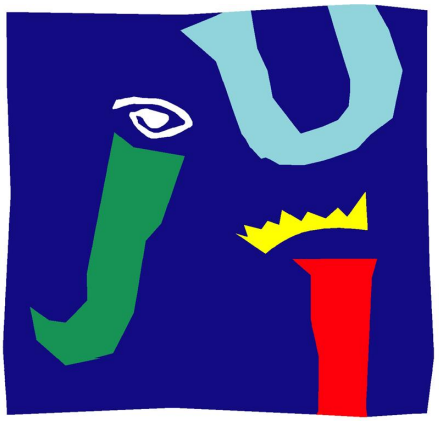

UNIVERSITAT JAUME·I

Breaking down the EU emissions trading system through the literature

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To the extraordinary F. Navarro Ortega, who instilled in his grandsons the virtues of perseverance and commitment and relentlessly encouraged us to strive for improvement.

Content

Table 1. Abatement estimates during phase I

Breaking down the EU emissions trading system through the literature

1. Abstract:

I began to research with the sole purpose of trying to understand the carbon market,out of curiosity, right after my summer internship at Esmalglass-Itaca group, a heavy energy dependent producer in the tile, frits and glazes industry, and a heavy carbon emitter. The environmental quality control team showed me some data proving that the group (Altadia) has reduced its emissions by 40% since 2005, and yet in the carbon market they have gone from a selling position in regard to emission rights, to a buyers one in the market perspective.

They have to buy emission rights despite such a significant reduction. Since then, all I wanted to do was to understand how the market works and what the experts have to say about its trends, market mechanisms and controversies.

Keywords: EU ETS, carbon market, sustainable development, effectiveness, abatement

2. Introduction:

With the recently revised carbon reduction objectives carried by the European Union, aiming to reduce carbon emissions in the ballpark of 90% when compared to the 1990 level of emissions, in order to set a less carbon dependent economy. Various researchers like Ellerman, Brown and Anderson have estimated that the EU ETS is responsible for an average of 2,5% to 5% reduction in emissions in its first two phases. The third phase came after the global economic crisis that had started in 2008, and had adverse effects on the pricing mechanisms of allowances. Like mentioned, over the years after, the cap is constantly being adjusted to meet the targets set by the European Council.

The EU ETS since it was first implemented in 2005, is the only active tool in the European Union with the sole purpose of limiting carbon strictly, whilst being a highly cost effective reduction mechanism with its trading mechanism. Its uniqueness and

efficiency in terms of cost effective abatement has captured the interest of a large number of experts and policy makers not only in the European continent, but globally as well. Since its policies have effects on a global market, conflicting viewpoints continue to spark debates among academic peers, that is why a review of literature was in order.

Many factors can alter the effectiveness of the EU Emissions trading system, from now on EU ETS; such as the way all factors are taken into account, the market structure, legal framework, and others can affect the way benchmarks are or are not met.

In this thesis I will break down the emission trading system by synthesizing the literature through its controversial and plenty of unique perspectives on the emissions trading scheme.This paper is organized as follows.

Firstly I use “Reflections” from Convery(2020) as a starting point on current literature about the European emissions trading system. On where he gives insights on where the most important pools of data can be found, giving examples of quality researched essays. We start off by describing the EU ETS and later on categorizing essays cited by Convery as well as articles that cite him too; also diving into the ETS phases, it´s auction mechanism, from carbon leakage to taxation alternatives and mentioning the awakening effects the european market has done all over the globe in terms of rising carbon markets and what they learned from the EU .

3. The EU ETS

Among the most economical techniques for reducing greenhouse gas emissions are emissions trading schemes(ETS). Trading, as opposed to conventional "command and control" regulation, uses market forces to identify the least expensive strategies to cut emissions (Meckling, 2011). The market is ruled by a cap and trade system that has been active for more than 10 years.

The European Union introduced the EU Emissions Trading System (EU ETS) in 2005, being the first of its kind carbon market in the world, and is still by far the largest in existence.The overall sum ofCO_2 that facilities are allowed to emit is limited and lowered over time. Agents purchase or receive permits that can be exchanged and the limited overall amount guarantees that they have a purpose. The EU ETS has put climate change on the agenda by pricing carbon and assigning a monetary value to

each tonne of emissions avoided. On the agenda of corporate boards across Europe is change. Pricing carbon encourages investment in low-carbon, clean technologies and incentives biggest polluters to change their behavior.

3.1. How does the ETS operate?

The maximum allowed amount of greenhouse emissions for a multiyear phase by the factories, power plants, and other businesses is set by the EU. Companies acquire or purchase emission permits within this cap, and if chosen, they can freely trade them.

