans, 2012). Therefore, it cannot be addressed by traditional forms of top-down command-and-control governance (Evans, 2012). Meanwhile, markets represent a global forum that is common to all the countries around the world. In light of this, market mechanisms such as carbon taxes, cap-and-trade systems, and others aim to fight climate change by creating a carbon price, making it expensive to emit GHGs, and thus encouraging decarbonisation (Hsu & Bauman, 2012).

Regardless of the global nature of climate change, currently most mitigation efforts are undertaken on a national or regional basis (Rocchi et al., 2018). Consequently, no global carbon price exists: in fact, just under 20% of global emissions are subject to carbon pricing (Mehling et al., 2019). As a result, we live in a "multi-speed carbon world", whereby some countries (the abating regions) have adopted different forms of carbon pricing, while others (non-abating regions) have either no carbon price or even provide subsidies to the most carbon-intensive industries (Helm et al., 2012, p. 369). This in turn has given rise to fears of carbon leakage: a phenomenon whereby emissions restriction in one region leads to an increase in emissions elsewhere, or globally (Branger & Quirion, 2014a). Carbon leakage can occur when carbon pricing increases production costs for some industries, creating incentives for them to relocate to countries with lower or no carbon price and continue emitting (Helm et al., 2012).

The fear of carbon leakage is reflected in the design of the European Union's (EU) principal decarbonisation tool, the Emissions Trading Scheme (ETS). The EU ETS is currently the largest cap-and-trade scheme in the world, covering more than 11,000 energy-intensive production facilities and airlines operating between the ETS Member States (European Commission, 2016a). Together, the sectors covered by the ETS are responsible for approximately 45% of EU's total emissions (European Commission, 2016a). While most industries covered by the scheme are expected to pay for the EU emissions allowances (EUAs), those considered both energy-intensive and trade-exposed (EITE) and thus most at risk of carbon leakage, including many manufacturing installations and airlines, are allocated EUAs for free (European Commission, 2016b). The goal of free EUAs is to mitigate the increase in production costs, preventing domestic EITE industries from losing their competitive position in relation to imports from countries with no carbon pricing and lower production costs (European Commission, 2016b). However, free allocation has resulted in a number of issues, including overallocation of EUAs, windfall profits for the most polluting industries, a downward pressure on EUA prices, and a failure to incentivise emissions cuts among EITE industries (Ellerman et al., 2010; Whitmore, 2019).

As a result, a border carbon adjustment (BCA) has been suggested as an alternative to free EUAs. This mechanism would require importers to pay the same price for their GHG emissions as domestic producers do (Whitmore, 2019). By doing so, BCAs would level the playing field between domestic and foreign producers, eliminating both the incentives for carbon leakage and the need to allocate free EUAs.

The idea of a BCA has been gaining increasing prominence among world leaders. It has recently been endorsed by the President of the European Commission Ursula von der Leyen (2019), who pledged to introduce a BCA as part of her campaign platform. Additionally, the French government has already put forward proposals for an EU-wide BCA twice, in 2009 and 2016 (Mehling et al., 2019), while the current President of France Emmanuel Macron has called the measure "indispensable" (van Asselt et al., 2019, para. 7).

Several issues surround the potential adoption of a BCA. A commonly cited concern is the potential incompatibility with international trade law, namely the World Trade Organisation (WTO) rules (Simon, 2020). In fact, the previous proposals for an EU-wide BCA have been dismissed by the then EU Trade Commissioner as a violation of the WTO rules and, in general, "not good politics" due to its potential to undermine trade relationships and trust in the global climate regime (Bounds, 2006, para. 1). Among other concerns are its debatable effectiveness as a unilateral trade instrument in reducing leakage (Pauer, 2018) and the unjust distributional effects due to the tendency to shift the burden of climate change mitigation towards developing countries (Cosbey et al., 2019).

Currently, the European Commission is undertaking a BCA feasibility analysis due for results in late 2020 or early 2021 (Simon, 2020). However, the Commission President von der Leyen made only one explicit requirement when asking for the feasibility of a BCA to be assessed: making sure that it would be compatible with the trade law and thus avoid challenge from EU's trading partners under the WTO rules (Simon, 2020). The same concern is reflected in the European Green Deal plan, which stresses the importance of a BCA being compatible with WTO rules as well as EU's other international obligations (European Commission, 2019).

To evaluate the implications of adopting a BCA, it is not enough to assess its compatibility with the WTO regime alone. Rather, consideration of the aforementioned concerns regarding the BCA's effectiveness and distributional effects as well as compatibility with EU's other international obligations is also needed. In this thesis, my objective is to develop a more holistic understanding of what an EU-wide BCA would mean for the EU and the rest of the world. In line with the conceptual framework developed by Pickering, Vanderheiden and Miller (2012) on evaluating climate policies, I aim to assess a potential EU-wide BCA against three criteria: feasibility, effectiveness and fairness. My main research question is: ***What are the feasibility, effectiveness and fairness implications of adopting an EU-wide BCA?***

Through this investigation, I contribute to the tradition of sustainability science by utilising an interdisciplinary perspective (Jerneck et al., 2011) to evaluate a potential climate change mitigation tool regarding its legal, environmental, social and economic dimensions. In the following sections, I set the basis for my analysis and answer the research question by synthesising findings from a systematic literature review.

Chapter 2 sets the basis for understanding carbon leakage and the difference between EUAs and BCAs. Chapter 3 provides the theoretical underpinnings for understanding the BCA as both a trade and a climate change mitigation instrument. Chapter 4 discusses the scope of this thesis, details the application of Pickering et al.'s (2012) conceptual framework, and describes the systematic literature review process. Chapter 5 summarises findings from the systematic literature review as well as their implications for an EU-wide BCA according to the three criteria set out in the conceptual framework: feasibility, effectiveness and fairness. Chapter 6 discerns the most important aspects that the EU should consider before adopting a BCA and discusses tensions inherent in utilising market measures for climate change mitigation under the existing WTO rules. Chapter 7 concludes by restating key findings and posing question for future research.

2. Background

2.1 Carbon leakage and EU ETS

The basic premise of the EU ETS is that the EU sets a cap on total GHG emissions and releases a limited number of EUAs (European Commission, 2016a). Industries covered by the ETS must ensure that they purchase enough EUAs to cover their total emissions (Hirst, 2018). The aim is to continuously reduce the overall emissions cap, resulting in fewer EUAs available on the market over time (European

Commission, 2016a). The fewer EUAs there are, the higher their price, leading to increased production costs for carbon-intensive industries. This sends a pricing signal to companies to reduce their emissions rather than keep buying limited, expensive EUAs.

However, increasing production costs make the products of domestic companies less competitive in the international market, disadvantaging them against industries from non-abating countries. Due to this, two concerns were prevalent among policymakers when considering the inclusion of EITE industries in the EU ETS (van Asselt & Brewer, 2010). Firstly, if these companies choose to pass the costs resulting from the requirement to purchase EUAs to their consumers, they may lose their competitive position and have to shut down (Monjon & Quirion, 2011; Zhang, 2018). Secondly, if companies are unwilling to sustain larger production costs, this may lead to relocation to jurisdictions without a carbon price, thus shifting rather than reducing emissions and failing to deliver overall emissions cuts (van Asselt & Brewer, 2010). In each case, the implication is that these negative effects would be compounded with resulting job losses for European workers.

In other words, the design of the EU ETS was influenced by the fear of carbon leakage. The notion of carbon leakage stems from the idea of pollution haven: the assumption that if some countries put a price on pollution, in this case carbon emissions, industries subject to this price will move to countries where the price on pollution is lower or non-existent (Antimiani et al., 2012). Regarding climate change, this fear can be traced back to the United Nations Framework Convention on Climate Change (UNFCCC) (Ladly, 2012), the foundational framework of the global climate regime. In addition to establishing the avoidance of dangerous climate change as the key aim of the climate regime, the UNFCCC also determined that in this regime, developed and developing countries have different responsibilities (UN, 1992). Following the convention, developed countries, which have historically been responsible for a disproportionate share of GHG emissions, should bear the brunt of climate change mitigation efforts, thus ensuring just and effective burden-sharing (Ladly, 2012). As developing countries are not expected to contribute to climate change mitigation to the same degree, including when pricing emissions, the principle of differentiated responsibilities could lead to developing countries becoming carbon havens.

The risk of carbon leakage has been reinforced more recently with the Paris Agreement of 2015. Following Paris, emissions reductions are to take place in the form of nationally determined contributions (NDCs), which means that each country can pledge to reduce emissions at the level, speed and form deemed reasonable given their national context (van Asselt and Bobber, 2016). On the one hand, Paris strengthens the global climate regime by obliging all countries to put forward pledges. On the other hand, the focus on nation-based mitigation efforts makes it more difficult to coordinate climate policies and reach a global carbon price. Therefore, the potential for carbon leakage remains.

