EU'S CARBON BORDER ADJUSTMENT MECHANISM – ITS PURPOSE AND EFFECTS ON CARBON LEAKAGE

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Abstract

Part of the European Green Deal, a package of climate policy initiatives, launched in 2019 is the Carbon Border Adjustment Mechanism (CBAM). The CBAM is essentially a tariff placed on imported goods’ carbon content. This literature review aims to explore why carbon border adjustment is a favoured climate policy instrument and is it an effective way to reduce carbon leakage. The partial and general equilibrium models show that from a global welfare point of view a border carbon adjustment increases welfare but setting an optimal tariff level is complex and could have unwanted results. When applying the carbon tariff only on emissions-intensive and trade-exposed (EITE) industries carbon leakage would decrease. However, for CBAM to succeed it needs to follow the rules of World Trade Organization and a compatible tariff design diminishes the leakage reduction.

Keywords  carbon border adjustment, carbon leakage, unilateral trade policy, optimal carbon tariff, carbon border adjustment mechanism
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1 Introduction

The European Commission proposed a policy initiative called European Green Deal on 11 December 2019 to tackle climate change. Global warming is a major cause for climate change and the EU among 195 countries has committed to limit the warming to 1.5 degrees Celsius. To achieve this goal, global carbon neutrality is crucial and with the Green Deal EU aims to achieve it by 2050. Carbon neutrality is attained when emitting and absorbing carbon is in balance. Currently emitting outweighs absorbing and thus emissions reductions are needed. (European Parliament, 2019)

The Green Deal includes various policy measures to reduce carbon emissions and one of them is Carbon Border Adjustment Mechanism (CBAM) that gained European Parliament’s approval 10.3.2021. The European Green Deal states that Carbon Border Adjustment Mechanism’s main function is to reduce the risk of carbon leakage and ensure that the price of imported commodities reflect their carbon footprint. (European Commission, 2019)

The proposed mechanism is strongly linked to the EU Emissions Trading System (EU ETS) as it entered its 4th phase in 2021 where the total number of emissions allowances were cut by 2.2 percent annually compared to the 1.74 percent rate prior to 2021 (European Commission, 2015b). As the emissions allowances are made more scarce, the risk of emitting industries relocating to areas outside the EU, where emissions are not restricted, increases. This phenomenon is known as carbon leakage (e.g. Felder & Rutherford, 1993). Preventing carbon leakage is uttermost importance for EU since if leakage occurs, EU’s climate actions are insignificant.

The threat of leakage could be solved with a global uniform Pigouvian tax1 (Shapiro, 2020). However, multilaterally coordinated policies have proven to be intractable issues in the United Nations Climate Change Conferences e.g. COP 15 and COP 25, and thus unilateral actions such as border carbon adjustments have gained attraction (Droege & Fischer, 2020; Gros & Egenhofer, 2011).

1 Pigouvian tax is a tax to combat market failures due to externality. The Pigouvian tax changes the marginal cost of the emitting party in a way that they have to take into consideration the social cost not just the private cost. (CORE Team, 2017)
The only running carbon border adjustment system is part of the cap-and-trade program in California targeting electricity imports (Pauer, 2018). However, a border carbon adjustment (BCA) hasn’t influenced international trade before and thus EU’s initiative requires close consideration. Due to the lack of implementation, different scenarios need to be assessed to study the impacts and effectiveness of BCA to ensure rational decision-making in the EU. There has been increased interest in research, e.g. Balistreri et al. (2019), Böhringer et al. (2012a) & Gros (2009), and in the media to discover costs and benefits.

Without empirical evidence the current research focuses heavily on computable general equilibrium (CGE) models. The wide use of CGE modelling stems from Markusen (1975), who developed model of two trading countries, of which the other maximizes social welfare function with tax structure. Markusen’s ground-breaking model has since become the base for CGE models in the research of BCAs to explore the possibilities of carbon border measures.

1.1 Research questions

This study focuses on the following research questions:

1. Why is BCA a favoured climate policy instrument?
2. Is the CBAM or BCAs in general an effective way to address carbon leakage?

The vast majority of research around BCAs are built on the CGE models, which assess carbon leakage and possible losses in competitiveness of industries with high energy-intensity. Only few studies discuss the rationale for the border adjustments in terms of general welfare. The basic principle behind the policy instrument is explored by Gros (2009) from the global welfare point of view with a partial equilibrium approach. Gros (2009) finds that small tariff will invariably increase global welfare.

However the issue of carbon leakage is on a national or regional (as in the case of EU) level. To address this specific issue Jakob et al. (2013), whom base their 2 x 2 trade model on Markusen's (1975) framework, focus on home country’s (region implementing the BCA) welfare maximization. With this 2 x 2 general equilibrium model Jakob et al. show conflicting results of BCA as in some cases imposing a positive carbon tariff could lead to even more leakage.
The effects of a BCA are more complex than a two-country, two-sector model can detect. Böhringer et al. (2012a) present an overview of 12 CGE models by 12 expert groups to explore impacts of BCA applied on emission-intensive and trade-exposed (EITE) industries in terms of carbon leakage and competitiveness. They find that BCA can reduce leakage through EITE industries, but cost savings are small. Furthermore, the inequality gap between developed and developing countries increase with abatement burden.

