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EUROPEAN UNION EMISSIONS TRADING SYSTEM – THE EFFECT OF FREE ALLOWANCES ON GREENHOUSE GAS EMISSIONS

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Abstract

This paper reviews the literature on free allowance allocation in the European Union Emissions Trading System (EU ETS). The objective is to shed light on how free allocation has affected global greenhouse gas emissions in the past trading phases of the EU ETS. I explain why emissions trading, in theory, is an economically efficient way to reduce greenhouse gas emissions. Also, I describe the rationale behind free allocation as a means of preventing carbon leakage. I provide a brief overview of the evolution of the EU ETS – focusing on allowance allocation –, and then review the relevant literature.

The ETS has reduced emissions in the EU. Still, there seems to be no significant evidence of carbon leakage. Free allocation is one of the main reasons for this. However, especially in the first two trading phases, the number of allowances granted for free has been too high: with less generous free allocation, the EU could have achieved larger emission cuts. Many sectors have even benefited from free allocation, instead of being forced to pay for polluting. Moreover, those firms that have enjoyed overallocation have reduced emissions less, which means that emission cuts have not necessarily taken place where they are least costly. This calls into question the cost-effectiveness of the EU ETS in its previous phases. On the other hand, the number of free allowances has declined annually since 2013 and the method for free allocation has changed, so the results cannot be generalized to the current situation.

Keywords emissions trading, carbon leakage, free allocation, grandfathering, benchmarking

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1 Introduction

Climate change is one of the major threats to humankind and the planet Earth, and it has widespread impacts on the economy. In 2019, the European Union (EU) was the third largest greenhouse gas emitter in the world after China and the United States (United Nations Environment Programme, 2020). In addition to this remarkable direct impact, the EU is a globally more influential climate actor than its size would suggest. It is implementing ambitious climate policies, planning to become the world's first climate-neutral continent by 2050, providing international climate finance for developing countries, and promoting innovative low-carbon technologies. Set up in 2005 and being the world's first major carbon market, the EU Emissions Trading System (ETS) has been a cornerstone of the EU's climate policy (European Commission, n.d.). According to many studies, the ETS has indeed reduced carbon emissions in the EU (e.g., Bayer & Aklin, 2020; Laing et al., 2014; Martin et al., 2016; Venmans, 2012). On the other hand, some argue that the effect on greenhouse gas emissions has been moderate when compared to the targets set by the Paris Agreement (Green, 2021).

To meet its targets and fulfill its commitments, the EU is currently making substantial changes to its climate policy. For example, the European Commission has proposed measures to complement the ETS so that carbon pricing would also be applied to firms outside the EU. Despite the changes, the ETS remains a key instrument in the climate policy toolkit of the EU, and the ETS Directive has recently been revised to help to achieve the ambitious goal of climate neutrality by 2050.

In emissions trading, economics is used to combat climate change. Emissions trading is a tool to internalize a negative externality – emissions – by forcing polluters to pay for emitting. In a cap-and-trade system like the EU ETS, decision-makers set an upper limit on the total amount of emissions that can be produced by the regulated installations (European Commission, n.d.). Polluters must hold enough allowances to cover their emissions, and in principle, they have to pay for those allowances. Allowances are tradable, which means that emissions are cut where it costs least to do so. In other words, an emissions trading system – when properly designed – is largely considered as an economically efficient way to reduce greenhouse gas emissions (see, e.g., Braathen, 2011; Rubin, 1996; Tietenberg, 2010). Designing a system like the EU ETS thus requires contribution from not only scientists but also economists.

One of the main threats in a cap-and-trade system is 'carbon leakage': regulated firms avoid paying for polluting by relocating to countries with less stringent climate policy. This means that locally, greenhouse gas emissions do decline, but there is no cut in global emissions. The EU has tried to tackle this issue by granting free allowances to some polluters. Traditionally, however, it has been argued that free allowances violate the 'polluter pays' principle – a key principle of emissions trading (Sorrell & Sijm, 2003; Woerdman et al., 2008). Indeed, according to Nash (2000), the core of the polluter pays principle is that "neither the government nor society-at-large should subsidize pollution and polluters" and that "polluters should internalize the costs of pollution abatement." Therefore, while granting free allowances to regulated installations may reduce the risk of relocation, it also erodes the credibility of the EU's climate policy.

1.1 Research question

In this literature review, I examine the earlier phases of the ETS and, more specifically, the effects of allowances allocated free of charge. Based on existing literature, I try to answer the following question: What has been the impact of free allocation in the EU ETS on global greenhouse gas emissions? This further raises a question about whether free allocation has been necessary to prevent carbon leakage. I discuss this topic as well.