Regardless of these fears, it is difficult to estimate the scale of carbon leakage in practice. Most existing studies, called *ex ante* studies, estimate leakage by running simulations of the global economy to determine what could happen if a certain carbon price or measure was adopted. They conclude that globally, the scale of carbon leakage is between 5% and 30% (Mehling et al., 2019). This means that approximately 5-30% of emissions reduction due to carbon policies is offset by increasing emissions in non-abating regions (Branger & Quirion, 2014a). When it comes to EITE industries, the estimated number is usually much higher – even up to 90% (Mehling et al., 2019).

Of the several channels of leakage (Cosbey et al., 2019; Steininger et al., 2014), two are most relevant for a BCA: competitiveness and energy market (Table 1).

Table 1. The two channels of carbon leakage most relevant for the BCA. The definitions are based on Cosbey et al. (2019) and Steininger et al. (2014). Own illustration.

Type of channel	**How does leakage occur?**
Competitiveness	Direct channel, whereby increasing costs of production due to carbon pricing lead to industries relocating to non-abating regions, where the production costs are lower.
Energy market	Indirect channel, whereby higher energy costs due to carbon pricing lead to a drop in fossil fuel use and thus reduction in fossil fuel price, resulting in increased use of fossil fuels in non-abating regions.

Most *ex ante* studies estimate that the energy market channel is the principal route through which carbon leakage takes place (Lininger, 2015), constituting half to two-thirds of all leakage globally (Mehling et al., 2019). Competitiveness is the second biggest channel (Steininger et al., 2014).

In contrast, there is a shortage of studies using empirical data to estimate carbon leakage that has already occurred as a result of specific policies – that is, *ex post* studies. Existing *ex post* studies paint quite a different picture from *ex ante* studies, finding either much lower leakage rates or no evidence of leakage at all (Antimiani et al., 2016; Branger & Quirion, 2014a). This is potentially due to current carbon prices being much lower than necessary to encourage emissions cuts or cause carbon leakage (Mehling et al., 2019). Additionally, the threat of carbon leakage has resulted in protective policy packages for many industries deemed at risk (Mehling et al., 2019).

In the EU ETS, the policy safeguard against carbon leakage has been allocating free EUAs to EITE industries. Free allocation has resulted in several externalities that have contributed to distorting the EUAs' pricing signal. Firstly, free EUAs have been handed out based on past emissions, which depended to a large extent on past production levels (Ellerman et al., 2010). This resulted in a significant overallocation of EUAs: of the 30,000 cases observed in the first three years of the ETS, just 27 marked instances where the number of EUAs awarded to a company where equal to their annual emissions (Ellerman et al., 2010).

Secondly, allocation of free EUAs allowed many recipients to generate windfall profits (Whitmore, 2019). This happened when companies either passed on the cost of emissions cuts to customers or sold the EUAs on the market despite in both cases having received the emissions permits for free (Ellerman et al., 2010). During the years 2005-2008, the windfall profits resulting from free EUAs were estimated to be €14 billion, constituting a major transfer of funds from taxpayers to some of the most polluting sectors (Carbon Market Watch, 2014) and a loss of revenue that could have been invested in climate and social initiatives (Grantham Research Institute, 2013).

The overallocation and trade of free allowances flooded the market with more EUAs than planned (Carbon Market Watch, 2014). The resulting EUA prices were thus persistently lower than needed to encourage sufficient decarbonisation, which significantly undermined the effectiveness of the EU ETS (Planète Énergies, 2015).

2.2. A BCA for the EU

In light of the problems with free EUAs, recent years have seen more discussion about BCAs. BCAs aim to attach a carbon price to emissions associated with international trade by imposing a carbon tariff on imported goods (Eckersley, 2010). In some cases, BCAs also include export rebates: a refund on any carbon price paid by domestic companies on exported goods (Eichner & Pethig, 2015). While a BCA can appear as a carbon tax at the border, introducing it as part of the EU ETS would likely mean requiring importers to purchase enough EUAs to cover the emissions embedded in their goods or pay a tariff equivalent to the price of the required number of EUAs (Sakai & Barrett, 2016).

The envisioned benefits of BCAs are threefold (Ladly, 2012) (Figure 1). Firstly, a BCA would eliminate the competitive disadvantage of domestic industries by requiring importers to pay the same carbon price (Whitmore, 2019). Secondly, by subjecting both domestic and foreign producers to a carbon price, it would eliminate incentives for carbon leakage (Ladly, 2012). Eliminating competitive disadvantage and incentives for carbon leakage would eliminate the necessity of free EUAs. Therefore, all polluting industries, both domestic and foreign, would be required to pay a full price for their pollution, helping to correct the pricing signal not only in the EU ETS but also among the EU's trading partners. Thirdly, by sending this signal globally, a BCA would constitute a strategic leverage point in the global climate regime, which could push non-abating countries to adopt a BCA and make use of the revenue associated with carbon pricing (Sakai & Barret, 2016). This in turn would bring the world closer to a global carbon price.

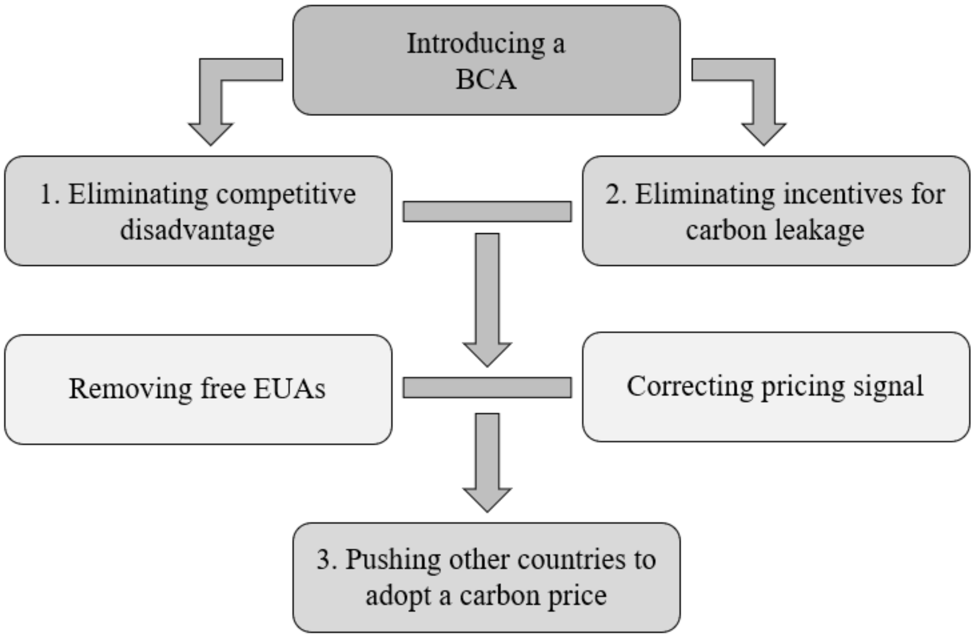

Figure 1. The three key benefits of a BCA as identified by Ladly (2012). Own illustration.

The only existing BCAs can be found in California and Quebec, where they were imposed as part of the Western Climate Initiative cap-and-trade system on electricity imports from states not connected to the scheme (Whitmore, 2019). No BCA has so far been imposed on a national or regional level or across more than one sector (Morris, 2018).

3. Theoretical underpinnings

The BCA is intended as an instrument that would price emissions embedded in international trade and thus help mitigate climate change. As a result, the BCA has an inherent duality as an instrument of both the trade and global climate regimes.

3.1 BCA as a trade instrument

The use of market mechanisms to solve environmental problems generally stems from the idea that markets are the optimal mechanism for managing limited resources (Andrew, 2008). This reasoning can be understood by reading Friedrich's Hayek's work on pricing signal. According to Hayek (1958), no one person or authority can possess all the knowledge about which resources are scarce and should be economised and to which degree, because it is reliant on the specific time, location and circumstances of the resource's existence and use. This information is instead dispersed among numerous different individuals (Hayek, 1958). If each resource is valued at a certain price, this pricing mechanism can communicate the information about the relative scarcity of resources and coordinate people around the world to make the "right" decision and use scarce resources less or switch to alternatives (Hayek, 1958).

However, pricing signals can only be an effective coordinating mechanism for carbon emissions if the price transmitted is "right" in that it reflects the costs of negative social and environmental effects, or externalities, associated with climate change (Hepburn, 2010). Free allocation of EUAs fails to attach a price to the pollution of some industries, which means that the pricing signal cannot convey accurate information about the true scarcity of the atmosphere's absorptive capacity (Helm et al., 2012). In addition, the global pricing signal for carbon emissions is further distorted by the absence of carbon pricing in many other jurisdictions (Mehling et al., 2019), which makes it possible for companies to relocate from abating to non-abating regions to avoid carbon pricing. From this perspective, climate change is the result of a market failure to adequately price the negative externalities inherent in unrestricted GHG emissions (Stern, 2007).