From 2013 to 2020, the limit on emissions from power plants and other permanent installations are downsized every year by 1.74%. Therefore, by the year 2020, these industries' gas emissions will be 21% lower than 2005. The currency of the EU ETS market is emissions permits and they have value due to the cap on the overall number of available units. Each allowance entitles the owner to emit one tonne of carbon dioxide(main GHG) or the equivalent of two other potent greenhouse gasses, nitrous oxide(N20) and perfluorocarbons(PDCs). Said allowances can only be used once and businesses must give them up for each tonne of CO2 covered by the UE ETS that they released the year prior. Fines are charged in case of failure to submit sufficient allowances to match the output emissions.

4. EU ETS phases

The EU ETS is divided into four different phases

4.1. Phase I

From 2005 to 2007, the first trading session served as a “learning by doing” procedure, considered as a trial phase (Martin, 2012). Though little to no impact was expected in this period, the EU ETS succeeded in becoming the largest carbon market in the world, yet the quantity of allowances depending on anticipated requirements ended up being exorbitant, as the result of which, the cost of the first period allowances dropped to zero in 2007.

Three are the main sources of data on which researchers based their estimations of reduction effects from 2005 to 2007: National academies press, UNFCCC and Eurostat.

Ellerman and Buchner (2007) frequented the NAP as a data pool source, focusing on the first two years of Phase 1, adjusting the pre-2005 emissions statistics by accounting for GDP growth and the historical trend of declining carbon intensity of production. This data was flawed in two main ways: firstly, the information was gathered under a lot of time constraints with close to no official verification. The incentive of enterprises to heighten emissions in hope of receiving a more favorable allocation was at its peak. Secondly country- specific emissions were calculated using various years of data, making them poorly comparable. With the information at hand they discovered a reduction between 100 and 200 million tonnes of CO2 spanning all EU ETS nations in the two years under consideration. Resulting in a total abatement rate ranging from 2.4% to 4.7%.

Herold (2007) conducted a thorough comparison of the CRF(common reporting format) and the confirmed EU ETS emissions information for 2005, and found that with minimal correction, CRF data may be usable with proper adjustments. Ellerman Convery and Perthuis (2010) enhance the defects in the NAP data and predict the reduction to be around 3%.

Anderson and Di MAria (2011) use Eurostat data, matching the EU ETS sectors accordingly. This resulted in a 2.8% reduction during phase 1, when compared to the findings utilizing the other sources of data. The outcome varied on a country-level, with some nations showing under allocations and others emitting more than anticipated. This last finding may be the result of the increased emissions in 2007, to gain better allocation later on, once the market is more competitive.

The table below summarizes the abatement estimates of the works mentioned earlier, the data source used in a period characterized by the lack of data availability and its estimated abatement reduction. It also contains two more works on Germany, one from all industries and another that treats only the energy sector.

Table 1. Estimates of abatement during Phase I

Authors	*Estimated abatement*	*Country*	*Time period*	*Sector*	*Data source*
Ellerman and Buchner (2008)	50 to 100 Mt per year (–2.4% to -4.7%)	EU	2005-2006	All	NAP
Ellerman, Convery and de Perthuis (2010)	70 Mt per year (-3.3%)	EU	2005-2007	All	CRF (UNFCCC)
Anderson and Di Maria (2011)	58 Mt per year (– 2.8%)	EU	2005-2007	All	Eurostat
Ellerman and Feilhauer (2008)	28.5 Mt per year (– 5.7%)	Germany	2005-2007	All	CRF (UNFCCC)
Ellerman and Feilhauer (2008)	11.7 Mt per year (– 6.3%)	Germany	2005-2007	Industry	CRF (UNFCCC)

Source: R. Martin 2012

The abatement levels differed across countries, showing that the EU15 had a higher average rates of reduction while East European countries lagged behind in this matter. This supported the findings of Ellerman and Feilhauer (2008) who used similar methodology to study Germany, and discovered that the total annual abatement attributed to the ETS was closer to 5%. It is important to highlight that the end goal of phase I wasn't necessarily reducing emissions per se, but to instill the vision and model for setting the ETS up for future success.

Data is the key element when analyzing if a mechanism is effective in reducing emissions or not.The absence of trustworthy information to provide allocations to companies was generalized among the EU ETS members, this made it more difficult to set scenarios on allowances allocation per state. Since most of the data is known in retrospection, ex-post[1] is more precise than ex ante.