Studying the impact of free allowances on emissions is important for the purpose of improving the system and deciding about the new policy measures. Even though the number of free allowances declines, they remain a central element in the system, which means an analysis of their effects is needed. Since the EU ETS is a relatively new instrument and there are no previous examples of major carbon markets, policy decisions have largely been based on estimates and predictions. Hence, papers utilizing data from the previous phases and articles reviewing previous studies are welcomed – not only for the future of the EU ETS but also for other countries implementing or planning their own emissions trading schemes.

Likewise, a limited number of up-to-date research papers is one of the main challenges when answering the research question of this paper. As stated by Verde (2020), literature covering the EU ETS "suffers from a substantial delay." According to him, all the steps from the release of new data to the publication of the paper take time. This delay – combined with rapid changes in the rules of the EU ETS, including the declining number of allowances and the new measures, such as the Market Stability Reserve (MSR) and back-loading – means that the data are inevitably describing a world somewhat different from what we currently live in. Importantly, carbon prices – that is, allowance prices – have increased significantly after 2017 (see Figure 1), and free allocation was a lot more generous in the first two phases of the EU ETS than in Phase III, which started in 2013. Consequently, this literature review reflects only a little the recent years of the EU ETS.

Figure 1: EU carbon allowance price 2005–2021 (EUR). Source: Trading Economics

Another challenge concerns causality. In the existing literature, one of the hardest tasks seems to be to isolate the effects of the EU ETS from the effects caused by other factors, such as the financial crisis (Laing et al., 2014). The same issue is discussed by Martin et al. (2016). Interestingly, they point out that up to the year 2016, most of the available literature on the EU ETS had focused on correlation rather than causation. According to them, however, the studies increasingly rely on microdata to "establish causal impact estimates on the basis of large and representative samples," while in the past, the data were either more aggregate-level or more limited, focusing on a small number of firms.

Lastly, it is challenging to compare empirical academic papers on the EU ETS for many reasons. First, they use data on different time periods and different countries. Second, some of them measure only carbon emissions, while others take into account several greenhouse gases. Carbon dioxide accounts for about two-thirds of greenhouse gases (United Nations

Environment Programme, n.d.). Hence, it is utterly important but does not tell the whole story. Besides carbon dioxide, the EU ETS covers a few more greenhouse gases. However, the focus of this paper is not on which greenhouse gases are examined in the reviewed studies – only carbon dioxide or some other less important greenhouse gases as well. The articles are selected based on other attributes. Third, different studies cover different sectors. For example, some articles focus on the cement and steel industry only. Altogether, the ETS covers about 10,000 installations in the power sector and manufacturing industry. In addition, the emissions from airlines operating between the EU ETS countries are covered (European Commission, n.d.).

1.2 Overview

To study the effects of free allocation in the EU ETS on global greenhouse gas emissions, this paper combines two aspects. First, it is of course important to focus on emissions inside the EU. Dechezleprêtre et al. (2018), for instance, carefully examine this topic. Teixidó et al. (2019), in turn, provide a review of how the EU ETS, including free allocation, has affected the adoption of low-carbon technologies. New, clean technologies are crucial when installations aim at emission reductions. Second, when studying the impact of free allocation on emissions, it is necessary to extend the analysis beyond the EU borders and search for possible evidence of carbon leakage. Namely, emission cuts in the EU area are not a solution if they lead to corresponding emission increases elsewhere. Naegele and Zaklan (2019) study carbon leakage in their article.

Along with these aspects, this paper presents a couple of articles that criticize the free allocation rules in the past phases of the EU ETS. Critique on free allocation is justifiable: granting allowances for free violates the polluter pays principle, and obviously, the money the EU would get if the free allowances were auctioned could be used for other purposes. Many companies have even earned so-called windfall profits thanks to free allocation, meaning that the EU has in practice subsidized the polluting firms. Martin et al. (2014a), as well as Colmer et al. (2020), address this question.

Based on the existing literature, the following observations can be made. The EU ETS has led to reductions in emissions, and no significant evidence of carbon leakage can be found in the studies reviewed. One of the main reasons for the absence of carbon leakage has been free allocation. Nevertheless, free allocation has been far too generous, especially in the first two trading phases (2005–2007 and 2008–2012). With a smaller number of free allowances, larger emission reductions could potentially have been achieved without increasing the risk of carbon leakage. Free allocation has led to a situation where some regulated sectors have received a net subsidy from the ETS, which may also evoke negative feelings among citizens. On the other hand, it seems that in the earlier phases, the EU succeeded to convince the firms that despite the temporary oversupply of allowances, the price of carbon will rise sooner or later. Thus, firms cut down their emissions even when allowance prices were low. After 2017, the prices have indeed soared.

When it comes to the economic efficiency of the EU ETS, it seems that firms receiving plenty of allowances for free have cut their emissions less, meaning that in the EU, the outcome in the allowance market has not been independent of the initial allocation of allowances. This is a threat to the efficiency of the system since it means that the emission cuts have not necessarily taken place where they can be made with the least cost. However, this finding only concerns the past phases of the EU ETS and should not be considered as a feature of emissions trading or free allocation in general. Additionally, as the role of free allocation in the EU ETS gradually decreases and more and more allowances are allocated through auctions, this threat is likely to diminish.