This failure can be corrected by imposing a Pigovian tax: a mechanism suggested by Albert Pigou (1932) that would make market actors pay for the full negative effects of their actions. Consequently, pollution in the form of GHGs emissions would be priced based on the extent of its negative consequences, internalising the costs associated with climate change and the damage it wrecks on communities around the world. The fact that the global climate regime is founded in the Westphalian system of state sovereignty (Rocchi et al., 2018) means that while governments can establish a carbon price in their jurisdiction, they cannot ensure that other countries will follow suit in their commitments. In the absence of a global carbon price, the EU can attempt to correct the pricing signal through unilateral action by adopting a BCA. A BCA is a form of a Pigovian tax that would send a more accurate pricing signal regarding the damage of GHG emissions by specifically taxing the emissions embedded in imports (Böhringer et al., 2017).

3.2 BCA as a climate change mitigation instrument

While the basis of BCAs as trade mechanisms is more focused on the practicalities of fixing the pricing signal, the implications of BCAs as instruments of the global climate regime concern ethical dimensions. As discussed previously, the global climate regime is underpinned by the UNFCCC and its principle of burden-sharing. In addition to acknowledging the differing historical responsibility for climate change, Article 3(1) of the UNFCCC also recognises that developed and developing nations exist in different economic and social contexts (UN, 1992). Consequently, it argues that the costs associated with climate change mitigation should be distributed according to the "common but differentiated responsibilities and respective capabilities" (CBDR&RC) principle (UN, 1992, p. 4). Under UNFCCC, burden-sharing thus combines the Polluter Pays and the Ability to Pay principles (Steininger et al., 2014). This means that industrialised countries, which have been historically responsible for the vast majority of GHG emissions and have a larger financial and technological capacity to address the issue, should lead climate change mitigation efforts (Gardiner, 2010).

According to Brandi (2013), the principle of CBDR&RC can also be understood along the lines of climate justice, which is concerned with fair distributive effects of policies: namely, that countries like the EU, which have been disproportionately responsible for causing climate change, should end up paying the most for its mitigation. This makes the economic basis of a BCA somewhat problematic. As discussed above, the BCA is largely concerned with levelling the playing field between domestic and foreign producers and pushing non-abating countries to adopt a carbon price. However, since the EU has historically been a major emitter, it has an obligation of distributive justice regarding developing countries (Shrivastava & Bhaduri, 2019). Therefore, when it comes to an EU-wide BCA, it cannot be seen as a neutral one-dimensional instrument that simply internalises externalities and punishes non-abating countries. Many of these non-abating countries have historically not contributed as much to climate change, and as such do not have the same climate change mitigation responsibility as the EU.

To uphold its obligations under the CBDR&RC principle, the EU would have to ensure that adopting a BCA would not redistribute the burden of climate change mitigation to developing countries. Since climate change is projected to negatively affect the economic and social well-being of the poorest and most vulnerable people the most, a BCA could in theory help developing nations by ensuring sufficient mitigation of climate change (Brandi, 2013). Nevertheless, this would depend on whether this positive effect in terms of climate change mitigation is not offset by the negative effect of BCAs on developing countries' economies, which would constitute burden-shifting from developed to developing nations and contravention of EU's obligations under the UNFCCC.

4. Research design

4.1. Objective

Since discussions for the EU-wide BCA are at a very early stage and still subject to a feasibility analysis, in my research I wanted to identify what aspects the EU should consider when it comes to both adopting and designing a BCA. The fact that a BCA has never been adopted on a national level, let alone as part of a regional bloc the scale of the EU, limits the ability to look at lessons learnt in other parts of the world and how they could be applied to the EU. While some lessons can be drawn from California and Quebec, the BCAs there are only applied at the state/province level and only to electricity imports, which makes it difficult to compare it with a potential EU-wide BCA. Consequently, I have decided to undertake a systematic literature review to identify what experts consider as key strengths and concerns regarding BCAs.

In this thesis, my objective is to synthesise the findings from different studies on the implications of adopting an EU-wide BCA. I do not aim to prepare a proposal for how an EU-wide BCA should look or evaluate whether a BCA should be adopted or not. Following the distinction developed by Cox (1981) and expanded upon by Jerneck et al. (2011), my thesis is more critical than problem-solving in that it focuses on assessing the different advantages and barriers of a BCA as discussed in the literature. However, I hope that identifying the implications of a BCA for the EU itself and the rest of the world will contribute some problem-solving aspects by highlighting the most important considerations that the EU should take into account before adopting the measure.

4.2. Conceptual framework

For this analysis, I adopted a conceptual framework to help me both identify what evidence to look for and structure my findings in a way that would provide a useful overview of the main concerns and implications regarding an EU-wide BCA. The framework chosen for my analysis was developed by Pickering et al. (2012). This framework was first identified when reading the thesis of Katalin Lakatos (2019), who used it to synthesise her findings from a systematic literature review on consumption-based emissions accounting methods. I supplemented the framework with the Intergovernmental Panel on Climate Change (IPCC) (2007) Working Group III's suggestions on how international climate agreements and policies should be evaluated (see Table 2 for the full conceptual framework used in this thesis).

Table 2. The conceptual framework used to evaluate an EU-wide BCA in this thesis. The framework uses criteria from the Pickering et al. (2012) framework, supplementing it with definitions from the IPCC (2007) recommendations and findings from the background research on BCAs. Own illustration.

Criteria in Pickering et al. framework	Corresponding criteria according to the IPCC	Criteria used to assess an EU-wide BCA in this thesis
Feasibility	Institutional feasibility	Compatibility with WTO rules
		Acceptance by stakeholders
Effectiveness	Environmental effectiveness	Ability to reduce carbon leakage
	Cost effectiveness	Cost effectiveness of adopting a BCA (if identified in literature)
Fairness	Distributional considerations	Adherence to the CBDR&RC principle

The Pickering et al. (2012) framework was initially developed to determine how fair multilateral climate agreements are by evaluating them against three criteria: feasibility, effectiveness and fairness. Although I am not looking at a multilateral climate agreement, this framework is still relevant for three reasons. Firstly, while the BCA would be adopted as an EU-wide rather than a global tool, it would still have international implications by affecting EU's trading partners.

Secondly, as discussed above, the European Green Deal strategy states that the ability to uphold the EU's international obligations (European Commission, 2019) and thus the fairness of its policies is important to the EU regarding the BCA. Therefore, I considered a framework that provides a conceptualisation of what makes a climate policy fair a suitable tool for my analysis.

Finally, the third reason why I chose this framework was the open-endedness of the evaluation criteria. While the tool sets out the criteria of feasibility, effectiveness, and fairness for evaluating the policies against, it leaves it open for interpretation as to how these criteria should look in practice. For example, with regard to effectiveness, the framework suggests that proponents of a climate agreement should ensure that it is supported by a critical mass of countries and includes mitigation efforts that would be adequate to keep global warming within 2°C (Pickering et al., 2012), without discussing more what critical mass or adequate mitigation efforts would entail. This open-endedness allows for a broader application of the framework and tailoring it to specific climate policies and research contexts. Consequently, while the framework was originally developed to evaluate international agreements, I could define the criteria in a way that would help evaluate domestic climate policies with international implications, as in the case of an EU BCA.

The Pickering et al. (2012) framework is in line with the four criteria that IPCC (2007) suggests are important to evaluate climate policies: institutional feasibility, environmental effectiveness, cost effectiveness, and distributional effects. The IPCC (2007) provides more specific definitions of the criteria than Pickering et al. (2012), having identified them through a systematic review of the existing literature on evaluating climate policies. For my analysis of the BCA here, I thus used the conceptual framework by Pickering et al. (2012), while supplementing it with the more specific definitions of the evaluation criteria suggested by the IPCC (2007) as well as findings from the initial background research that I found relevant to the conceptual framework (Table 2). Although Pickering et al. (2012) look at the effectiveness first before proceeding to feasibility and fairness, I have decided to first consider the feasibility of an EU-wide BCA, since some of the legal aspects have implications for the effectiveness and fairness of the measure. The definitions of the criteria are set out below. It is important to note that neither one of these criteria exists in isolation: rather, they inevitably involve some trade-offs. These will be addressed in chapters 5 and 6.

4.2.1. Feasibility

Following the IPCC (2007), the most important aspect of a policy's feasibility is institutional feasibility: that is, the likelihood that a given policy or mechanism will be accepted as legitimate by relevant stakeholders, and subsequently implemented. To ensure the adoption of an EU BCA, these stakeholders include EU Member States, EITE industries and EU's trading partners. Furthermore, as discussed before, a commonly cited concern on behalf of the EU is the compatibility with WTO rules (Simon, 2020). Therefore, the primary feasibility criteria the BCA is evaluated against are the extent to which it can be made compatible with WTO rules and accepted by the relevant stakeholders.