In the premature stages of the EU ETS with close to no information two factors are key in pricing carbon. The expected volume of reduction needed and the projected price of carbon. From there on, one quantitative implementation that can be made is by the disparity of anticipated emissions and the expected cap. An example of ex ante anticipation would be to compute the expected caps from phase one to phase two, with

[1] Ex ante is an experiment conducted before the event has taken place, trying to predict the results when they have not even occurred yet based on variables. With solid foundation research it can serve as preparation for what's to come. On the contrary, an ex post analysis treats results after the event has occurred.

the known number of the setted cap in phase one. An exante examination of pricing expectations can conclude such predictions of necessary reductions. As for ex post observations we can break down the evolution of trade allowances where agents engage in two types of transactions. On spot trading immediate deals, issue and repay european union allowances (EUAs), and derivatives(contracts with detailed specifics on specific conditions for the arrangements such as dates, prices, etc).

4.2. Phase II

Also known as the trading period it added air transport industries to its coverage. For its duration (2008- 2012) the quantity of allowances was decreased by 6.5%, but the economic meltdown decreased emissions and demand even further. The result is an excess of unused allowances that put pressure on the carbon price. Despite uncertainties and limitations of aggregate analysis Abrell, Ndoye and Zachman (2011) made a unique approach estimating reductions around the transition of phases, stacking reduction strategies from phase I against the ones applied on phase II.

Analysis revealed that there was a 3.6% extra reduction from phase II than its predecessor. That is after taking into account external forces that affect the total output of carbon. As per theory predicts, firm's decisions about abatement are unaffected by firm-specific caps. Companies, excluding trading costs and other market flaws, reduce until the marginal cost of mitigation equals the permits market price. At that moment instead of internally reducing emissions, the company finds it more cost-effective to purchase emissions rights. So neither underallocation or overallocation have a significant impact. The idea that allotment choices don't reflect on ET is the one called “independence property”. After controlling the model with dummies the only argument possible is that the EU ETS limitations (liquidity or future allocations) made corporate decisions reliant on their first abatement budget.

On a more qualitative approach(surveys on market members), no generalizations should be made on this basis, but the results show some insights of potential reduction mechanisms. Small percentage of firms (6%) surveyed believed that reductions were caused by the sole goal of abatement. In contrast, almost everyone (more than 90%) believed that the causes were positive externalities such as efficiency investments.

Based on the essays cited and which topics are more frequently discussed among them, we can argue that the allowance price dynamics and marginal abatement were

the main concerns during phase II. As well as the evolution of counterfactual emissions measures, or data on how the scenarios would have played out if measures would´not have been implemented.

4.3. Phase III

Aligned with the ending of the Kyoto protocol that ended in 2012, the European organizations in Brussels have taken over from regional governments, the allocation of allowances for the third phase going from 2013 to 2020 , characterized by huge structural changes. To name a few, the implementation of an EU wide cap that is reduced each year and the implementation of auction instead of free allocation to lessen market inefficiencies among manufacturers of substitute goods among its members and aluminum and organic chemistry industry are now under the cap.

5. Allowances allocation and grandfathering

Auctioning has been the standard allocation technique since 2013 for emission permits. The method implies that companies must buy progressively more allowances at each auction.This adheres to the idea that the one that emits carbon dioxide or other harmful gasses, must pay the price. Allowances are valuable due to its limited amount and allocation is the term given to the free distribution of allowances. It generates a distribution of rent and benefits similar to a tax on emissions, where the government collects revenue and the price of emissions is fixed by the tax itself.

Allocation in the first two periods functioned as a decentralized auctioning framework. Each state had to present a road map estimating amount and allocation trends pending to be approved by the European commission. This creates a total of caps equal to the EU cap members, it also creates notable differences in the way total allowances are allocated among states, this can affect companies, giving them competitive advantage.

Free allocation was initially created as a way to compensate owners of already established manufacturing assets due to a sudden change in the regulations. Those owners would get a single large payment of a fixed amount of years worth of annual allocations that covers the expense of buying permits on the market. This has been

defined as the grandfathering effect Nranger . F (2015). It states that entities have the right to emit proportionally as they used to Paterson (1996).

What actually was distributed were tradable emissions rights, this allowed to reduce costs; meaning countries with high abatement costs exchange money with other countries to achieve part of their reduction goal. Some currents of thought don´t view caps and reductions for a system that tries to control a previously unlimited amount of emissions, instead they see it as a way to profit from emissions (benchmarking it against a zero pollution situation). Whereas a more reasonable approach criticizes the trading itself.