The rest of the paper is organized as follows. Section 2 lays out a theoretical framework for emissions trading, carbon leakage, and free allocation. Section 3 summarizes the evolution of the EU ETS. Section 4 reviews literature on the topic. Section 5 discusses the findings, and Section 6 concludes.

2 Theoretical framework

2.1 Externalities and an emissions trading system

Emissions are a negative externality. The very purpose of any emissions trading system is to internalize this externality – that is, make the polluter pay for the harm it causes to other people and thereby achieve the outcome that maximizes social welfare. A tradable permit system is a way to achieve the required emission cuts cost-effectively. In this section, I describe why tradable allowances are an economically efficient instrument. I also briefly discuss the literature comparing different policy instruments.

The condition for achieving a cost-effective outcome is familiar to economists: As Tietenberg and Lewis (2018) put it, "the cost of achieving a given reduction in emissions will be minimized if and only if the marginal costs of control are equalized for all emitters" (p. 341). 'Marginal costs of control' here mean the marginal costs arising from emission cuts – also called marginal abatement costs. The greatest advantage of a tradable permit system is that the decision-makers do not have to know the firms' abatement costs – they can only set an upper limit for emissions and let the markets determine the price for allowances.

Cost-effectiveness of a tradable permit system can easily be demonstrated graphically by comparing it to a simple command-and-control restriction set by the decision-makers. Babiker et al. (2004) provide a straightforward illustration in a world with no distortions. In Figure 2, suppose the decision-makers decide the optimal total emission reduction to be Q*. If this target is split equally between the two firms, Firm 1 and Firm 2, they both need to reduce emissions by $Q_1 = Q_2$. However, in this situation, marginal abatement cost for Firm 1 (MAC_1) is higher than MAC_2. The outcome is not efficient.

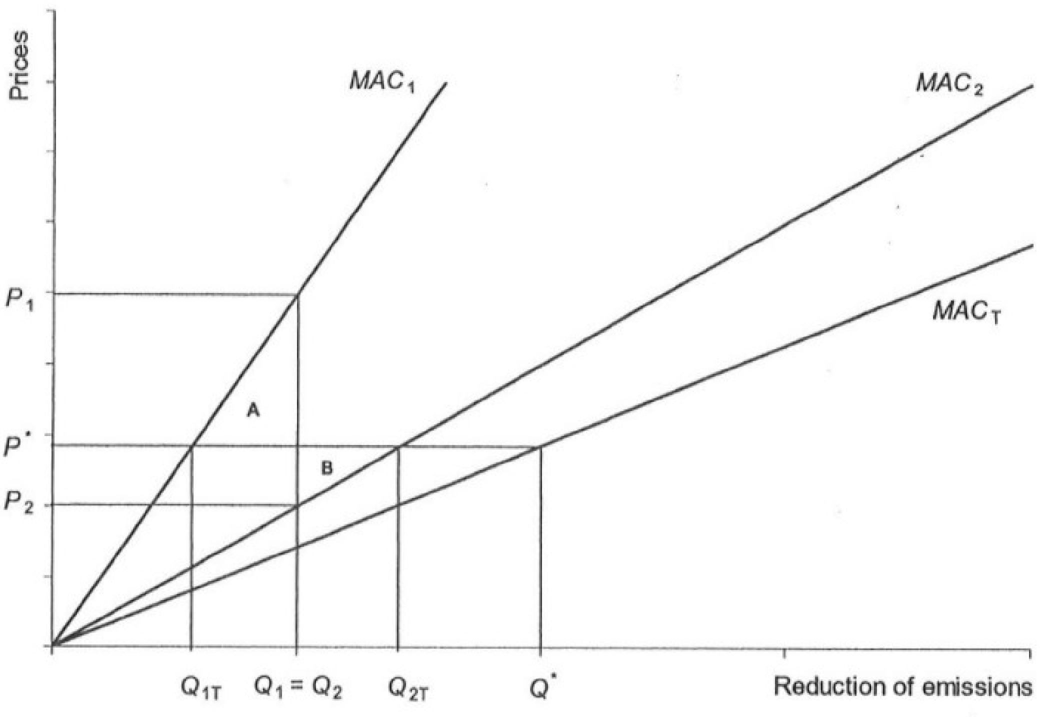

Figure 2: Cost-effectiveness of emissions trading. Source: Babiker et al. (2004)

Now, suppose an emissions trading regime is implemented and an agreed number of tradable allowances is issued. The price for those allowances is determined by demand and supply, and each firm reduces emissions up to the point where the marginal abatement cost exceeds the allowance price. In the figure, cutting emissions is more costly to Firm 1, so it reduces emissions only Q_{1T}. Firm 2, on the other hand, has a low cost of abatement, so it reduces emissions more, Q_{2T}. Firm 1 buys and Firm 2 sells emission allowances at price P*. In total, the emissions are cut by the same amount as when direct emission constraints are set. Both firms are better off: The net income gains for Firm 1 and Firm 2 are A and B, respectively. The outcome is efficient.