4.2.2. Effectiveness

Following the IPCC's (2007) recommendations, there are two main forms of effectiveness that should be considered with each measure: environmental effectiveness and cost effectiveness. Environmental effectiveness measures the ability of a given policy to achieve the environmental outcomes it sets out to deliver (IPCC, 2007). Environmental effectiveness therefore only looks at what positive environmental outcomes the policy delivers (IPCC, 2007). In contrast, cost effectiveness looks at both the costs and benefits of a given policy and is concerned with ensuring that the environmental benefits the policy delivers significantly outweigh the different costs (IPCC, 2007). However, it is difficult to obtain information on costs since an EU-wide BCA is currently in the early stages of a feasibility analysis, and no concrete proposal on what it should entail exists (Simon, 2020). Consequently, it is more practical to focus on environmental effectiveness, even if that renders the evaluation of the BCA somewhat incomplete (Lininger, 2015). The effectiveness criteria that the BCA is evaluated against is the extent to which it can achieve its primary environmental purpose: reducing carbon leakage. Any cost effectiveness considerations mentioned in the literature are also covered.

4.2.3. Fairness

When it comes to the fairness of a climate measure, the IPCC (2007) advises that the most important aspect to take into account is distributional considerations: that is, how a given policy is likely to redistribute the burden of climate change mitigation among different countries. This is in line with the approach of climate justice, especially the CBDR&RC principle. As discussed above, the European Green Deal emphasises the importance of upholding international obligations regarding a BCA (European Commission, 2019). Since a BCA is a climate measure, and the EU – a major historical emitter, one such obligation is CBDR&RC.

If a policy can ensure a just distribution of the climate change mitigation burdens, it can be considered fair (Steininger et al., 2014). Therefore, the primary criteria of fairness that the BCA is evaluated against is the extent to which it ensures that developing countries do not suffer a disproportionate burden of climate change mitigation costs.

4.3. Methodology

4.3.1. The importance of systematic literature reviews

A systematic literature review is a method that involves "identifying, synthesising and assessing all available evidence" in relevant scholarly fields to answer a particular research question (Mallett et al., 2012, p. 445). One of the benefits of a systematic literature review is that it should reduce the bias in identifying certain studies or choosing one piece of evidence over another, since it identifies all studies relevant to answering a particular research question, regardless of what their evidence posits (Petticrew & Roberts, 2006). In addition, a systematic literature review helps to identify all the relevant studies and find evidence from different disciplines. This is particularly helpful for in this thesis, since identifying the implications of an EU-wide BCA regarding its feasibility, effectiveness and fairness is undoubtedly an interdisciplinary question, concerning legal, environmental, social and economic considerations.

4.3.2. Undertaking the systematic literature review

The systematic literature review was conducted in line with the approach set out by Luederitz et al. (2016) on carrying out literature reviews for sustainability science. Firstly, I defined the selection criteria. For this thesis, I decided to analyse peer-reviewed articles in Scopus to ensure that the information gathered is of high quality and considered legitimate by professionals in relevant fields. Since the discussions for an EU BCA are still at the theoretical level, I decided not to limit my scope of research to only the articles discussing the EU, as lessons learnt from the BCA in California and Quebec, for example, may still be important. Consequently, I decided to look for all articles analysing BCAs.

Secondly, I devised and ran a search string in Scopus. To identify all relevant peer-reviewed articles on BCAs, I used the following search string:

(TITLE-ABS-KEY ("border carbon adjustment") OR TITLE-ABS-KEY ("carbon border adjustment") OR TITLE-ABS-KEY ("carbon border tax"))

I chose the three variations of the term BCA – “border carbon adjustment”, “carbon border adjustment”, and “carbon border tax” – as I found that these variations were commonly used to describe BCAs. The search string, which was run on 10th March 2020, returned 98 documents.

I downloaded the list of articles returned by the Scopus search string and proceeded to evaluate their relevance to my research by reading their title and abstract. In cases where the relevance was still unclear, I read the entire article. I eliminated articles that were not relevant for my research as well as those that I could not access. The articles were deemed irrelevant if they did not contain references to information fitting the three criteria of the conceptual framework, or if they looked specifically into devising a BCA for countries that were not part of the EU. Through this process, I reduced the number of articles to be reviewed to 41 (see Appendix), which served as input for my qualitative content analysis. I organised the relevant information and evidence according to the definitions of the three evaluation criteria set out in section 4.2 in an Excel sheet. These findings are summarised in the following chapter.

5. Findings

5.1. Feasibility

5.1.1. Legality

The WTO was created to ensure free international trade by preventing protectionism and arbitrary discrimination (Branger & Quirion, 2014a). The main principle underlying WTO law and its foundational treaty, the General Agreement on Tariffs and Trade (GATT), is non-discrimination of one country against foreign products or between foreign products based on their country of origin (Colares & Rode, 2017). The majority of the literature agrees that a number of WTO provisions are relevant to the legality of BCAs, particularly articles I, III and XX of GATT (Lininger, 2015; Mehling et al., 2019; Moore, 2017; Zhang, 2012).

Article I of GATT, the Most-Favoured Nation provision, posits that WTO member states cannot treat imported products less favourably than "like" domestic products (GATT, 1986). "Like" products are those considered "similar in all respects except their method of production" (Lininger, 2015, p. 47). Therefore, Article I would forbid countries from differentiating between otherwise similar products produced with emissions-intensive (dirty) technology and those produced with lower-carbon (clean) technology (Lininger, 2015).

Article III of GATT contains the National Treatment provision, whereby importers can only be subjected to internal taxes and regulations if domestic producers face the exact same restrictions (GATT, 1986). A product must be subjected to the tax not just because it is an import, but because there exists a corresponding internal price levied on domestic products (Mehling et al., 2019). In line with Article I, imported products cannot be subject to a charge bigger than "like" domestic products (Mehling et al., 2019).

The provisions in Article I and III forbid countries from applying a higher price to dirtier products, which contradicts the purpose of BCAs to internalise the negative effects associated with GHG emissions, thus fixing the pricing signal and providing incentives to switch to low-carbon production. For this reason, some literature argues that a BCA should instead be adopted as a mechanism under Article XX (Lininger, 2015). Article XX contains "General Exceptions" to the application of the GATT regulations, including those in Articles I and III (GATT, 1986). A BCA could be justified with regard to two GATT exceptions (Lininger, 2015): to "protect human, animal or plant life or health" and/or to ensure "conservation of exhaustible natural resources" (GATT, 1986, pp. 37-38), such as the atmosphere's absorptive capacity (Ladly, 2012; Moore, 2011).

Provisions in Article XX indicate that the only valid reason for the introduction of BCAs is environmental protection (Lininger, 2015). Therefore, while a BCA can be adopted with the overarching aim of limiting leakage, it should not be principally aimed at levelling the trade playing field or coercing other countries into strengthening their environmental policies (Lininger, 2015).

Adopting a BCA as an instrument under Article XX's exceptions may allow differentiated pricing between "like" products made with clean and dirty technologies (Lininger, 2015). However, no article states this with certainty. Instead, literature emphasises that even when it comes to environmental degradation and the general exceptions under Article XX, it is important that policies are compatible with the WTO's key principle of non-discrimination (Moore, 2017; Scobie, 2013).

Until a BCA is adopted, it is impossible to determine whether it would be compatible with WTO rules (Helm et al., 2012). The WTO Dispute Panel cannot rule on trade measures in abstract: they can only uphold or strike down a measure that has already been introduced and challenged by another WTO Member State (Hepburn, 2012). This makes acceptance of a BCA by EU's trading partners even more important. It is reasonable to assume that one of the main aspects a WTO Panel would judge a BCA against is the extent to which it upholds the non-discrimination principle (Colares & Rode, 2017).

Another key concern regarding the legality of the BCA is whether it should include just the import tariff or an export rebate as well. The WTO's Agreement on Subsidies and Countervailing Measures (SCM) forbids any subsidies that are only offered to goods that are exported as opposed to all the relevant goods produced in the country (Cosbey et al., 2019). Offering rebates to exports could be seen as a prohibited trade subsidy (Böhringer, Carbone, et al., 2012). The SCM agreement is a separate treaty from GATT, which means that the EU could not claim the exceptions under Article XX to justify export rebates (Cosbey et al., 2019).

5.1.2. Acceptance by stakeholders

The potential to push non-abating countries to adopt carbon pricing is seen as an advantage of BCAs. This includes the major emerging economies considered to be on the path to becoming the principal polluters in the future, such as Brazil, Russia, India, China (BRIC) and others (Brandi, 2013). However, experience shows that these countries would not necessarily willingly accept a BCA. For example, India, China and a large group of other developing nations have already appealed to the UNFCCC to prevent industrialised countries from introducing BCAs (Lininger, 2015). This reluctance could be due to a fear of green protectionism: developed countries imposing environmental measures to protect their industries from imports rather than uphold certain environmental standards (Lininger, 2015; Mehling et al., 2019).