Along with inequality issues Böhringer et al. (2012a) remark the problems with international trade law and how a compatible BCA will generate less efficiency improvements. Balistreri et al. (2019) build the environmentally optimal BCA under World Trade Organization’s General Agreement on Tariffs and Trade (GATT). They point out that lower than domestic carbon prices should be applied at the border, as otherwise it goes against GATT’s trade rules.

This thesis is a literature review that explores the logic behind a carbon border adjustment and examines how it affects carbon leakage. The abbreviations used in the text can be found in the Appendix (Chapter 7). The paper is structured as follows. Chapter 2 describes the current available information on EU’s CBAM. Chapter 3 presents the partial and general equilibrium models that explore BCA’s performance. Chapter 4 introduces model comparison study by Böhringer et al. (2012a) where results of twelve expert groups on the BCA’s performance are compared. Chapter 5 discusses the compatibility of the CBAM with GATT and how an optimal border adjustment design could look like. Chapter 6 draws conclusions.

2 Carbon Border Adjustment Mechanism

Implementing carbon border adjustment has been part of the political debates concerning climate change from 2000s when then sitting French president Jacques Chirac introduced the idea in the Grenelle Environment Forum 2007. Since then, the French presidents have been in the favour of a carbon border tax. The proposition was met reluctantly initially, but the allure of a unilateral policy instrument has since gained wide popularity. The reasons behind opinion change lie behind the turbulence in global climate policy initiatives with US pulling out of Paris Agreement 4.11.20202 (Mcgrath, 2020) and environmental scrapping by China on the EU

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2 The United States later rejoined the Paris Agreement 19.2.2021 after President Joe Biden signed a deed on his inauguration day 20.1.2021 (Blinken, 2021).
markets. To the decision-making tables the CBAM was brought by French president Emmanuel Macron and German Chancellor Angela Merkel and added to the European Green Deal in 2019 with European Commission President Ursula von der Leyen declaring it as a “key tool”. (Stam & Rozès Moscovenko, 2020)

The elements of the European Green Deal are illustrated in Figure 1 by European Commission (2019). The categories where the CBAM falls is the zero-pollution ambition, financing the transition and increasing the EU’s Climate ambition for 2030 and 2050. The CBAM could above all have an important role in financing the change. The revenue stream through tariff collection could range from 0.8 billion euros to 25.2 billion euros depending how inclusive the adjustment mechanism is (European Commission, 2020 & Kuusi et al., 2020). Where and how this revenue is utilized, is still an open question. European Comission (2020) has proposed that the revenue gathered could be channeled to EU budget and the Recovery Plan for Europe³.

Figure 1: The elements of European Green Deal (European Commission, 2019)

Kuusi et al. (2020) go through various possibilities for the revenue use and in addition to suggesting the revenues to be used in the European post-pandemic recovery package, they discuss that partly the revenue could be directed to developed countries to help domestic

³ The Recovery Plan for Europe is an initiative to mitigate the economic and social impacts of the COVID-19 pandemic with a focus on green and digital transition. The investment cap to be covered is 1.5 billion euros at least. (European Commission, 2020)
adaptation and mitigation as developing countries host emitting industries that export to EU. This type of revenue allocation would align with “Leave no one behind” principle shown in Figure 1. Besides from a trade law perspective Kuusi et al. (2020) state that if EU directs the tariff revenues to its own financing needs the original environmental target blurs and weakens the WTO compatibility. The revenue stream is among one of the issues concerning the CBAM and needs addressing.

Seeking expert opinion the European Commission launched a public consultation on 22 July 2020 in form of questionnaire (European Commission, 2021) and European Parliament accepted a resolution 10 March 2021 on a World Trade Organisation compatible Carbon Border Adjustment Mechanism that covers all commodities covered in the EU Emissions Trading System (European Parliament, 2021). The timeline for CBAM is intensive and the Commission is scheduled to present a proposal for a directive in the second quarter of 2021. Thus my thesis is a contribution to the public consultation as it explores the economic reasoning behind this policy initiative and the efficiency of the CBAM in regard to preventing carbon leakage.

3 Partial and general equilibrium models

The concept behind the EU’s Carbon Border Adjustment Mechanism is called by several different terms. In literature it is described with terms such as carbon border tax, border tax adjustment or carbon import tax (Aylor et al., 2020; Gros & Egenhofer, 2011; Jakob et al., 2013). However as a policy instrument it is simply a tariff placed on embodied carbon content in traded goods (Böhringer et al., 2018). As costs and benefits of carbon tariffs have attracted a lot of discussion and research, this chapter introduces two simple models to illustrate the economic effects of carbon tariffs.

Gros (2009) introduces the partial equilibrium approach using linear supply-and-demand framework to showcase the welfare effects of a carbon tariff and estimates the optimal tariff with a simple two-country model. The further research of optimal tax structure concerning competitiveness and carbon leakage itself bases itself heavily on the theoretical work of Markusen (1975). His reduced-form general equilibrium model has been a basis for several studies such as Balistreri et al. (2019), Böhringer et al. (2016) and Jakob et al. (2013). To
discover the characteristics and demand of carbon tariffs, I will explore the partial equilibrium approach and a simple general equilibrium approach by Jakob et al. (2013).