Mingxi Wang (2014) proposes a Pareto optimal equilibrium for the auctioning of carbon rights taking into consideration an infinite amount of periods. After explaining the model and the Pareto optimal auction mechanism, and acknowledging the unique characteristics of the allocation rights, and additionally that most of the literature focuses on whether the ETS is effective or on its policies.

Despite the fact that emission rights have particularities and cannot be exported into an ordinary auction mechanism, existing literature mainly discusses the amount of reduction the system does provide and performances. Wang tries to fill in the gap by proposing a pareto optimal model which results demonstrate efficiency in a simple to apply mechanism.

Though it's a good improvement it still doesn't answer all questions such as how the economy determines the benefits or how to generalize the scheme when profits of market agents are not linear.

Carl Knight (2013) does a really detailed analysis on his paper on grandfathering, distinguishing through types of grandfathering and phases of EU ETS. According to Carl, there are three main justifications for it. On a realistic approach, it is the only way to get high-emission countries on board in line with their self interest. This string of thought defends that polluting nations must reach an accord to lessen negative externalities of climate change, whilst a more instrumental justification argues that it is the best option in the lack of a better solution. Carl concludes that grandfathering must be used moderately in balance when facing third considerations, either short term or

long term(permanent) ones. Challenging practical philosophers and theorists to think more appealing ways to frame grandfathering theories.

High controversy and vivid debate was brought by the Kyoto protocol due to its intention to impose higher restrictions on developed countries than developing ones.On the contrary some critics say that governments gladly accept the trade off between inefficient systems like grandfathering in exchange for the control distribution carried on regulation(Stavins 1997).

The following part discusses why the auction system is better than the traditional grandfathering from different points of view.

For instance, in terms of revenue, the profits will function in a more straightforward manner thus transforming carbon into a limited good. Unlike in grandfathering where permits are given, in an auction, rents would be collected by organisms(governments) that could allocate the money in numerous ways such ar R&D to further reduce carbon usage, gaining in efficiency, or pursuing social causes such as labor reforms and such. Private entities argue the honesty and fair usage of the money collected. It is also cheaper to reduce by auctioning than by grandfathering, numberwise Parry(1998) estimates that a 10% reduction would cost as much as three times more with the free allocations counterpart.

Positive externalities happen when applying auctioning in spite of grandfathering. The R&D mentioned earlier lowers prices of allocations and the costs of reduction themselves. Arguments based on the energy producers, are based on the need of cash to drive innovation to reduce carbon emissions. While established firms might continue to receive permits based on their historical emissions on a grandfathering scheme, new market agents who don't receive them would need to carry most if not all of the innovation costs. These costs, or earnings, depending where your standpoint is, can be distributed in different ways. This is true on both systems.

The ability to pass through costs is key to determine a proper effective mechanism. If firms can charge more for their products, consumers would simply pay more and end up carrying the cost by themselves, this would have little effect on fomenting investment in carbon reducing technologies. If the cost is not passed on, business owners are the ones paying the price. This overall effect depends on elasticity of

demand for carbon, the good that ultimately rises in price, and all of goods produced by its high intensive users.

Collections from the auctioning system can be used to lower taxes on consumers, to lessen payroll taxations, reduce debt in benefit of future generations whilst grandfathering only does benefit the ones who get the permits. Therefore equality is more reasonable to be achieved with an auctioning system.

Peter Cramton (2002) assessed which of both allocation systems would be more effective in achieving carbon reduction objectives. Concluding that an auction based not only would raise revenue for the government, it also allocates permits to those who need them the most while keeping costs to a bare minimum.

Luc Bovens (2011) does a deep analysis trying to find arguments in favor of emissions rights, based on Lockean theory. A greate comparison on emissions rights and land property rights is performed in three different arguments on the Lockean argument. He concludes that his alternative method will result in a distribution that in time would be progressively more equal. His egalitarian regime would need certain balances like rectification of whomever pollutes, pays; a concern in reducing waste through all production processes among other ones.

One interesting debate occurs when distributing emission rights and caps are applied, if the effects on developed and developing economies are being considered on said caps and limitations. Paterson (1996) states that if reductions are applied, they have to be in proportion of each country's established levels.

5.1. Theories of fair distribution

Since emissions cause global warming, a negative externality that affects all of Earth's life, many are in favor, and rightfully so, of a globalized emissions cap. Question that might pop into our heads is if there is an appropriate way of allocation, Lukas Meyer (2006) analyzes why traditional systems are of no use and breaks it down through central principles. In order to bring some clarity, we break down below the following theories (Meyer 2006) of allocation fairness that give a general idea focusing on theories of distributive justice. Some theories are described below.