The attempt to include international aviation under the EU ETS provides another insight into how countries could react to an EU-wide BCA. The provision meant that emissions from domestic and international flights, both departing from and arriving to the EU, were to be covered by the EU ETS, constituting a *de facto* BCA (Helm et al., 2012). The measure was met by strong resistance from both airlines and a coalition of China, India, Russia, the US, and a number of other countries, which refused to allow their airlines to pay the tariff and threatened retaliation with other trade measures (Moore, 2017). Following the international backlash, the EU ETS now covers only the domestic flights (Moore, 2017). Some scholars are thus sceptical of a BCA's ability to strengthen global climate commitments; instead, they fear potential trade wars and breakdowns of international relations (Antimiani et al., 2016).

When it comes to industry support, the experience of the Californian BCA on electricity imports shows that it largely depends on how much these industries are exposed to the BCA. Most of the industry support for the Californian BCA stemmed unsurprisingly from in-state producers of electricity, who saw the BCA as improving their competitive position (Pauer, 2018). Meanwhile, utilities that imported carbon-intensive electricity from other states opposed the scheme and lobbied for provisions that eventually weakened the measure (Pauer, 2018).

Industrial lobbies are another factor to consider regarding the acceptability of a BCA. The EITE sectors have significant lobbying powers when determining the strength and scope of EU climate policies (Branger & Quirion, 2014a). The rules and restrictions to which the EITE sectors are subjected under the EU ETS were found to be less stringent in the final version of the relevant documents than early drafts (Branger & Quirion, 2014a). Furthermore, the energy-intensive industry associations in Europe have already voiced their opposition to the BCA, preferring the continuous allocation of free EUAs (De Ville, 2012). This is because a significant number of these companies already have branches outsourced to other countries, and so replacing free EUAs with a BCA would mean not only having to pay a carbon price for domestic production, but also for imports into the EU from outsourced production facilities (De Ville, 2012).

5.1.3. Feasibility implications for an EU-wide BCA

Following the conceptual framework, the feasibility of a potential EU BCA is evaluated regarding its compatibility with WTO rules and acceptance of the measure by EU Member States, industries and trading partners. The findings indicate that while in theory the EU could design a WTO-compatible BCA, it would depend on its specific design. There are some options for designing a BCA that could potentially make it more compatible with WTO law, such as introducing a BCA only as an import tax rather than an export rebate (Böhringer, Carbone, et al., 2012).

Regardless, the EU will not truly know the outcome of whether a given BCA is compatible with WTO rules until it adopts it, gets challenged, and receives a WTO ruling on it (Hepburn, 2012). Ensuring the support of relevant stakeholders, including both governments and industry, could help avoid a challenge under WTO rules. Based on the fact that they have already voiced their opposition to a BCA (De Ville, 2012), major backlash can still be expected from EITE industries, especially companies that have already outsourced part of their production abroad. It is conceivable that the resistance of domestic EITE sectors would also undermine EU Member States' support.

In theory, the effects of a BCA could either encourage countries to strengthen their own climate commitments or undermine international trust and cause a trade war (Branger & Quirion, 2014b). In practice, even if compatibility with trade rules is upheld by the WTO, experience shows that EU's trading partners are unlikely to accept the measure without boycott, which could cause significant damage to both trade relationships and collaboration over climate change mitigation (Mehling et al., 2019; Lininger, 2015).

5.2. Effectiveness

5.2.1. Carbon leakage

The findings regarding the effectiveness of BCAs in reducing carbon leakage have been conflicting. Due to a lack of real-life BCAs, studies have had to rely on simulation models. Of the 41 articles reviewed, 23 discussed aspects related to the environmental effectiveness of BCAs. 14 of them ran their own models of the world economy to determine the extent to which a BCA could reduce carbon leakage. The remaining nine reviewed models run in other academic studies. While studies seem to agree that BCAs do indeed reduce carbon leakage with statistical significance (Branger & Quirion, 2014b), the extent to which they do so depends largely on the particular model of the global economy used in the study and the assumptions underlying it (Branger & Quirion, 2014a, 2014b). A review of 35 *ex ante* studies finds that globally, a BCA can reduce carbon leakage by approximately 6% (Branger & Quirion, 2014b). Other studies estimate that a BCA could reduce leakage by as much as 9% (Böhringer et al., 2017) or 15% (Branger & Quirion, 2014b).

Resource shuffling presents a problem for the effectiveness of BCAs. This phenomenon occurs when producers shift their more carbon-intensive goods to areas without a carbon price and sell less carbon-intensive goods in areas with a carbon price (Pauer, 2018). The problem with this form of leakage is that no overall emissions reduction takes place: instead, they are just shifted around. This occurred when California introduced a BCA to cover electricity imports: utilities simply replaced the generators that produced more carbon-intensive electricity with ones that were less carbon-intensive, while the carbon-intensive facilities were used to serve clients outside of California (Pauer, 2018).

Another problem is the incapacity of BCAs to address all types of leakage. As mentioned above, the energy market is the primary leakage channel (Table 1). Studies imply that a BCA could address the leakage resulting from the competitiveness channel by simply levelling the playing field between domestic and foreign companies (Caron, 2012). However, the existence of the energy market channel means that a BCA could not eliminate leakage completely, since it is projected to lead to decreasing domestic consumption of fossil fuels, driving down their prices and resulting in increased consumption of fossil fuels elsewhere (Böhringer, Balistreri, et al., 2012; Caron, 2012; Weitzel et al., 2012; Zhang, 2012).

For this reason, one study investigated the difference in leakage in a non-cooperative scenario where the EU unilaterally adopts a BCA, as compared to a cooperative scenario where the EU introduces a BCA and all other countries in the world adopt some kind of carbon price by, for example, participating in emissions trading (Antimiani et al., 2012). While a unilateral EU BCA without cooperation from the rest of the world is found to reduce leakage only to a limited extent, the cooperative scenario virtually eliminates carbon leakage in addition to also contributing to global emissions reduction (Antimiani et al., 2012). Studies thus conclude that a unilateral BCA is still only the second-best option to reduce carbon leakage, with the optimal solution being a global carbon price (Helm et al., 2012).

5.2.2. Scope of the BCA

An important aspect to consider when adopting a BCA is which emissions it should cover. Depending on the length and complexity of a given product's supply chain, the literature currently identifies three types of emissions: (1) direct emissions caused in the production process of a particular good; (2) indirect emissions resulting from energy use; and (3) indirect emissions from other inputs, such as machinery, transport, and even waste disposal (Cosbey et al., 2019).

Studies argue that a BCA could offer a solution to the energy market leakage channel by covering indirect emissions from energy inputs in the assessment of the embedded carbon content of imported goods (Mehling et al., 2019). However, a major concern is the potentially high administrative costs of measuring the embedded carbon content, particularly regarding indirect emissions. Electricity is found to be responsible for up to one-third of total emissions embedded in products (Sakai & Barrett, 2016). Nevertheless, energy sources and therefore emissions can vary greatly across regions, especially in areas with integrated electricity systems that use inputs from different energy sources (Sakai & Barrett, 2016). In addition, even when it comes to "like" products, due to intricate global supply chains their embedded carbon content can be very different depending on the origin country of the inputs used for the product. For example, the same car produced in Malaysia with steel imported from Brazil has a significantly different carbon footprint than one produced with steel from China due to different technologies, energy sources and intermediate supply chains (Böhriger et al., 2015; Mattoo et al., 2013). Including indirect emissions under a BCA would require extensive amounts of data on globally dispersed inputs and could lead to double-counting and coverage of emissions that are not even accounted for in the EU ETS, since the EU ETS does not cover emissions embedded in the whole supply chain (Cosbey et al., 2019; Sakai & Barrett, 2016).

Consequently, another aspect to consider is which sectors the BCA should be applied to. Some research shows that the most cost-effective option would be applying the BCA only to major EITE sectors such as cement, aluminium, steel and electricity (Mehling et al., 2019). This limited coverage would still reduce leakage while also lowering administrative costs associated with calculating and verifying the embedded carbon content (Mehling et al., 2019). Otherwise, if the BCA covers all the sectors under the EU ETS, the administrative costs resulting from the measuring and verification requirements might outweigh the benefits of emissions reduction (Cosbey et al., 2019).

One of the remaining literature gaps is how to accurately determine sectors that are most at risk of carbon leakage (Cosbey et al., 2019). Some argue that the two main criteria should be carbon exposure and trade exposure: that is, would a BCA result in a substantial increase in the production costs of a particular good, and would international trade competition prevent these costs from being passed onto consumers (Cosbey et al., 2019). However, these criteria still leave substantial amount of freedom for interpretation: what does a significant increase in production prices really mean, how can one determine the level of competition, and at what level is this competition too intense to allow consumers to subsume the price.

Another consideration regarding the scope of the BCA is whether exports should be offered a rebate under the BCA. As already discussed, export rebates might prove illegal under the SCM (Böhringer, Carbone, et al., 2012). Studies agree that a full BCA, including both an import tariff and export rebate, would be the most effective option to reduce carbon leakage (Fischer & Fox, 2012). Nevertheless, there is also evidence that even if a BCA is only applied to imports, it will deliver most of the envisioned benefits (Böhringer, Carbone, et al., 2012; Mehling et al., 2019). This is because the EU is a major net importer of embodied carbon emissions, which makes rebates less important (Böhringer, Carbone, et al., 2012).