Many papers have studied different policies for reducing carbon emissions, and carbon pricing is often ranked the most incentive. Some of those papers emphasize tradable emission rights and especially auctioned allowances, while others speak about carbon pricing at a more general level. To name a few, the superiority of carbon pricing or auctioned allowances over other policies has been praised by Fischer and Newell (2008), Jung et al. (1996), as well as Milliman and Prince (1989). On the other hand, Requate and Unold (2003) show that in some circumstances, an emission tax can provide stronger incentives to adopt advanced abatement technology than other market-based instruments. In any case, research tends to favor carbon pricing over command-and-control regulation. Requate (2005) has surveyed different policy instruments and concludes that "under competitive conditions market-based instruments usually perform better than command and control." That being said, Fischer et al. (2003) argue that the ranking depends on numerous factors and is often ambiguous, even between market-based and command-and-control policies.

2.2 Carbon leakage and free allocation

It is a widely acknowledged fact that setting a price to carbon can lead firms to relocate, that is, shifting their production to countries with less stringent climate regulation. Numerous articles, as well as non-scientific sources, raise this concern of so-called carbon leakage. Firms thereby avoid paying for polluting, which threatens to erode the whole polluter pays principle and means that the market equilibrium is not socially optimal. Below I briefly review how the risk of carbon leakage has been described in the literature. I then explain why freely allocated allowances have been seen as a solution to carbon leakage. I also present a model by Schmidt and Heitzig (2014) describing firms' relocation choice.

According to Naegele and Zaklan (2019), carbon leakage has been discussed a lot in the literature, and there are both academic and policy debates about the effectiveness of unilateral climate policy. Likewise, Schmidt and Heitzig (2014) see that the risk of carbon leakage, caused by unilateral regulation of polluting industries, is widely known. Naegele and Zaklan note that the debates arise especially in Europe, where many sectors are covered by the EU ETS. They describe the extreme case where "carbon leakage undoes the contribution of the unilateral policy to mitigate aggregate global emissions." They also talk about the other negative effects of carbon leakage that hit the region implementing the policy: losses in output, employment, and welfare in general.

Goulder and Parry (2008) discuss the different channels of carbon leakage and identify at least two ways in which the leakage can occur. First is the relocation of firms, caused by the increased production costs. Secondly, however, demand as well can be a source of carbon leakage: When the firms pass through the increased production costs to the consumers, demand may shift away from the higher-priced domestic goods, leading to increased demand for foreign goods and higher emissions elsewhere. In the report of the Intergovernmental Panel on Climate Change (IPCC), Blanco et al. (2014) add a few more channels for carbon leakage. The third channel affects through international fossil fuel prices. Climate regulation in some region may reduce demand for fossil fuels, thus causing a fall in world prices. This, in turn, results in an increase in demand for fossil fuels elsewhere. The fourth channel is 'nested regulation': Suppose a group of countries imposes an aggregate cap on emissions. If the emission reduction efforts of an individual country are remarkable, this frees up allowances in another country under the scheme, thus shifting the emissions from one regulated country to another.

One solution to prevent relocation is to allocate a share of emission allowances to the firms and other installations for free. Dechezleprêtre et al. (2021) note in the context of the EU ETS that free allocation is a direct consequence of the concern of carbon leakage. Teixidó et al. (2019) also explain the economic rationale for using free allocation. By minimizing the risk of causing market share losses to the domestic firms, they argue, free allowances minimize the risk of carbon leakage.

The main allocation rule, at least in the EU, is to give most free allowances to the firms that are considered to be at a significant risk of relocation. The risk may be higher in energy-intensive industries or in sectors that are highly exposed to international trade (European Commission, n.d.). Free allocation does not affect the total emission cap, but granting free allowances – or not granting them – may have indirect effects on emissions through, for example, carbon leakage and incentives to invest in low-carbon technologies. In addition, free allocation directly affects regulated firms' profitability (Schmidt & Heitzig, 2014). Finally, it has distributional impacts not only between polluting firms and other economic actors but also across household income groups (Goulder & Parry, 2008; Verde et al., 2019). For example, Naegele and Zaklan (2019) show that in the EU ETS during the period 2004–2011, most sectors received a net subsidy from emissions trading, when free allocation was taken into account.