Egalitarianism is characterized by Its core value, equality; completely against scenarios where some have less than others, still relying on well being and free of choice values. As for sufficientarism, It suggests that the motive to eliminate inequality is the fear of being worse off and not disparities. Everyone must have enough (Frankfurt 1987). This viewpoint is distinguishable by the fact that help should be given to anyone that falls below sufficiency, which is achievable whether individuals are below or above it. It has its fair share of flaws though, it is challenging to defend a criterion that deems those below the barrier as an absolute priority. A second issue arises due to the threshold itself: it would require solid justifications in a systematic manner to precisely choose the right level.Additionally would the gap among those above said limit matter? This raises an inequality level debate on its own.

Prioritarianism is based on the principle that improving someone's situation matters, but it does even more the worse off one is. It is impartial, in a sense that an increase in an individual 's well being holds the same value as the gain in any other individual who is as endowed. It's not only about increasing general well being, it's also about a fair distribution of it. It can take various forms depending on how much emphasis is placed on the well being of those in extreme need. It can help build an equal distribution of carbon permits.

As Woerdman (2008) explains, energy producers found a way to earn profit by passing by the cost to consumers of what they had previously received for free. The European Council who sets the political trajectory of the EU, agreed to abandon grandfathering in favor of allocation. The tightening of regulations raised concerns among industrial lobbies arguing that it would result in less international market competitiveness, higher cost and the eventual leakage of companies to other countries with softer regulations. By simply switching production to a non EU country can achieve emission reduction target Helm (2009).

6. EU ETS issues

In this section, main issues that the EU ETS has and is currently facing are discussed. From mentioning the setting of caps to focusing on some other things like carbon leakage.

As mentioned earlier, the measures adopted by an ETS system sometimes confront established policies(WTO for instance), and due to it´s market nature, prices can be unstable. In more clarifying manner, De Perthuis says “EU ETS has been undermined variously by the weakness of it regulation, and undesirable overlap with other public policies and the far-reaching economic and financial crisis that caused the market price of allowances to plunge”.(De Perthuis 2014). The cap setting issue, as mentioned, is still a vivid debate among researchers, while the majority of researchers support the idea that a combination of pricing and quantity management is preferable, like a railway line, with a ceiling and a bottom; other ETS use alternative approaches, like California, who uses a price floor. That is the “carbon leakage” problem. It occurs when a country with a tight climate policy focuses on reducing emissions whilst as a result a secondary country increases theirs as direct result of the previous one higher regulations Andrés Cala (2014).

Once the price has been established on emissions, corporations, specially those who use energy intensively, see an increase in operating costs. Their international risk on international competitiveness is determined on whether this additional cost can be factored into the final price. Due to their greater exposure manufacturing industries have fewer options of passing along the higher costs to the final customer without suffering a significant loss of customers to other facilities that don´t fall under the EU ETS umbrella, thus not obliged by regulations. Allegations were made that if the cap were to tighten and the “grandfathering” switched to a pure auction system, this would have severely harmed firms' competitiveness against foreign rivals (non EU) forcing them to relocate production overseas since the regulations affect only the production process, not the use of the product itself. This is directly related to the “pollution haven hypothesis”.

This theory claims, since its proposal (Walter, Ugelow; 1979), that as a result of a globalized economy, polluting companies will mostly relocate to nations with less strict environmental laws. Developing countries are the ones that receive more foreign investment not only by corporations seeking cheaper labor or resources, but also more

flexible environmental regulations. This has motivated many researchers to study empirically “foreign direct investment”(FDI), industrial production from international business, which an increase in said factors will result in a higher level of pollution (S.A. Solarin 2017).

Multiple international agreements, the Kyoto protocol or the Paris agreement were approved due to the global nature of the problem, which aimed to tackle it with international cooperation. Qualitative research has tested different models using from panel data to DiD(difference in difference) with an increase in usage of input/output models. Zhang Z. (2017) takes into account,when conducting the analysis, the fact that more and more businesses have externalized phases or sometimes all the production process in search of cheaper costs and less stringent environmental regulations.

This phenomenon is a key element to take into account when planning international accords. This topic has gathered interest among the comunity from linking foreign investment, international activity and policies applied. Fairly recent research indicates the necessity to reconsider how environmental control measures pollution haven hypothesis due to contradictory data findings, the majority of conflicts reside in environmental regulations and abatement costs that differ among countries and markets.