5.2.3. Calculating and verifying the embedded carbon content

To increase the effectiveness and acceptance of a BCA, it is important to ensure accurate and transparent measurement of the embedded carbon content (Sakai & Barrett, 2016). In addition, accurate estimates of carbon content can send a better pricing signal to polluters (Zhang et al., 2018). However, one of the main issues is again the high associated administrative costs as well as the bureaucracy that a verification procedure would require (Böhringer et al., 2017).

There are currently two main ways of determining emissions: firstly, a bottom-up approach that determines the carbon content of each product, requiring extensive information of both direct emissions caused when making the product and indirect emissions, including suppliers from other countries; and, secondly, a top-down approach, which looks at the aggregate amount of emissions produced by a sector and then sets this emissions level as a standardised benchmark when determining the carbon intensity of products from the sector (Lininger, 2015). With regard to the second option, a benchmark is usually set based on emissions resulting from production with best (least emissions-intensive) or worst (most emissions-intensive) technology available in a particular sector in the abating region (Mehling et al., 2019). The use of standardised benchmarks based on domestic sector performance rather than taking into account the performance of foreign producers is conditioned by the difficulty in obtaining information regarding complex supply chains and the limited jurisdictional power in requesting foreign companies to provide such information (Sakai & Barrett, 2016).

Since determining direct and indirect emissions for each product is a very resource-intensive activity due to complicated global input supply chains and varying production methods in different countries (Sakai & Barrett, 2016), standardised benchmarks appear to be the less resource-intensive option (Mehling et al., 2019). However, as already discussed, the non-discrimination clause of the WTO could mean that even if the embedded carbon content of foreign products is larger, they may need to be charged the same as domestic products to avoid the BCA being ruled as arbitrary discrimination against foreign industries (Lininger 2015; Sakai & Barrett, 2016). This would imply that the benchmark for setting an EU BCA level would likely need to be best available technology (BAT) in the EU (Lininger, 2015; Sakai & Barrett, 2016). It is important to note that basing the BCA on BAT would undermine its environmental effectiveness, since the tariff would fail to penalise dirtier industries more than cleaner producers (Fischer & Fox, 2012). This would in turn fail to send adequate pricing signals and provide producers with sufficient incentives to lower their carbon footprint (Lininger, 2015).

A problem with using benchmarks based on domestic producers to measure the embodied carbon content of imports is the failure to acknowledge that foreign producers could indeed be using less carbon intensive technology (Rocchi et al., 2018). For the sake of transparency, and the fact that importers are unlikely to be willing to accept high tariffs, importers should be allowed to prove that the embedded carbon content of their products is lower than the benchmark (Cosbey et al., 2019). Otherwise, failure to reward low-carbon technology use might create perverse incentives for producers to adopt dirtier technology instead.

Furthermore, it is necessary to ensure that the embedded carbon content is not only measured, but also verified in a transparent fashion. There is currently no clear WTO guidance on how the carbon content of foreign products should be assessed (Moore, 2011). One of the ways to go would be utilising a procedure used for the Clean Development Mechanism (CDM) under UNFCCC, whereby a project is deemed eligible under CDM following a triple verification: initial certification by the Designated National Authority, subsequent verification by an external validator, and a final ruling by the CDM Executive Board (Böhringer et al., 2017). Another option would be utilising the International Organisation of Standardisation (ISO) standard on carbon footprint (Böhringer et al., 2017). This standard takes into account the emissions embedded in a product across its whole life cycle – from initial inputs such as raw materials and energy to actual waste disposal, including any offsetting schemes that the company utilises to minimise their impact (Böhringer et al., 2017). Nevertheless, the ISO provides the guidance, not the calculation or verification of the embedded carbon content (ISO, n.d.). Consequently, an external agency would still be needed to provide this service.

5.2.4. Effectiveness implications for an EU-wide BCA

The effectiveness of a potential EU BCA is evaluated against its primary environmental objective: reducing carbon leakage. The literature review revealed that effectiveness should mean not just the ability of a BCA to reduce carbon leakage in general, but also the extent to which it can do so. Most studies show that while a BCA is indeed capable of reducing carbon leakage, it cannot eliminate it entirely because of the energy market channel (Caron, 2012). An EU-wide BCA could only eliminate leakage completely in a world where all the other countries adopt some form of carbon pricing themselves (Antimiani et al., 2012). In cases where the EU would adopt the BCA unilaterally, depending on the design and assumptions of the models, it could reduce carbon leakage by approximately 6-15% (Böhringer et al., 2017; Branger & Quirion, 2014b). Therefore, while a unilateral BCA can indeed reduce leakage, the limited extent to which it is able to do so raises a question as to whether it can really be considered an effective measure.

In general, there is an inherent trade-off between the feasibility of the BCA, particularly its compatibility with the international trade law, and effectiveness. The global trade regime is based on the fundamental principle of non-discrimination. Intuitively, it seems that a BCA would send the best pricing signal if companies importing more carbon-intensive goods would have to pay a higher BCA, encouraging producers to invest in low-carbon technology. Nevertheless, differentiated carbon tariffs for importers and domestic producers, even if based on embedded carbon content, may prove to be incompatible with the WTO law, at least GATT's Articles I and III and their prohibition from discriminating between "like" products (Mehling et al., 2019). The literature does not provide a conclusive verdict as to whether the general exceptions of GATT's Article XX would allow differentiated pricing. To not violate the principle of non-discrimination, the EU would likely have to rely on setting a benchmark for the BCA based on BAT, thus avoiding differentiation between clean and dirty products (Lininger, 2015). However, using BAT as a benchmark would likely undermine the effectiveness of the pricing signal and fail to provide sufficient incentives for producers to switch to cleaner production methods.

5.3. Fairness

5.3.1. Adherence to the CBDR&RC

Regarding the embedded carbon content, developed countries tend to import more emissions than export, while developing countries export more emissions than import (Steininger et al., 2014). When countries that are net exporters of emissions are less developed than the net importers, a BCA is found to shift the financial burden of climate change mitigation towards developing countries (Böhringer, Balistreri, et al., 2012).

Some studies attempt to determine which developing countries would be affected the most negatively by an EU-wide BCA. Brandi's (2013) study on trade flows between the EU and developing countries identified that low-income countries (LICs) such as Tajikistan and Zimbabwe as well as least-developed countries (LDCs) such as Mozambique were particularly vulnerable to an EU BCA, because they tend to export more EITE products to the EU. While exports to the EU constitute a relatively low share of most LICs and LDCs' total production, exports from the EITE industries provide a substantial source of employment and income for local people (Brandi, 2013). If BCAs are applied, they could limit the market access of these countries and potentially increase poverty levels (Brandi, 2013).

GATT recognises the special circumstances of some developing countries. Under the Enabling Clause of GATT (1979, p. 193), LDCs can be granted exemption from environmental policies because of their "special economic situation and <…> development, financial and trade needs". LDCs could thus be exempted from the BCA (Scobie, 2013). However, this does not apply to developing countries that are not categorised as LDCs. GATT states that all other developing countries should be treated the same, which includes LICs like Tajikistan and Zimbabwe that bear no historical responsibility for climate change and yet could potentially be harmed by the BCA (Brandi, 2013).

Adopting an EU-wide BCA when the developing countries' exports tend to be more carbon-intensive means that developing countries would be expected to bear the major costs of climate change mitigation (Steininger et al., 2014). This would contravene the CBDR&RC principle that the global climate regime is founded on, as it is the EU that bears the historical responsibility for climate change and should be subjected to major mitigation costs (Steininger et al., 2014).

5.3.2. A fair design of the BCA

Research shows that using the revenue from the BCA to aid climate change mitigation and adaptation efforts and clean technology transfer to developing countries can actually offset the negative economic effects of BCAs (Böhringer, Carbone, et al., 2012; Cosbey et al., 2019; Steininger et al., 2014). In addition, it could help uphold the EU's responsibilities under the Paris Agreement by providing revenue for the Green Climate Fund, which was created to aid developing countries in climate mitigation efforts but has so far been largely lacking funding (Mattar et al., 2019). Dedicating the revenue to developing countries would also help comply with the CBDR&RC principle as well as show that a BCA is adopted as a mechanism to reduce carbon leakage as opposed to protect domestic industries (Cosbey et al., 2019), helping to classify the BCA under the environmental exceptions of GATT's Article XX. Nevertheless, it is not clear how willing abating countries would be to transfer the revenues from BCAs to non-abating regions (Böhringer, Carbone, et al., 2012).

Allowing a grace period before the BCA is introduced for developing countries to prepare and potentially strengthen their own environmental standards could also improve the fairness of the measure (Branger & Quirion, 2014a). Another suggestion is limiting the BCA to only the most EITE sectors (Mehling et al., 2019). Studies show that the wider the sectoral coverage of the BCA, the more likely it is to shift the financial burden towards developing nations (Cosbey et al., 2019; Mehling et al., 2019).