Roughly, there are two main methods for free allocation: grandfathering and benchmarking. ICAP (n.d.) describes the two methods. In grandfathering, free allowances are granted based on historical emissions. This method may face less opposition from the regulated firms and thus be easier for politicians to implement than benchmarking. Benchmarking means that the allocation of free allowances is based on performance indicators. For every installation, performance with respect to emissions is compared to the 'top performers' – the most efficient installations. The better the installation performs, the more it gets free allowances. Benchmarking rewards installations that can rapidly cut their emissions, whereas grandfathering tends to favor the installations with large historical emissions. Grandfathering also requires further provisions for new entrants, since they do not have historical emissions.

Schmidt and Heitzig (2014) suggest grandfathering as a means to prevent relocation. They construct a model where a firm can relocate in time $T \in [0, \infty]$ and where $\Pi(T)$ denotes the net present value of the firm at time zero, excluding any monetary benefits from grandfathering, if it relocates at $T \in [0, \infty]$ and optimizes its other behavior accordingly. $G(T)$ denotes the total additional payoff from the grandfathering scheme that the firm will get during period $[0, \infty]$ if it relocates in time T. Thus, the firm prefers to never relocate if

$$\Pi(\infty) + G(\infty) \geq \Pi(T) + G(T) \text{ for all } T. \tag{1}$$

The firm determines its optimal relocation time T by maximizing $\Pi(T) + G(T)$, that is, its net present value plus total additional payoff from the grandfathering scheme. This means that the firm solves a first-order condition

$$\frac{\partial(\Pi(T) + G(T))}{\partial T} = 0 \tag{2}$$

Now suppose $g(t)$ specifies the additional payoff that the firm gets from the grandfathering scheme in period t. If $g_{crit}(t)$ denotes the grandfathering scheme for which the firm is indifferent between staying or relocating in time t, then a sufficient condition for a grandfathering scheme that deters the relocation permanently is

$$g(t) \geq g_{crit}(t) \qquad \text{for all } t. \tag{3}$$

The authors derive an optimal grandfathering scheme that prevents relocation with the minimum number of free allowances and show that grandfathering can permanently avert relocation, even if free allocation is phased out over time. This optimal scheme depends on the patience of the regulator. The authors emphasize the importance of both not phasing out free allocation too rapidly and the regulator's commitment to the rules of free allowance reductions, since if the number of free allowances is cut abruptly, then the firms may first enjoy the benefits of the generous allocation but, when the policy changes, relocate. Schmidt and Heitzig talk about a 'lock-in effect': When the number of free allowances is gradually decreased, the firms have time to adapt to the policy by investing in low-carbon technologies and abatement capital. These sunk investments prevent the firms from relocating even after the grandfathering scheme ends. The more the firms have invested, the less they suffer from the rising prices for carbon, and the less likely they are to relocate. On the other hand, carbon prices in the future must be high enough to induce enough investment in low-carbon technology.

There are many other papers, too, suggesting ways to tackle carbon leakage and trying to find out the optimal rules for free allocation. These include Nachtigall (2019) – also referring to the lock-in effect –, Martin et al. (2014a, 2014b), and Mæstad (2001).

3 The evolution of the EU ETS

The policies to reduce greenhouse gas emissions vary significantly between OECD countries (Fischer & Newell, 2008). However, the EU countries plus Iceland, Liechtenstein, and Norway have adopted a common emissions trading scheme, the EU ETS, to address the global threat of climate change (European Commission, n.d.). As stated by Klemetsen et al. (2016), both allowance prices and allocation rules have changed significantly between the three trading phases of the EU ETS. In this section, I provide a summary of the evolution of the EU ETS and its allowance allocation through the past three phases. After that, I describe the current phase (2021–2030), listing the most relevant changes from the previous periods and shedding light on what will follow. Verde et al. (2019) provide a comprehensive summary of the allowance allocation through the trading periods. I base this section on their review, along with the information provided by the European Commission.

3.1 Phase I and Phase II

In 1997, the Kyoto Protocol set legally binding emission reduction targets for 37 industrialized countries for the first time, creating a need for policy instruments to reach these targets. In the EU, some first ideas about the EU ETS were presented in 2000 by the European Commission. The EU ETS Directive was adopted in 2003. Finally, in 2005, the system was launched and Phase I started. (European Commission, n.d.)

Both in Phase I (2005–2007) and Phase II (2008–2012), grandfathering was the primary method for allocation of allowances. In other words, almost all allowances were allocated for free, based on the installations' historical emissions. In the first two trading periods, national governments had to establish their National Allocation Plans (NAPs), in which they determined the total volume of allowances and allowance allocation. NAPs had to be reviewed by the European Commission to ensure they would be in line with the ETS Directive. The ETS Directive strictly limited the number of allowances that could be auctioned, encouraging member states to free allocation. As a matter of fact, many countries decided to give all the allowances for free. (Verde et al., 2019)

Practically, Phase I was a three-year pilot that prepared the EU for Phase II. There were no reliable data on emissions, which led the member states to set the caps based on estimates. As a result, the total amount of allowances issued exceeded emissions – supply exceeded demand. It followed that in 2007, the price of allowances fell to zero since the allowances from Phase I could not be banked for use in Phase II. (European Commission, n.d.)