Data shows that imports from non EU countries have risen in the last decade, so carbon leakage might have already taken place. Aichele and Felbermayr(2015) show that the Kyoto protocol is responsible for a 14% decrease in exports and an 8% rise in non-participant countries, backing the statement that leakage is already here and it affects notorious industries today.

After a thorough analysis of the Carbon leakage results of different assessments and various models of aggregate data, STefano Clò(2010) concludes that a more uniform ruling must be applied to the ETS in order to reach effective distribution and reduce fluctuations. Grandfathering allocation, during the third phase of the ETS will gradually be replaced by alternative allocation rules. For instance, energy sectors from now on, will have to buy allocation rights on the market. In addition, industrial sectors deemed of high carbon leakage risk will receive free allocation having considered the main risks of it.

The analysis conducted concludes that the new established criteria are ineffective and irregular to determine which sectors are excluded from auctions rather than imposing a crystal clear allocation and more harmonized system.

The ETS remains excluding industries considered of carbon leakage risk from auctions R. Martin et al (2014). Showing the linkage across carbon intensive industries and leakage risk, while excluding trade exposure, Martin et al.(2014) provide two approaches to strengthen the requirements of exemption without risking relocation increase. In line with Helm, Woerdman and Cala they acknowledge the carbon leakage and propose a simple solution(on paper) to it, tax the products that cross the border. This would go against the WTO ruling.

Given the results on the model conducted, they propose a series of tweaks. For instance,only to take into consideration trade intensive sectors when they also happen to be carbon intensive. “This report provides facts to support claims that the European Commission overcompensates polluting sectors at the expense of the EU taxpayers”(R. Martin).

To see if the ETS policy causes carbon leakage we must study real data on the spatial distribution of carbon on multinational companies, and how much the ETS affects it. As Dechezlepretre et al (2022) do, evaluating facts from more than a thousand companies, based on intuitive data and regression analysis results reveal that the EU ETS effect on carbon leakage is not significantly relevant until 2014. As per why such a thing can be true is due to the possibility that free allocation to sectors in risk works.

6.1. What can we expect on carbon leakage?

Estimates from investigations of carbon leakage studies vary from a 5 to 20 percent rate, though estimates are affected by numerous variables such as the reduction efforts, the reduction goal that wants to be achieved and even the instruments and mechanisms of the economic model.

The most popular way to avoid said leakage is allocating emission rights, this is usually done at the expense of subsidizing intensive carbon goods, which is not a long term solution if net zero emissions wanted to be achievable. The term is widely used to promote green development and carbon reduction, but beware, it doesn't mean that no damage is being done, it only means that it is “compensated”. For instance if a firm

emits 15 tons and it plants or subsidizes tree plantations which are equivalent to 15 tons less carbon, it would be considered as net zero; but it is a great first step into tackling climate change.

As mentioned, a border adjustment on imported goods produced by firms that haven't carbon reduction among their goals. Once all considerations have been taken into account, such as how this would affect developing countries outputs and inequality, this measure is better presented as a warning against “freeriders”(countries that benefit from actions of others, with no cost to them).

Border carbon adjustment or BCA is a widely discussed option by the community to reduce carbon leakage, despite being the most efficient, it is also the one that presents more challenges, from the legal side of things to the controversies raised. A. Cosbey (2020).

Literature shows that BCA are difficult to apply and often not align with WTO regulations, additionally exporting countries can retaliate with tariffs. Most studies to date focus on energy consuming sectors(Baker 2017) . To identify sectors in high risk of leakage we must know by how much the production prices would rise in the sector once carbon is priced and secondly, if the market elasticity would allow for the increase to be passed down or it would simply increase demand on non regulated ones.

To summarize, most of the literature supports usage of trade intensity instead of other estimates more challenging to calculate. Where the revenues collected are placed has impactful consequences; when retained for instance, developing countries are the ones paying the price, this additionally demonstrates that BCA policies end goal is carbon reduction not domestic goods protectionism.

7. Trading schemes in the making

As the EU ETS grows into a more sophisticated system of emissions abatement, other regions of the world are noticing it and start to design ways to apply it regionally into their economies. We can observe this by the amount of emerging literature in the Asiatic continent and North America. The rapid growing Chinese economy, their dependence on coal and their high ranking among world top carbon emitters form the perfect storm for one of biggest potential emissions reduction.

7.1. The Case of China:

From exclusively regulatory interventions to trade systems, China is preparing for a change, and can use experiences learned from the EU market and Australian carbon system(revoked), Californian ETS, Canada, US east coast and New Zealand.