3.1 Global welfare gains with partial equilibrium model

Gros (2009) uses linear supply and demand curves to illustrate the global welfare effects of a carbon tariff. His framework is presented in the following pages. In the simple model the World has two actors: the home country or group of countries, that are the importers, and the rest of the world. In the case of CBAM EU is the home country/region.

Figure 2 offers the global supply and demand curves of one good. Emissions of CO$_2$ (at a given unit rate) originate in production and private producers do not take into account, hence the global private supply curve lies under the global social supply curve that includes the externalities from CO$_2$ emissions. If no government actions are established, the international price of the good is defined in the intersection point of private supply and demand (point O).

As EU has its “cap-and-trade” system with the ETS in place, the global supply curve is not straight, but kinked at the quantity, where ETS limits the quantity of production in the home country. The limitation reduces the elasticity of the supply and the new international price is where the global private supply curve taking ETS into account intercepts with the global demand without the tariff (point A).

![Equilibrium without tariff](image)

*Figure 2: Partial equilibrium without tariff (Gros, 2009).*

For A and O see text. ETS stands for EU’s Emissions Trading Scheme.
When home country imposes an import tariff on carbon dioxide in addition to the ETS the domestic demand is bound to decrease and thus the global demand drops as home country’s reduced demand doesn’t influence the rest of the world. This downwards shift is shown in Figure 3 and the international price drops from point A to point E where the new global demand curve with tariff intercepts the global private cost supply curve including ETS. Produced quantity decreases as well, because the ETS limits domestic production which results in reduction of global production ceteris paribus.

If production quantities decrease, the global consumption has to fall as well ($Q_{\text{tariff}} < Q_{\text{ETS}}$). This happens when domestic consumption falls in greater extent than foreign, as foreign consumption should increase with lower international prices. The drastic fall in domestic consumption is result of import tariffs raising domestic prices which include the cost of externality (point C).

![Impact of tariff](image)

**Figure 3: Partial equilibrium with tariff** (Gros, 2009).

*For A, B, C, D, E and F see text. ETS stands for EU’s Emissions Trading Scheme.*

The welfare effects of imposing a carbon tariff are also shown in Figure 3. As with tariffs always there is a death weight loss associated with it (area ADE). If the tariff is “small”, the welfare loss is second order. In addition to loss, there is a welfare gain because of the global externality of production. This gain is illustrated by the area ABCE. When combining the death weight losses and gains the net welfare gain is the area enclosed by ABCD. Hence a small tariff will enhance global welfare. Significant is that the shift domestic consumption to foreign
results only in second-order importance, when increase in global welfare from foreign production losses is first-order importance.

In this light is quite intuitive to see the demand for carbon tariffs and why EU is proposing it as a unilateral policy instrument to combat climate change. However it remains undiscovered what is the optimal “small” tariff where the gain form foreign production losses override the reallocation of consumption from domestic customers to customers abroad. Yet EU doesn’t approach the CBAM with a global welfare angle. Instead the focus is leaning heavily towards reduction of carbon leakage. Hence it is valid to move the viewpoint from global welfare to national/regional welfare.

3.2 General equilibrium model to estimate carbon tariff’s impact on leakage
As no effective global climate actions countries with a high motivation to mitigate climate change are looking into unilateral climate policies. Without multinational cooperation the focus shifts from mutual welfare maximization to individual level. Besides if no global agreements, the countries or regions issuing restrictions on emissions can end up in a situation where through carbon leakage the global emissions do not decrease and the competitive environment at home is worse compared to neighbors. To experiment the implications of a BCA from a domestic welfare maximization angle, that with common sense and intuition is viewed as a way to block leakage and stabilize the competitiveness, I take a look at Jakob et al. (2013) two-country, two sector general equilibrium (GE) model build on Markusen's (1975) reduced-form GE model. After the model introduction, a formula for optimal tariff is resented and limitations of the model discussed.

Jakob et al. (2013) divide the world in two regions similarly to Gros (2009) previously. The regions are Home ($h$) and Foreign ($f$), producing goods $X$ and $Y$ that are tradable. $X$ is the good exported by Home to Foreign and $Y$ exported by Foreign to Home. It is assumed that the Foreign doesn’t apply any trade policies, so it faces $p^*$, the global market price. Furthermore the production possibilities frontiers of the regions differ, which implies that Home has comparative advantage producing $X$ and Foreign $Y$ respectively. No trade imbalance is allowed, so it is required trade balance is as follows:

$$E^{Xh} - p^* M^{Yh} = 0$$

(1)

Where $E^{Xh}$ is exports of $X$ by Home and $M^{Yh}$ is the imports of $Y$ from Foreign.
Consumption is represented with utility from consumption of goods $X$ and $Y$. As dealing with a unilateral policy, it is adequate to make assumption only for Home, that experiences a concave (increasing) utility function:

$$U^h(C^{Xh}, C^{Yh})$$

Home’s consumption interrelates with exports and imports:

$$C^{Xh} = Q^{Xh} - E^{Xh}, \quad C^{Yh} = Q^{Yh} - M^{Yh}$$

(3)

Where $Q$ is the output of $X$ or $Y$.