5.3.3. Fairness implications for an EU-wide BCA

For an EU BCA to be considered a fair measure, it should ensure that the distributional effects resulting from the BCA do not contravene the CBDR&RC principle. In contrast, studies agree that if a bloc of industrialised countries like the EU introduces a BCA, it will shift the burden of climate change mitigation to less developed countries and exacerbate pre-existing social and economic inequalities within the countries (Böhringer, Carbone, et al., 2012; Böhringer et al., 2017; Sakai & Barrett, 2016)

Therefore, another trade-off exists between the feasibility and the fairness of a BCA. GATT rules state that all developing countries bar the LDCs should be treated the same (Brandi, 2013). This means that both major emerging economies like the BRICs and LICs such as Tajikistan and Zimbabwe would likely have to be subjected to the BCA regardless of their very different economic contexts and contributions to overall GHG emission levels (Brandi, 2013). If the EU adopted a BCA without additional measures to mitigate these consequences, it would violate its international commitments under CBDR&RC. As a result, a BCA could not be considered a just, or fair, tool.

However, studies also conclude that these effects could be offset by the EU redirecting all the revenue from the BCA back to the affected developing countries (Böhringer, Carbone, et al., 2012). This could be done by funding existing initiatives such as the Green Climate Fund under Paris, thus helping developing countries adopt low-carbon technologies and potentially gain a better competitive position in relation to EU companies under a BCA.

6. Discussion

The findings of the systematic literature review reveal tensions between the WTO and global climate regimes as well as trade-offs inherent in designing a BCA. A key takeaway for the EU is that the ambiguity of the WTO rules makes it difficult to design an effective BCA that would also be compatible with trade rules. As has already been discussed, Articles I and III of the GATT would likely mean that a BCA could not fully differentiate between products made with clean and dirty technologies, constituting a trade-off between the feasibility and effectiveness of a BCA. Furthermore, the literature is unable to offer a conclusive verdict as to whether environmental exceptions under GATT's Article XX would allow differentiated pricing. As studies unanimously agree that non-discrimination is the most important principle in the WTO regime, it seems likely that differentiated pricing would be subject to challenge from EU's trading partners. The non-discrimination clause also creates a further trade-off between the feasibility and fairness of a BCA: since GATT rules forbid differentiated treatment of developing countries that are not LDCs, it means that all other developing countries would have to be subject to the BCA regardless of what their contribution to climate change has been.

While not directly related to the definitions of evaluation criteria set out in the conceptual framework, there is also another trade-off that concerns all three criteria. By forbidding differentiated pricing between dirty and clean products, GATT constrains the ability of BCAs to fight carbon leakage and incentivise GHG reductions, making the instrument ineffective in the face of climate change. As a result, the EU would fail to uphold its responsibility as a historical emitter to lead climate change mitigation efforts and deliver significant emissions cuts. The feasibility constraints under the WTO law thus undermine a BCA's effectiveness, which in turn jeopardises the fairness of the measure regarding developing countries.

Whether the BCA would be struck down in case of a challenge under WTO rules cannot be foreseen. The absence of comparable BCAs at either a national or regional level makes it difficult to speculate how a BCA may be perceived. Although the WTO is not bound by preceding rulings (Branger & Quirion, 2014a), an example of a BCA adopted elsewhere could still show which design features would make it more or less likely to be compatible with WTO rules. Nevertheless, the existence of the aforementioned trade-offs could still undermine the EU's ability to uphold its international obligations under the trade and global climate regimes. As a result, a more comprehensive assessment on behalf of the EU that considers BCAs' limited effectiveness and implications for climate justice rather than just focusing on the measure's overall compatibility with WTO rules is needed.

Another point for the EU to consider is what level of effectiveness in reducing carbon leakage warrants adopting a BCA. As we have seen, due to the energy market leakage channel, a BCA imposed by the EU alone would not eliminate leakage completely and could only reduce it to a rather limited degree (for example, 6-15% in the studies considered for this thesis). Given the ambiguity of the WTO rules, the likelihood of a challenge and the considerable administrative burden associated with measuring and verifying the embedded carbon footprint, it is crucial to consider whether the benefits of this limited impact in reducing leakage do indeed outweigh the costs of adopting a BCA. This question is further complicated by the fact that the existence of carbon leakage itself is still a subject of debate (Antimiani et al., 2016).

This perhaps points to the main limitation of this analysis, and of an attempt to investigate the impacts of BCAs in general: due to a lack of real-life examples, studies all inevitably rely on models simulating the effects of the global economy. Since EITE industries are currently provided free EUAs to prevent leakage, and a BCA has so far not been adopted in the EU, it is reasonable to conclude that the real extent of either carbon leakage or the ability of a BCA to reduce it will not be known until free EUAs are eliminated and a BCA is adopted.

There are reasons outside of leakage reduction for the EU to adopt a BCA. Literature agrees that a global carbon price would indeed be the most effective solution to carbon leakage (Helm et al., 2012). However, with the Paris Agreement and the move towards climate change mitigation based on NDCs, such global price does not seem easily attainable. Meanwhile, global emissions levels continue to rise (IPCC, 2018). A BCA, even if it is a second-best option, could help price at least some of the emissions from non-abating regions. In addition, adopting a BCA could be seen as a statement on behalf of the

EU to the rest of the world that carbon emissions should not go unpriced, and that countries should therefore make good on their pledges and adopt a carbon price themselves. Indeed, Commission President von der Leyen warned China that if they fail to adopt a carbon price, they would have to face it in the EU in the form of a BCA (Khan & Rachman, 2020). Nevertheless, if the attempt to coerce countries into adopting carbon pricing is seen as the main objective of the BCA, it would be deemed incompatible with the general exceptions under Article XX of the GATT, which would allow a BCA only with regard to its environmental goals (Lininger, 2015).

The extent to which the envisioned benefits of a BCA outweigh the costs of adoption is thus not only a question of cost effectiveness, but also a normative dilemma. Determining how far should the leakage be reduced or how important it is to make a statement on carbon pricing to make it worth the potential legal hurdles and resulting backlash depends at least to some extent on how much the EU values its decarbonisation commitments in relation to its trade relationships.

Consequently, the main question here is whether the fear of challenge under WTO rules or the inability to eliminate leakage will prevent the EU from adopting a BCA in the first place. As mentioned before, the EU has previously dismissed the idea of a BCA solely due to its potential incompatibility with trade rules, even when WTO had not ruled BCAs out themselves (Zhang, 2012). This fear of challenge, coupled with the continuing allocation of free EUAs due to a fear of carbon leakage, indicates that the EU's climate policy has so far been somewhat based on a fear of hypotheticals. However, instances where the EU has attempted to take a stronger unilateral stance and influence climate policy in other countries, such as adopting international aviation under the EU ETS, have shown how easy it is to undermine international trust and even spark a potential trade war. Consequently, it is perhaps understandable that the EU would want to tread carefully in attempting to adopt a similar measure again.

The overall findings do strike another question: the compatibility of WTO rules and the global climate regime. Market mechanisms for climate change mitigation can only work efficiently when they send appropriate price signals, internalising the negative environmental and social externalities associated with GHG emissions (Hepburn, 2010). Keeping in mind the restrictions to carbon pricing under GATT, such as the non-discrimination between dirty and clean technologies, can there ever be a global carbon price that will internalise the relevant externalities and be high enough to encourage sufficient decarbonisation? Or is climate policy based on market mechanisms simply predisposed to fall short of its potential due to trade rules that were made before climate change was on the global agenda? This question is outside the scope of this thesis, but it does bear important implications for the future of climate change mitigation.

WTO rules are not impervious to amendments: they can be changed if members agree that some rules are no longer fitting for their needs or the world we are living in (Charnovitz, 2003). Nevertheless, amending WTO law would likely require a consensus on behalf of all its Member States (Georgetown Law Library, 2019). Therefore, a debate in both the scholarly literature and political arena is needed on making the WTO and the global climate regimes more compatible.

7. Conclusion

The systematic literature review undertaken in this thesis finds that, in theory, it is possible to design a BCA compatible with WTO rules. The compatibility depends largely on the design of the particular BCA and its ability to uphold the non-discrimination principle, which provides the foundation for the WTO regime. Since WTO cannot provide rulings on the legality of measures before they are in place, the EU will only know whether a BCA is compatible with international trade rules once it adopts it and gets challenged by another WTO Member State. Given the opposition that has already been voiced by EITE industries and EU's trading partners, a challenge under WTO rules is likely.

The principle of non-discrimination means that a BCA would potentially be unable to apply differentiated pricing to goods produced with dirty and clean technologies. This constitutes a major trade-off between feasibility and effectiveness, since the idea behind a BCA is that it should penalise emissions-intensive products more to incentivise emissions cuts. The inability to differentiate between dirty and clean products would severely undermine the BCA's effectiveness. In addition, the effectiveness of a BCA in reducing leakage is limited when it is applied as a unilateral measure on behalf of the EU. Only some form of global carbon pricing can eliminate leakage completely.