In this context Frank Jotzo (2014) reviews emerging ETS and lessons learned from other international markets and speaks about his conclusions, and what can China learn from international markets. One of China's main problems is its strong state owned economy, since cost effectiveness and efficiency are only in reach if a market structure reform takes place. The government slowly started a plan to introduce ETS regionally by provinces. Concluding that the implementation of a carbon pricing system will require special attention from authorities due to its highly regulated energy sectors.

Gao, S.(2021) is a great example of such a new phenomenon. Using a survey approach from companies in China that are attempting to establish an ETS, and taking the EU ETS as a benchmark, their work underlines which characteristics have more significant effects on pushing the development of technologies that are less carbon intensive. Previously, researchers looked how policies themselves affected technological progress using a more analytical framework that considered how several variables interact to influence innovation capabilities, whilst Gao . S is more interested in the effect innovation has on designing policies, mainly strictness which ultimately is the increasing costs firms experience.

Adaptability focuses on the ability of firms to overcome these changes and predictability on the assurance level of a policy and future implications, the adaptation period and long term corporate investment. Summarizes which policy´s main attributes companies deemed important as well as the EU ETS with their respective levels. The questionnaire for data collection had its own particularities such as data collection in multiple phases, the geographical limitations and requirements narrowing it down from a thousand sent to the final hundred making the cut.

After a thorough model explanation followed by an evaluation they concluded that allocation, compliance, new entries allocation, banking and stable policies; all have significant effects on corporate low carbon technologies investment. The results present certain limitations, for instance one can´t be certain that data collected is legitimate and other issues related with online survey methodologies, advising future

researchers to gather more precise data and a wider sample group(mainly areas that are not yet implementing ETS).

In a similar way, more papers are analyzing the early stages of the Chinese ETS, pointing out issues and highlighting future guidance based on other markets' experiences. Zhang D.(2014) also focuses on the early stages of ETS implementation by provinces.

Some researchers argue that it is the right choice to slowly introduce carbon markets in China by its trials in certain provinces and five year plans. Pointing out the key role state owned companies like energy sectors have in market systems; and mentioning that initially the problems said introduction to carbon trading faced, were not so different from the European market faced on phases 1 and 2. From data availability, grandfathering effects and new entrants,allocation criteria to monitoring, reporting and data verification,the lack of legal structure and collision with existing climate policies Da Zhang (2014).

Like phase I of the ETS, the goal was to ease the introduction of carbon markets and to learn more than it was about abatement. It only mentions that the Chinese can learn from other markets (EU, Canada,...) lacking in my opinion a more detailed explanation of what and how. Majority of newer papers use a compute general equilibrium approach(CGE) trying to predict results such as linkage of coverage, B. Lin (2017) and despite being a reasonably researched topic, only a few focus on choice of coverage. Despite being written in a more developed and evolved market state, it still emphasizes on the trial phase China setted up in several regions nationwide but doing so in a more logical way, comparing it directly with other world carbon markets. Results of analysis in a more sophisticated and empirical way than previous works, are indicative of how the data availability has improved over time, finding that the reduction effect of the ETS is significant while the coverage effect impacts more the GDP, social welfare and commodity price. Also, the wider coverage means a more stable market.

Some even go as far as simulating a fusion between Chinese national ETS and the European one,the emissions, the economical and energetic consequences. In an ideal scenario it seems like a wonderful idea,virtually, it should eliminate “Carbon leakage” and would unify the world against emissions.

8. Cap-and trade vs Carbon taxation

Like we briefly mentioned earlier, tax focused systems make too directly attributable the costs of abatement. In this section we will compare different approaches on a widely controversial topic among researchers; carbon taxes vs .cap and trade.

Gilbert E. Metcalf(2020) does some work in favor of Carbon taxes firstly proposing a tax model with the respective analysis, followed by a remarkable argumentation and self criticism of the tax models.

According to Metcalf some of the tax system holds on the cap and trade are the following:

The explicitness of the price on emissions, facing the uncertainties setting up the reduction process by kickstarting investment. On the other hand, it could create enough public attention to end some discussions and focus on how to apply the policy correctly. Additionally studies suggest that it is faster to implement than a model like EU ETS,specially when there are already existing tax models, and so many firm´s crucial information is already in most governments databases.

Following theory by the book , knowledge says that negative externalities like gasses emissions won´t reach a socially optimal level on its own. Having firms pollute until reduction costs equals the marginal cost of emissions; with perfect information both systems drive to the same conclusion, which is reduction.