Maximizing the consumption utility function is part of Home’s welfare ($W$) maximization problem, but in addition the environmental damages $D$ have to be taken into account that originate from producing the output $Q$. The damages are a non-negative convex function of global carbon emissions $Z$.

$$W^h = U^h(C^{Xh}, C^{Yh}) - D(Z)$$

(4)

The sum of emissions from Home and Foreign form the global carbon emissions. The sum of emissions is assumed to be linear combination of outputs of $X$ and $Y$ and the emissions intensities (sector- and country-specific) are denoted with $\gamma^{Xr}$ and $\gamma^{Yr}$:

$$Z = Z^h + Z^f = \gamma^{Xh} Q^{Xh} + \gamma^{Yh} Q^{Yh} + \gamma^{Xf} Q^{Xf} + \gamma^{Yf} Q^{Yf}$$

(5)

Lastly Jakob et al. (2013) suppose that Home has some market power, so its supply and demand affect the world prices. This since if Home doesn’t have any influence in terms-of-trade\(^4\), no carbon leakage would occur. Home’s effect on $p^*$ is represented by $G^h$, when Foreign has an excess supply for any $p^*$:

$$G^h \equiv \frac{dp^*}{dM^{Yh}} = p_{MYh}^* > 0, \quad p_{EYh}^* > 0$$

(6)

Meaning that increased demand of $Y$ at Home, lift the prices of $Y$.

\(^4\) Terms-of-trade describes the ratio of export prices to import prices (Böhringer et al., 2012a).
3.2.1 Optimal carbon tariff

Next, I will explore the optimal tariff design by Jakob et al. (2013). When designing the optimal unilateral climate policy such as a BCA, Home will maximize its own welfare function (equation (4)) by optimizing imports and domestic production of $Y$:

$$\max_{Q^{Yh}, M^{Yh}} W^h$$

From the maximization problem the optimal tariff $\theta^{opt}$ can be derived to:

$$\theta^{opt} = q - p^* = G^h M^{Yh} - q^Z G^h R^f (y^{Yf} - p^* y^{Xf})$$

$$\theta^Z = -q^Z G^h R^f (y^{Yf} - p^* y^{Xf})$$

Where $q$ is the marginal rate of substitution on customer prices, $q^Z$ the price of environmental externality in terms of $X$ and $R^f$ the Foreign producers’ response to change in $p^*$ (the global market price of $Y$).

The first term in $\theta^{opt}$ tells the Home’s gains from influencing the terms-of-trade and is unambiguously positive ($G^h M^{Yh} > 0$). The latter part ($\theta^Z$) of the equation $\theta^{opt}$ represents the optimal carbon tariff as $G^h M^{Yh}$ isn’t depended on the externality. Inspecting $\theta^Z$ more closely we know that one marginal import of $Y$ lifts the global market price by $G^h$. Due to this production of $Y$ increases by $G^h R^f$ and production of $X$ decreases by $p^* G^h R^f$. As a result, global emissions rise to $G^h R^f (y^{Yf} - p^* y^{Xf})$ and reduce Home’s welfare by $= -q^Z G^h R^f (y^{Yf} - p^* y^{Xf})$. As $\theta^Z$ is the welfare loss, it is simultaneously the externality that the tariff should internalize.

When analyzing the welfare affects Jakob et al. (2013) find that the sign of optimal carbon tariff $\theta^Z$ depends on the difference between carbon-intensities in Foreign’s export sector of $Y$ and non-export sector of $X$. If the carbon intensity of Foreign’s exported goods $Y$ is comparatively low ($y^{Yf} < p^* y^{Xf}$), a negative carbon tariff would reduce leakage. But if the first term $G^h M^{Yh}$ of $\theta^{opt}$ tops $\theta^Z$ the welfare maximizing tariff would be positive and in fact increase the leakage.

Jakob et al. (2013) employs a data set from 2004 by Davis & Caldeira (2010) to their theoretical GE model. In this empirical application they find that in 77 out of 95 countries (i.a. China)
included in the data set, the optimal carbon tariff $\theta^Z$ would be negative. Thus setting a positive carbon tariff through a BCA would in fact increase carbon leakage, not reduce it as the aim is.

3.2.2 Limitations of the model

The empirical evidence from Jakob et al. (2013) imposes a serious question, if a BCA is a sensible policy instrument for the EU whilst highlighting the limitations of the model. Most importantly it is advised to keep in mind that the model is a 2 x 2 reduced-form general equilibrium model and hence it is a great generalization. For example strategic interactions, sectoral composition of traded goods and developments in production technologies are absent from the model. These more complex effects can be incorporated into computable general equilibrium (CGE) model to enhance the results.

Since EU has proposed that the CBAM includes the sectors covered by the ETS\(^5\), it could be beneficial to explore GE models concentrating only on emissions-intensive and trade-exposed (EITE) sectors (matches the sectors of ETS). In addition, the EITE sectors are most “vulnerable” for leakage and competitiveness (Fischer & Fox, 2011). As per Jakob et al. (2013) a BCA on EITE sectors could decrease carbon leakage if the production of carbon-intensive exports would be replaced by less carbon-intensive products, but it wouldn’t be the “optimal” policy.