Compared to Phase I, Phase II slightly extended the ETS, and the overall direction was towards stricter rules. However, the financial crisis in 2008 led to emissions reductions greater than expected. The result was a large surplus of allowances, which created a strong downward pressure on carbon prices throughout Phase II. (European Commission, n.d.)

3.2 Phase III

In Phase III (2013–2020), auctioning became the default method for allocating allowances, instead of free allocation. In auctioning, businesses covered by the ETS must buy their allowances through auctions, implying that the polluter pays principle was seriously put into practice. The number of freely allocated allowances decreased every year in Phase III. Importantly, from 2013 onwards, free allocation has been based on benchmarking rather than grandfathering, meaning that firms have stronger incentives to reduce emissions quickly. Nevertheless, in both Phase III and Phase IV, installations in the sectors deemed at significant risk of carbon leakage have received free allowances covering 100% of their benchmarked emissions. (European Commission, n.d.; Verde et al., 2019)

Since Phase III, free allocation has not been applied to the electricity generation sector, with some exceptions. This is due to high cost pass-through: As the electricity demand is highly inelastic – consumers and firms have limited possibilities to adapt to the price changes –, the suppliers of electricity are able to pass the cost of carbon to electricity prices. Prior to Phase III, this possibility to raise the prices without causing a significant drop in volumes, combined with free allowances, led to windfall profits to electricity producers. (Verde et al., 2019)

The other remarkable changes compared to Phase II were an EU-wide emissions cap that replaced the national caps; more sectors and greenhouse gases included in the ETS; and an introduction of new measures to address the oversupply of emission allowances. To tackle the surplus of allowances, the EU postponed the auctioning of 900 million allowances in total in Phase III (so-called back-loading). In addition, the Market Stability Reserve (MSR) was launched in 2019. Allowances are transferred to the reserve or released from it depending on whether the market suffers from surplus or shortage of allowances. Thus, the MSR makes the ETS more resilient to major shocks, such as economic downturns, by adjusting the supply of allowances. This means less price volatility. (European Commission, n.d.)

3.3 Phase IV

The EU ETS Directive has been revised for Phase IV (2021–2030) to help the EU reach its ambitious goal of climate neutrality by 2050. To meet the intermediate target of reducing 55% of greenhouse gas emissions by 2030 compared to 1990 levels, the sectors covered by the ETS should cut their emissions by 43% compared to 2005 levels. This means several changes to the ETS. Here, I list only some of them. (European Commission, n.d.)

First, the overall number of allowances still declines annually, but at a faster rate than in Phase III. Second, the MSR is reinforced in many ways. Third, the number of free allowances given to the sectors deemed at a smaller risk of carbon leakage decreases gradually. Free allocation to these sectors is predicted to be phased out after 2026 and reach zero level by the end of Phase IV (2030). Sectors at the highest risk receive 100% of their allowances for free until the end of the current phase. Fourth, new and growing installations are treated more equally with existing installations, partly because the new more flexible rules better reflect the actual production levels. Fifth, the Innovation Fund and the Modernization Fund support energy-intensive industrial sectors and the power sector in meeting the challenges of the transition to a low-carbon economy. (European Commission, n.d.)

In July 2021, the European Commission gave a new series of legislative proposals intended to pave the way to climate neutrality. The package includes the Carbon Border Adjustment Mechanism (CBAM), which would address the carbon leakage and gradually become an alternative to free allocation. Ideally, the CBAM would resolve the problem of carbon leakage by forcing importers to pay according to the emissions of their products produced outside the EU borders. This way, firms could not avoid the cost of carbon if they wish to do business in the EU. However, even in the best-case scenario, the CBAM would be applied only from 2026 onwards and, at least in the beginning, would only cover selected product groups due to the difficulties in measuring the carbon emissions of most products. These limitations of the CBAM justify the attention the EU ETS and its free allocation have attracted in the literature. (European Commission, n.d.)

4 Literature review

4.1 The effect of free allocation on emissions inside the EU and on carbon leakage

Emissions of the installations covered by the EU ETS have declined by 35% between 2005 and 2019 (European Commission, n.d.). However, this does not mean that the reduction is automatically caused by the ETS – there are many other factors, too, that affect the emissions. Martin et al. (2016) remind that we must try to compare the real situation to the world without the ETS. The policy, they state, is effective only if it yields emission reductions larger than would occur without the policy. The challenge here is, of course, that we cannot tell what the emission levels would have been without the ETS. In the following subsection, I examine the effect of free allocation in the EU ETS on firm-level emissions in the EU area. After that, in subsection 4.1.2, I review whether the ETS has caused carbon leakage. These are the key questions when scrutinizing the effect of free allocation on total emissions.