The key element is that reduction costs aren't exact science, Weitzman(1974).Pioneer research shows the relevance of marginal costs comparing reductions mechanisms. More modern theories, more sophisticated, upgraded ones based on Weitzman, repeatedly demonstrate (Karp and Zhang 2005) that the cap-and trade system is outclassed by the old school taxation system efficiently speaking. A cap offers no safeguards against rapid market shifts whereas a tax is extremely efficient in that regard. Adding another nail in the coffin for the case of cap and trade, Quirion(2004) considers additional conditions that must be taken into account that push the dominance of a tax system over the cap and trade even further.

Price volatility of the market is no secret, the EU ETS data shows how highly fluctuant prices are, as evidenced in research studies mentioned earlier from phase I. A committee could be placed to regulate emissions markets at the cost of credibility, or

the inclusion of a provision that sets a maximum price for needed permits from companies. However this last method was discarded by Burtraw and Palmer (2006) who suggest a hybrid approach. The Congressional Budget Office (2008) studied several more hybrid systems and came up with the same conclusion, that the efficiency of a tax based system is still unmatched by any other methodology.

9. Objections to carbon pricing:

The rising concerns about the carbon pricing are not only for the tax system but also for the cap and trade model.

One objection is the damage that might cause in economic growth. Though preliminary studies show that close to no effect is expected on prices for the majority of industries; some such as petrol related and coal ones might suffer severe changes than others.The distributional impacts have been topics of discussion among experts as well.

Like we have mentioned before, and directly related to carbon leakage is market competitiveness.It is the consequence of miscellaneous regulations on an international level of firms that operate in the same markets. It is uncertain if a tax on imports will be in compliance with the WTO ruling., same goes for the cap and trade system which is additionally far more complicated to adjust when products are crossing the border.

The differences in regulations generally produce a significant increase of costs in regulated firms, Pasurka (2008); as common sense dictates, differences are even higher in carbon intensive firms. Despite all the technological breakthroughs in data availability literature reviews continue to produce multiple competitive outcomes, although it is worth mentioning that it allows to obtain more accurate justifications on the impact on competitiveness.

The hypothetical influence of environmental regulations on global commerce, the region in which industries are located, capital investment and the labor implications of these impacts have been at the spotlight in terms of debate. In findings of recent literature the effects are frequently limited and narrowly focused on a few industries; it seems to agree with the existence of a “pollution heaven”. This hypothesis argues that if competitors vary only in environmental regulations, those with higher restrictions will face higher loss in competitiveness A. Dechezlepretre (2020). If measures are seen as

long term this may also see the manufacturing and labor markets shift towards less restrictive policies.

Unwanted distributional effects might result when applying any significant climate strategy. Additionally, it's crucial to compare said distributional effects of carbon pricing to other possibilities. Researchers agree that unabated climate change consequences would not be unevenly distributed among nations, with poorer ones being more impacted than affluent nations.

10. Conclusions

Despite the early questionable effectiveness of the European emission trade system and having reviewed studies that correlate a reduction of greenhouse gas emissions to the implementation of the EU ETS, and when the market framework behaves as intended, we can argue that the EU ETS, indeed, drives investment in clean carbon technologies. As we can see by the studies shown, during the first phase, the reduction averaged between 3% and 5%.

We can also rule out the EU ETS as responsible for a significant rise in carbon emissions outside the eurozone. But with free allocation as the main leakage countering measure, its effects tend to be less and less effective over time, and difficulty to be measured, carbon leakage should remain heavily supervised in future research. Also the reduction of competitiveness in business isn´t significantly related to the implementation of the ETS system. The total distribution of allowances, via allocation or distribution are too, in need of being revised.

As phase 3 is being left behind and phase 4 progresses, we have learned that carbon leakage can become a problem if policy makers around the globe do not align their interests. Personally I´d like to see it as an opportunity that can pave the way to future multilateral cooperation agreements, sInce most leading carbon producing regions in the world are considering or have already set net-zero carbon deadlines. Although compliance and overall competitiveness effects must be borne in mind when harmonizing policies. As we have mentioned, the border carbon adjustments as a coping mechanism in case some countries don't follow the restraint trends as their peers.

In this work we see that free allocation of allowances lowers the investment and development of low carbon technologies for not being stringent enough, also that auctioning may cause carbon leakage. We have seen that protectionism and arbitrary are the best words to define the EU approach to tackle carbon leakage, that keeps certain sectors outside the allocation scheme.

Finally, we see how the EU ETS has matured from its first stages where the purpose was only to pave the way and to instill a vision and a model of a less carbon dependent economy, to inspiring economies worldwide who are beginning to comprehend the potential of such a mechanism. We mainly focused on China since it´s the highest GHG emitter, hence has the biggest potential of reduction.

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