All in all the partial equilibrium approach by Gros (2009) provides simple framework to understand the appeal of BCA as it increases global welfare. On the other hand Jakob et al. (2013) highlight the complexity of actually designing an optimal policy. Both models are simple in form so to get a more comprehensive understanding, it is beneficial to explore the computable general equilibrium models where tariffs applied on EITE industries.

\(^5\) The ETS focuses on emissions from carbon dioxide (CO\(_2\)), nitrous oxide (N\(_2\)O) and perfluorocarbons (PFCs). CO\(_2\) emissions includes heat and power generation, commercial aviation (concerns only flights inside the European Economic Area until 31.12.2023) and high energy-intensive sectors (e.g. metals, oil refineries, steel works). N\(_2\)O emissions contain nitric, adipic and glyoxylic acids and glyoxal. PFCs emissions entail aluminum production. (European Commission, 2015a)
4 Economic and environmental impacts of carbon tariffs

To analyze the CBAM’s efficiency and effects on carbon leakage in the setting where the carbon import tariff would apply on sectors under the ETS, it is relevant to shift focus on EITE Böhringer et al. (2012a) provide an overview of 12 different CGE models developed by 12 different research groups participating in Energy Modeling Forum study (EMF 29). This overview provides a comprehension of the BCA’s different impacts presented below. All of the CGE models use the same database to study efficiency and distributional effects of a BCA applied to EITE sectors.

The 12 research groups establish they models to solve: (1) how effective is BCA in reducing carbon leakage, (2) is BCA an effective tool to protect EITE sectors (in the areas imposing a BCA), (3) what magnitude are cost savings from BCA and (4) what influence does BCA have across the globe. The world is divided to two parts, abating and non-abating regions. The abating region constitutes of A1xR coalition at includes Europe (EU-27 plus EFTA), United States of America, Japan, Canada, Belarus, Ukraine, Turkey, Australia and New Zealand (Böhringer et al., 2012b).

The different models of Böhringer et al. (2012a) are compared against a reference case where all abating nations/regions apply a uniform 20% emissions reduction target (e.g. through cap-and-trade system) that can be traded with other abating areas. In addition to import tariffs, the 12 CGE models include export rebates6. However they find that export rebates do not play an important role as EU imports more CO₂ intensive good than exports them. Furthermore Böhringer et al. (2012a) emphasize that a BCA is an additional instrument of domestic climate policy, not a stand-alone one.

Next, to provide a comprehensive analysis on BCA’s impacts, I present (1) main economic findings by Böhringer et al. (2012a), (2) possibility of increasing equalities between developed and developing countries and (3) other problems related to BCA on EITE industries.

6 Export rebates are subsidies paid to exports from countries implementing BCA to ease the burden of carbon payments in production. Without rebates the regions with a BCA could lose market share in non-abating regions. (Böhringer et al. 2012a)
4.1 BCA’s impacts on carbon leakage when applied on EITE industries

Böhringer et al. (2012a) discover that leakage rate, the change in foreign (non-abating) emissions over domestic (abating) emissions, in the reference scenario would be between 5% and 19% (mean 12%). In other words if the 20% emission reduction target would apply, the domestic emissions reduction would be counteracted with increase in foreign emissions by 12%. The BCA models show leakage to range between 2% and 12% (mean 8%) and hence the BCA is effective in reducing carbon leakage. Comparing the means the BCA would cut leakage rate by third from 12% to 8%.

After the introduction of BCA that reduces carbon leakage, the abating regions can decrease their emissions as seen in Table 1. The x axis contains the 12 different models of the study. Once again it is however highlighted that a border adjustment is a second-best instrument compared to a global cap-and-trade system or Pigouvian tax in overall emissions reduction since the emissions in non-abating countries continue to be above bau\(^7\) level. Moreover the marginal abatement cost in non-abating countries remains zero, so the tariffs do not act as an effective pricing tool on emission inputs in non-abating areas, thus no incentives to move towards less emission-intensive production technologies.

![Graph showing CO₂ emissions change](image)

**Table 1:** CO₂ emissions in abating (COA) and non-abating regions (NCOA) - % change from Business-as-usual (bau) (Böhringer et al., 2012a).

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\(^7\) Business-as-usual situation without any climate policy (Böhringer et al., 2012a).
When it comes to competitiveness in the EITE industries compared to the reference case Böhringer et al. (2012a) discover that production losses in EITE industries fall from 2.8% to 1%, implying BCA’s competence in protecting the competitiveness of EITE industries in abating regions. In addition to these microeconomic effects, BCA has macroeconomic impacts as well. The models suggest that BCA results in reasonable GDP losses ranging between 0.13% and 0.63% (mean 0.35%). As losses are moderate the motivation for implementing a BCA grows stronger.

4.2 Shifting abatement burden from developed countries to developing world

Within the 12 models Böhringer et al. (2012a) detect some distributional traps of BCA. The models show that in the reference scenario (uniform emission pricing) on average impose a burden on non-abating countries. This burden becomes even more weighty with implementation of BCA. This burden is explained by decline of non-abating countries terms-of-trade. Simultaneously abating countries enjoy gains in terms-of-trade. This is the situation since developed countries, in CBAM’s case EU, are net importers of embodied carbon from developing countries. As net importers for example EU can utilize its market power (simple illustration in equation (6)) and alter the terms-of-trade in its own favor.