4.1.1 Emissions inside the EU

Dechezleprêtre et al. (2018) study the impact of the EU ETS on carbon emissions by using installation-level emission data from France, Netherlands, Norway, and the United Kingdom. Their investigation covers the first two phases of the ETS (2005–2012). They utilize the fact that the EU ETS only covers installations exceeding a certain production capacity threshold, even though these installations may be very similar to the ones falling below the threshold and not being covered by the ETS. The authors compare installations falling under different regulatory regimes but operating in the same country and sector and of other similar characteristics by conducting a matched difference-in-differences analysis.

The four countries mentioned above are selected to the study because the national registers of these countries have a low reporting threshold for carbon emissions. Therefore, data exist also on installations that are not covered by the ETS, which means Dechezleprêtre et al. (2018) can use these installations as a control group. The authors determine regulatory status for each installation and compare the pairs of ETS and non-ETS installations before and after the ETS to control for the factors affecting either a) both regulatory groups or b) both periods (before and after). This is the way to isolate the effect of the policy on emissions.

Dechezleprêtre et al. (2018) find that in the first two phases, the EU ETS has led to a statistically significant –10% drop in emissions. Interestingly, the authors argue that the generous allocation of free allowances has weakened the impact of the ETS and that over-allocated installations have not reduced emissions. Dechezleprêtre et al. calculate that in case all the installations had received free allowances corresponding to only half of their pre-ETS emissions – instead of almost 100% –, then the impact of the ETS on emissions reduction would have been remarkably larger, around –25%. On the other hand, the authors point out that this finding suggests the effect of the EU ETS to increase in the future, independently of the total cap on emissions, because the number of free allowances shrinks.

The findings concerning free allocation are interesting because, in theory, free allocation should affect neither the total cap on emissions nor the distribution of the emission allowances. The latter, so-called independence property, states that if property rights for emitting are clearly established, then the equilibrium outcome in an efficient emission allowance market is independent of how the allowances are initially distributed (e.g., Fowlie & Perloff, 2013; Verde et al., 2019). The independence property, in turn, is an implication of the famous Coase Theorem that relies on negotiations and bargaining when dealing with externalities and claims that with a given allocation of property rights and in the absence of transaction costs, two parties find a solution that internalizes any externalities between them (Coase, 1960; Dixit & Olson, 2000; Farrell, 1987).

When it comes to the findings of Dechezleprêtre et al. (2018), it is important to note that their study covers only emissions *inside* the EU. Thus, the possibility of carbon leakage is not the focus of their research. Granting free allowances may have dampened the effect of the ETS on firm-level emissions, as the authors argue, but at the same time, free allocation may also have prevented carbon leakage to non-EU countries. Also, the data cover only four EU countries, which raises a question of whether the results can be generalized to the ETS overall. This concern, however, has been discussed in the paper, and the authors show that the installations covered by the study show highly similar attributes relative to installations in other EU countries. Moreover, utilizing matched difference-in-differences analysis enhances the capability to isolate the effect of the ETS on emissions and exclude the effect of the financial crisis, for instance.

Bayer and Aklin (2020), too, suggest that the EU ETS has saved 1.2 billion tons of carbon dioxide between 2008 and 2016 relative to a world without carbon markets. This is equivalent to a 3.8% reduction. Although the authors do not mention free allocation, they emphasize that the policy has been effective despite low carbon prices during the period under study. The following explanation is provided: If a carbon market is a credible institution and the affected firms anticipate it to become more stringent in the future, this may be a sufficient incentive for them to adopt low-carbon technologies and reduce emissions. The authors even argue that low prices might be a signal of a successful policy since it indicates that the demand for allowances is weak. At the same time, however, low prices suggest that there might be an oversupply of allowances. Bayer and Aklin's view is interesting in light of current carbon prices that are significantly higher than in the period under study: Which one is the primary reason for price hikes – strong demand for allowances or a tightening cap on emissions, meaning a decreasing supply of allowances?

4.1.2 Carbon leakage

Verde et al. (2019) review literature on the EU ETS to analyze the efficiency of the allocation rules, focusing on free allocation. They pay special attention to carbon leakage. They argue that Phase III was a turning point in the ETS, firstly because auctioning replaced free allocation as a default allocation method, and secondly because benchmarking replaced grandfathering as an approach used for free allocation. Benchmarking, the authors remind, provides additional incentives to cut emissions, and can be expected to induce more emission abatement than grandfathering in the first two periods. However, the studies reviewed in the paper show that the free allocation rules were too lenient even in Phase III, indicating that the same emission reductions would have been possible with less generous free allocation. The independence property is discussed as well, but the results of the previous studies reviewed in Verde et al.'s paper are conflicting.