A BCA is found to redistribute the burdens of climate change mitigation from the EU towards developing countries, thus contravening EU's obligations under the UNFCCC, namely the CBDR&RC principle. This constitutes another trade-off, one between feasibility and fairness, since the non-discrimination principle under WTO posits that all developing countries should be treated the same regardless of their varied contributions to climate change. However, these negative distributional effects can be mitigated by channelling the revenue from the BCA back into developing countries as a support for climate change policies and clean technology transfer.

The fact that WTO rules undermine the effectiveness and fairness of BCAs indicates that there is an inherent tension between the trade and global climate regimes. By forbidding differentiated pricing between dirty and clean products, the non-discrimination principle prevents BCAs and potentially other market mechanisms from fully internalising the negative externalities associated with GHG emissions. This in turn means that carbon pricing fails to transmit accurate pricing signals that would reflect the true scarcity of the atmosphere's absorptive capacity. Further research is needed on increasing the compatibility of the trade and global climate regimes. In addition, a more holistic assessment that considers the trade-offs inherent in a BCA rather than just its compatibility with the WTO rules should be undertaken if the EU wants to uphold its obligations under both the trade and global climate regimes.

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9. Appendix

The list of 41 articles chosen for the systematic literature review.

	Authors	Title	Year	Source title	Volume	Issue	Page start	Page end	DOI
2	Balistreri E.J., Kaffine D.T., Yonezawa H.	Optimal Environmental Border Adjustments Under the General Agreement on Tariffs and Trade	2019	Environmental and Resource Economics	74	3	1037	1075	10.1007/s10640-019-00359-2
3	Mehling M.A., Van Asselt H., Das K., Droege S., Verkuijl C.	Designing Border Carbon Adjustments for Enhanced Climate Action	2019	American Journal of International Law	113	3	433	481	10.1017/ajil.2019.22
4	Zhang D., Caron J., Winchester N.	Sectoral Aggregation Error in the Accounting of Energy and Emissions Embodied in Trade and Consumption	2019	Journal of Industrial Ecology	23	2	402	411	10.1111/jiec.12734
5	Cosbey A., Droege S., Fischer C., Munnings C.	Developing Guidance for Implementing Border Carbon Adjustments: Lessons, Cautions, and Research Needs from the Literature	2019	Review of Environmental Economics and Policy	13	1	3	22	10.1093/reep/rey020
6	Pauer S.U.	Including electricity imports in California's cap-and-trade program: A case study of a border carbon adjustment in practice	2018	Electricity Journal	31	10	39	45	10.1016/j.tej.2018.11.005
7	Rocchi P., Serrano M., Roca J., Arto I.	Border Carbon Adjustments Based on Avoided Emissions: Addressing the Challenge of Its Design	2018	Ecological Economics	145		126	136	10.1016/j.ecolecon.2017.08.003
8	Böhringer C., Bye B., Fæhn T., Rosendahl K.E.	Targeted carbon tariffs: Export response, leakage and welfare	2017	Resource and Energy Economics	50		51	73	10.1016/j.reseneeco.2017.06.003
9	Chang W.W.	World Trade and the Environment: Issues and Policies	2017	Pacific Economic Review	22	3	435	479	10.1111/1468-0106.12100
10	Colares J.F., Rode A.	The opportunities and limitations of neutral Carbon Tariffs	2017	American Law and Economics Review	19	2	423	463	10.1093/aler/ahx012
11	Moore M.O.	Carbon safeguard? Managing the friction between trade rules and climate policy	2017	Journal of World Trade	51	1	43	66	
12	Antimiani A., Costantini V., Kuik O., Paglialunga E.	Mitigation of adverse effects on competitiveness and leakage of unilateral EU climate policy: An assessment of policy instruments	2016	Ecological Economics	128		246	259	10.1016/j.ecolecon.2016.05.003
13	Sakai M., Barrett J.	Border carbon adjustments: Addressing emissions embodied in trade	2016	Energy Policy	92		102	110	10.1016/j.enpol.2016.01.038
14	Ismer R., Haussner M.	Inclusion of Consumption into the EU ETS: The Legal Basis under European Union Law	2016	Review of European, Comparative and International Environmental Law	25	1	69	80	10.1111/reel.12131
15	Eichner T., Pethig R.	Unilateral consumption-based carbon taxes and negative leakage	2015	Resource and Energy Economics	40		127	142	10.1016/j.reseneeco.2015.03.002
16	Helm C., Schmidt R.C.	Climate cooperation with technology investments and border carbon adjustment	2015	European Economic Review	75		112	130	10.1016/j.euroecorev.2015.01.007
17	Lininger C.	The Political and Legal Background to the Discussion About Consumption-Based Policies	2015	Springer Climate			41	51	

	A	B	C	D	E	F	G	H	I
18	Lininger C.	Quantitative Studies of Carbon Leakage and the Effects of Border Adjustments	2015	Springer Climate			63	90	
19	Lininger C.	Unilateral Climate Policies: The Theoretical Economic Background	2015	Springer Climate			53	61	
20	Lininger C.	Consumption as a Base for Emission Accounting and as a Policy Base	2015	Springer Climate			17	40	
21	Branger F., Quirion P.	Would border carbon adjustments prevent carbon leakage and heavy industry competitiveness losses? Insights from a meta-analysis of recent economic studies	2014	Ecological Economics	99		29	39	10.1016/j.ecolecon.2013.12.010
22	Steininger K., Lininger C., Droege S., Roser D., Tomlinson L., Meyer L.	Justice and cost effectiveness of consumption-based versus production-based approaches in the case of unilateral climate policies	2014	Global Environmental Change	24	1	75	87	10.1016/j.gloenvcha.2013.10.005
23	Branger F., Quirion P.	Climate policy and the 'carbon haven' effect	2014	Wiley Interdisciplinary Reviews: Climate Change	5	1	53	71	10.1002/wcc.245
24	Mattoo A., Subramanian A., van der Mensbrugghe D., He J.	Trade effects of alternative carbon border-tax schemes	2013	Review of World Economics	149	3	587	609	10.1007/s10290-013-0159-0
25	Brandi C.	Trade and Climate Change: Environmental, Economic and Ethical Perspectives on Border Carbon Adjustments	2013	Ethics, Policy and Environment	16	1	79	93	10.1080/21550085.2013.768395

	A	B	C	D	E	F	G	H	I
26	Antimiani A., Costantini V., Martini C., Salvatici L., Tommasino M.C.	Carbon leakage and trade adjustment policies	2013	The Dynamics of Environmental and Economic Systems: Innovation,	#######		25	43	10.1007/978-94-007-5089-0_2
27	Boehringer C., Fischer C., Rosendahl K.E.	The global effects of subglobal climate policies	2013	Distributional Aspects of Energy and Climate Policies			310	344	10.4337/9781783470273.00022
28	Scobie M.	Climate regulation: Implications for trade competitiveness in Caribbean states	2013	Climate Change Management			33	49	10.1007/978-3-642-37753-2_3
29	Hepburn C.	The energy mix, carbon pricing and border carbon adjustments	2012	Environmental Law and Management	24	4	177	185	
30	Böhringer C., Balistreri E.J., Rutherford T.F.	The role of border carbon adjustment in unilateral climate policy: Overview of an Energy Modeling Forum study (EMF 29)	2012	Energy Economics	34	SUPPL.2	S97	S110	10.1016/j.eneco.2012.10.003
31	Zhang Z.	Competitiveness and leakage concerns and border carbon adjustments	2012	International Review of Environmental and Resource Economics	6	3	225	287	10.1561/101.00000052
32	Helm D., Hepburn C., Ruta G.	Trade, climate change, and the political game theory of border carbon adjustments	2012	Oxford Review of Economic Policy	28	2	368	394	10.1093/oxrep/grs013
33	Bednar-Friedl B., Schinko T., Steininger K.W.	The relevance of process emissions for carbon leakage: A comparison of unilateral climate policy options with and without border carbon adjustment	2012	Energy Economics	34	SUPPL.2	S168	S180	10.1016/j.eneco.2012.08.038
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34	Böhringer C., Carbone J.C., Rutherford T.F.	Unilateral climate policy design: Efficiency and equity implications of alternative instruments to reduce carbon leakage	2012	Energy Economics	34	SUPPL.2	S208	S217	10.1016/j.eneco.2012.09.011
35	Caron J.	Estimating carbon leakage and the efficiency of border adjustments in general equilibrium - Does sectoral aggregation matter?	2012	Energy Economics	34	SUPPL.2	S111	S126	10.1016/j.eneco.2012.08.015
36	Weitzel M., Hübler M., Peterson S.	Fair, optimal or detrimental? Environmental vs. strategic use of border carbon adjustment	2012	Energy Economics	34	SUPPL.2	S198	S207	10.1016/j.eneco.2012.08.023
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