In another study Böhringer et al. (2018) explore effects of carbon tariffs applied by a coalition of OECD countries. The study finds similarly to Böhringer et al. (2012a) that carbon tariffs initiated by OECD countries worsen the inequalities between the developed OECD countries and developing non-OECD countries. They also find that the effect is more substantial if the tariff is applied on full carbon content of the imported goods. This implies that the richer OECD countries can free ride with their climate policies at the expense of poorer non-OECD countries. This fact has risen emotion in global politics and implementing a BCA could have a detrimental impact ongoing multilateral policy processes, in a worst case it could result in a trade/tariff war.

To move forward with BCA policy proposal, it is evidently beneficially to consider what could be done to this inequality gap. The presumption with Böhringer et al. (2012a) is that the revenue stream from import tariffs is directed to the abating regions themselves. However they find that redirecting the tariff revenues back to the non-abating can reduce, but not fully offset, the losses in terms-of-trade associated with implementation of the BCA. How the redirection could be done remains unexplored but referring to Kuusi et al. (2020) the redirection of the tariff...
revenues wouldn’t just balance the inequalities but would additionally make the border adjustment mechanism more compatible with GATT.

4.3 Other problems with BCA applied on EITE industries

When analyzing the results from Böhringer et al. (2012a) and reflect them to EU’s situation it is important to keep in mind that the study includes A1xR coalition countries as the abating region and hence doesn’t exactly mirror the setting for EU’s CBAM where the coalition consists of only EU. From EU’s point of view United States of America, Japan, Canada, Belarus, Ukraine, Turkey, Australia and New Zealand would be part of the non-abating regions and thus effect the outcomes. In the case of EU imposing their CBAM these other developed countries would face the tariffs as well as developing countries.

However as previously stated the developed countries are net importers of high emissions-intensive goods from the developing countries, so it could be argued that exclusion of other A1xR countries than EU from the coalition would not act as improvement in the negative redistributive effects. In addition the reduced coalition would increase the leakage rate (in the reference scenario). Leakage would be 23.9% if only EU is in the coalition, 11.8% if all A1xR countries included and only 6.7% if A1xR and China included according to Böhringer et al. (2012a). This shows that CBAM on its own isn’t the optimal policy, but global cooperation is needed.

In connection to modelling leakage changes with different size coalitions, Böhringer et al. (2012a) disregard the case where two coalitions are formed, and they place their individual border carbon adjustments. For example as a response to EU’s CBAM other countries could establish their own BCA. This point of view is absent in the existing literature. This unexplored scenario is a possible reality. In 2018 the US imposed 25% and 10% tariffs on steel and aluminum respectively against China, which resulted in a trade war (Kuusi et al., 2020). Furthermore Kuusi et al. (2020) state that impacts of trade war could erase all the economic benefits of the CBAM. Ignoring the impacts of counteractions by regions outside the EU is alarming.

The database used by Böhringer et al. (2012a) is from 2004 and the reference case is simulated with a uniform unilateral emission pricing. This pricing could be set up as a cap-and-trade system as mentioned earlier. The EU established first phase of ETS in 2005 so there is an actual
case of the reference scenario. Even though there is empirical data, it hasn’t been utilized and EU specific studies are rare, which would be appreciated at the moment with the fast-paced policy implementation.

The more empirical approach without CGE simulations have been scares in the field of unilateral trade policies. However one exception is Shapiro's (2020) study on environmental bias of trade policy which investigates existing implicit subsidies to CO$_2$ intensive sectors in the US. He tracks the already imposed tariffs and non-tariff barriers$^8$ to explore what is the level of trade barrier different industries face.

The result is that the industries with high CO$_2$ emissions per dollar output face much lower trade barriers than industries considered “clean” (lower CO$_2$ emissions). This is due to lobbying of more emitting downstream industries as industries are mainly seeking protection for their outputs not on their inputs. If this is a phenomenon in the US, it could be a bias that EU as well has in its existing trade policy. If so, according to Shapiro correcting the bias would decrease global CO$_2$ emissions. Wouldn’t correcting the existing policies act as a more cost efficient solve similar problems that the CBAM targets especially in EITE industries?

Overall in the light of Böhringer et al. (2012a) BCA seems effective in reducing carbon leakage. The models suggest a cut by third in leakage rates. Moreover a BCA applied on EITE industries could protect the competitiveness of those industries and the GDP losses are moderate. However these positive factors are shadowed by increasing inequalities between the developed and developing countries. Developed countries, the net importers and thus market power holders, can implement their climate policies on the expense of developing countries. Even if the redirection of tariff revenues to no-abating regions could ease the segregation and WTO compatibility, it still remains uncertain how EU’s CBAM should look like under GATT rules and if it is effective then.

$^8$ Non-tariff barrier is trade barrier on imports or exports. In Shapiro (2020) the non-tariff barrier means barrier on imports. Such barrier can be port quotas, import prohibitions, import licensing, and customs procedures and administration fees. (Staiger, 2012)
5 Optimal BCA under GATT

For the CBAM to gain approval in the international trade it has to be compatible with WTO’s General Agreement on Tariffs and Trade. Moreover as discussed in Chapter 2 the European Parliament has ruled 10.3.2021 that the CBAM has to be in line with the GATT. This Chapter discovers the premises for border carbon adjustments in terms of GATT, GATT optimal tariff level and risks involved.

GATT’s Article XX describes the nature of general exceptions that can overrule the agreement’s main principles. Two of the exceptions give room for trade-related environmental measures: “(b) necessary to protect human, animal or plant life or health” and “(g) relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption” (Evans, 1968, pp. 37-38). Balistreri et al. (2019), pp. 1038 state that the exceptions from Article XX are needed when establishing a BCA as “the implied tariffs exceed negotiated rates (bindings) and violate the most-favored-nation principle” of the GATT.

Balistreri et al. (2019) base their paper to the fact that GATT compatibility has to be achieved and build an optimal border carbon adjustment on this assumption. They search answer for what is the optimal level of tariff under GATT. Next, I will study this optimal BCA design by Balistreri et al. (2019) following a discussion about the uncertainties of a WTO compatible BCA in terms of carbon leakage and legislation.

5.1 Design of an optimal carbon border adjustment under GATT

Significant amount of literature (e.g. Cosbey et al. (2012)) suggest that the optimal tariff would equal the domestic price of carbon. In the case of EU according to this argument the tariff would mirror the carbon prize of the EU ETS. However, Balistreri et al. (2019) observe, Markusen (1975) states that optimal policy combating cross-border externalities features both strategic and environmental motives. If abstracting the strategic incentives out of the picture, it might be optimal to price carbon at the domestic Pigouvian or “cap-and-trade” price. Yet even the simple model by Jakob et al. (2013) in Chapter 3 shows that constructing an optimal border adjustment is more complex. It is influenced by regions market power in different goods and the reactions of producers and consumers. In this light setting the carbon tariff to equal the domestic carbon price isn’t as clear.
Similarly to Jakob et al. (2013), Balistreri et al. (2019) build a two-country, two-good trade model, but add a constraint demonstrating commitment to GATT to discover the optimal tariff level. Furthermore they calibrate the model with GTAP 7.1. dataset by Narayan & Walmsley (2008). They find that if the GATT constraint is not activated the optimal carbon price would be $101 per ton CO\textsubscript{2}, which is three times the domestic price of carbon in the region that applies the border adjustment. The price drops to $14 per ton CO\textsubscript{2} when the GATT constraint is applied, which is less than half of the domestic price. In addition to these two scenarios Balistreri et al. (2019) simulate a full border adjustment\textsuperscript{9} with GATT constraint, which results the optimal tariff to be 80% of the domestic price. These stimulations illustrate that the optimal tariff level should be under the domestic carbon price if the BCA is compatible with GATT.

However, as established by Böhringer et al. (2012a) in Chapter 4 a full carbon adjustment isn’t most likely in the cards as export rebates aren’t so significant with EU being a net importer of embodied carbon. Therefore it’s sensible to concentrate on the optimal carbon pricing policy with GATT constraint by Balistreri et al. (2019) (scenario with $14 per ton CO\textsubscript{2}). In this scenario the domestic carbon price is $34.95 which indicates that the optimal carbon price is 40% of the domestic price ($14/$34.95 = 0.40057 ... ≈ 40\%). It is evident that taking into account the strategic incentives of trade partners, the optimal carbon tariff level is under the domestic price of carbon. Yet it’s still unclear how a lower tariff will affect carbon leakage and what are the legislative issues with GATT. These uncertainties are discussed next.

5.2 Uncertainties of GATT compatible BCA

Balistreri et al. (2019), in addition to calculating the optimal tariff levels, simulate the carbon leakage rates for all the different scenarios. Without border adjustment aka carbon tariff the leakage rate is 18.3\%. In the scenario that doesn’t apply the GATT constraint leakage rate drops to 16.0\%. When the GATT constraint is applied the leakage rate decreases only by 0.5\% (from 18.3\% to 17.8\%). With the full border adjustment the decrease is slightly more as the carbon leakage is 17.2\%. Considering these results it is apparent that when designing a GATT compatible border carbon adjustment, as the EU is planning, the objective of preventing carbon leakage isn’t as fulfilled as without the compatibility.

\textsuperscript{9} Full carbon adjustment is policy instrument that applies not just embodied carbon tariffs on imports but also embodied carbon subsidies (rebates) on exports (Balistreri et al., 2019).
One reason for this phenomenon could be that when the carbon tariff is only 40% of the domestic price of carbon it’s still a more profitable for firms with high emissions intensive production to transfer their facilities outside the EU. It could add up in these situations that with overall lower cost (e.g. with labor and no carbon pricing) it’s more cost-effective to pay the tariffs than stay inside the EU. With this possibility in mind it then depends on EU if they think that reducing carbon leakage by 0.5% is a sufficient rate achieved by a substantial legislative initiative.

In addition to balancing between reducing carbon leakage and integrating GATT rules, BCA encounters uncertainties with practical implementation of the GATT legislation. Firstly as EU a forerunner in establishing a border carbon adjustment, it is unclear what aspects of GATT are mandatory when designing a BCA. Major part of the literature relay on the exceptions in Article XX for implementation. However, Krenek (2020) argues that a BCA should be based on Article II. Article II states that nothing prevents introduction of a tariff if it equals the burden on domestic producers (Evans, 1968). These are a few examples of different interpretations of possible leeways for GATT compatible BCA design, but it’s still only speculation.

Other uncertainty with the currently planned form of EU’s CBAM is the revenue stream allocation as mentioned in Chapters 2 & 4.3. If EU would approach GATT compatibility with Article XX, the sole target has to be environmental improvements. Using tariff revenues for internal financing needs contradicts the exemption rules of Article XX, thus the current plan isn’t feasible.

Overall a GATT compatible border carbon adjustment is possible and optimally the tariff level is below domestic carbon price. This is in line with GATT Article II that allows tariffs if the burden on importer is less or equal to the burden on domestic producers. However, when the tariff falls, carbon leakage decreases only marginally. Naturally as pioneers in the field EU will face legislative hurdles. More research on actual execution is required and the EU should thoroughly access if marginal reduction in carbon leakage is enough to cover the bureaucracy and operative costs.
6 Conclusions

The aim of this thesis is to explore why carbon border adjustments are forwarded as relevant policy instruments to combat climate change. Gros (2009) builds a partial equilibrium model to illustrate that from a global welfare perspective a small carbon tariff will always increase global welfare and that’s why BCA is a useful tool. However in the absence of sufficient global climate cooperation, BCA is approached by regional welfare maximization. Yet with a simple GE model Jakob et al. (2013) find that an “optimal” tariff could lead to increase of carbon leakage not reduction.

With a more inclusive CGE models, it’s found that carbon leakage is reduced with a BCA applied on goods produced by EITE industries. However the implementation of carbon tariffs, shift abatement burden to developing countries with little resources. Even if the CBAM is efficient in reducing leakage, it is nothing without GATT compatibility. To comply with WTO’s rules the tariff should be 40% of domestic carbon prices according to Balistreri et al. (2019) but the lower level of tariff would reduce leakage only a minor amount.

The effect of a carbon border adjustment is ambiguous, and it remains unclear if it is a worthy policy instrument as EU would be first to implement one. However in the light of the CGE models some reductions in carbon leakage could be achievable, but more importantly imposing the CBAM could act as a signaling force that EU is taking serious climate action. This approach would be in line with the European Green Deal’s statement “EU as the global leader” in Figure 1 (European Commission, 2019). This brave policy suggestion, to act in EU’s favor, has to respect GATT and through compatibility with international trade laws the signaling force strengthens and the threat of possible trade wars decreases.

In addition, many uncertainties lie in the execution of CBAM. Understandably there is a lack of studies about CBAM’s effects on customer prices for EU customers after tariffs, day-to-day operations design and who is responsible in paying the tariffs. The latter is a valid concern with global supply chains where emissions of one good can be created in multiple countries throughout the production process. Moreover exploration of existing biases as per Shapiro (2020) is needed to straighten the possible underlying distortion of trade barriers in order to avoid solely boosting the climate awareness of EU politicians with a risk of a rising trade war.
Appendix: Abbreviations used in the thesis

**A1xR** — A1xR is a coalition of countries usually including Europe (EU-27 plus EFTA), United States of America, Canada, Japan, Ukraine, Belarus, Turkey, Australia and New Zealand. (Böhinger et al., 2012a & Böhinger et al., 2012b)

**EITE** — EITE sectors stands for energy-intensive and trade-exposed sectors. According to Fischer et al. (2015) these sectors most probably include chemicals, paper, non-metallic minerals (e.g. cement and glass), or primary metals (e.g. aluminium and steel) sectors. There is two point to meet for the sector or industry to be defined as EITE sector: (1) being highly energy intensive, directly from fossil fuel combustion or use of carbon-intensive energy in production or (2) being exceptionally defenceless in terms of international competitiveness.

**EU ETS** — European Union Emissions Trading System (EU ETS) is a cap-and-trade system to control pollution with offering economic incentives. It limits the total volume of greenhouse gas emissions from chosen sectors and allows trading of the emissions allowances (European Commission, 2015a).

**BCA** — BCA stands for border carbon adjustment which is synonym for carbon border adjustment, carbon tax and carbon tariff in the existing literature and in this thesis.

**CBAM** — Carbon Border Adjustment Mechanism (CBAM) is EU’s version of border carbon adjustment (BCA).

**CGE** — Computable general equilibrium (CGE) model is model that provides a more tangible welfare analysis for policy making as it captures both indirect and direct inter-sectoral, inter-regional, and inter-temporal effects induced by policy changes (Burfisher, 2017).

**GATT** — General Agreement on Tariffs and Trade (GATT) is agreement between several countries that defines the rule of trade and promotes multilateral trading (Evans, 1968). World Trade Organization (WTO) is the successor of GATT.
**GE** — General equilibrium (GE) model is an extension from a partial equilibrium model so instead of just a single market a general equilibrium model considers supply, demand and prices off all markets in the economy (Levin, 2006).

**OECD** — Organization for Economic Co-operation and Development (OECD) is an international body consisting of 37 nations that aims to create better policies across the globe (OECD, 2019).

**WTO** — World Trade Organization (WTO) is an international organization focusing on rules of trade. WTO hosts multilateral trade negotiations and as a result of the negotiations, agreements or so called “WTO’s rules” are formed. (WTO, 2021)
8 References


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