One of the most important remarks of Verde et al. (2019) is that due to the shrinking share of freely allocated permits, the rules for free allocation are increasingly important to minimize the risk of carbon leakage. In other words, well-targeted free allocation is a key to preventing carbon leakage in the current phase. At the same time, the authors conclude that further efficiency in free allocation is challenging to achieve due to the difficulty to accurately measure the differences in cost pass-through ability of the regulated installations. Installations not capable to pass the carbon price through to consumers should receive more free allowances than the capable ones. Nevertheless, the authors are confident that the revised allocation rules for Phase IV help to identify those sectors that are at the highest risk of carbon leakage.

Naegele and Zaklan (2019) examine if the EU ETS has caused carbon leakage in European manufacturing. Their work differs from many other empirical papers studying carbon leakage since they study both main channels of carbon leakage – relocation and competitiveness – in the same paper and use a broad panel dataset of global trade flows, emission costs, and control variables. The data have been combined from multiple sources and cover years 2004, 2007, and 2011: one year before the ETS and two years after. A comprehensive dataset, extensive use of those data, and several robustness tests indicate valid results. The authors find no evidence of carbon leakage. Direct emission cost, they argue, has largely been defrayed by free allocation.

Naegele and Zaklan (2019) make a few important points. First, it is reasonable to measure carbon leakage with carbon emissions embodied in the traded goods rather than with monetary values of trade flows, because then the price changes do not affect the results. Second, many ex-ante models predict remarkable carbon leakage but rely heavily on certain assumptions, which are often unrealistic. These assumptions may concern, for example, relocation costs and the implementation details of the chosen policy. It is thus natural that many ex-ante models contradict with empirical studies, which tend to find no strong evidence of carbon leakage in the context of the EU ETS.

The third takeaway of Naegele and Zaklan's (2019) paper is that there are many reasons, along with free allocation, preventing firms from relocating. First, relocation costs may be remarkable, including opportunity costs in the home market: Firms may lose their domestic market share and influence on policymakers. Second, as the so-called Porter hypothesis predicts, firms may benefit from the stringent policy rules as they switch to low-carbon technologies and make green product innovations since this spurs a broader productivity increase and leads to greater profits. Finally, when all direct costs, indirect costs, and free allocation are taken into account, the authors calculate the net total emission cost for EU manufacturing firms to be as low as 0.10% of material cost on average over 2007 and 2011. Given this information, it is no wonder that evidence of carbon leakage is nil.

The same kind of results are found in numerous empirical studies and review papers (see, e.g., Branger et al., 2016; Colmer et al., 2020; Dechezleprêtre et al., 2021; De Jonghe et al., 2020; Verde, 2020), although some studies do find evidence of moderate carbon leakage. Unlike Naegele and Zaklan (2019), however, some of the above-mentioned papers focus on the relocation channel only, with no emphasis on carbon leakage occurring through competitiveness. It is also important to keep in mind that most empirical studies, even the recent ones, only cover the first two phases of the EU ETS, as Verde (2020) points out. After that, we have seen decreasing number of freely allocated permits and rising carbon prices, which means that the existing studies cannot be generalized to the current phase of the EU ETS.

To summarize Section 4.1, studies show that the EU ETS has indeed reduced emissions of the firms covered by the policy. At the same time, there seems to be little evidence of carbon leakage. Taken together, these results have the following implications. First, the ETS has worked as it should: It has cut emissions in the EU without shifting them elsewhere. Second, and more relevant to this paper, free allocation seems to be one of the main reasons why carbon leakage has not occurred. Third, however, free allocation has meant a redistribution of income, where winners are those firms that receive allowances free of charge and losers are other economic actors. The more generous the allocation, the greater the winners' gain. Further, since Dechezleprêtre et al. (2018) show that over-allocated installations have not reduced emissions, it seems that the independence property has not fully applied in the EU ETS. This raises a question about whether free allocation can impede the economic efficiency of the system – one of the key elements of any ETS. To better understand the effects of free allocation on emissions in the long run, it is necessary to ask how free allocation has affected the transition to low-carbon technology – a topic that I will address next.

4.2 The effect of free allocation on low-carbon technological change

In a process of cutting emissions, one key factor is the adoption of abatement technology. New, low-carbon technologies enable companies to reduce emissions cost-effectively, and these technologies may even prove to be cost-saving in the long run – especially if climate regulation makes polluting expensive. Consequently, low-carbon technological change is an important aspect also when analyzing the EU ETS and the effects of free allocation on emissions. In this section, I review the literature on this subject. I base this section on a review article by Teixidó et al. (2019). Instead of presenting the reviewed studies one by one, I focus on the observations Teixidó et al. make based on all these papers.

Teixidó et al. (2019) review the empirical literature on the effects of the EU ETS on the transition to low-carbon technology. Despite concluding that the complete picture is still missing – especially after Phase II – the authors observe that grandfathering tended to hinder the adoption of clean technologies in the first two phases. The article lists many potential ways in which free allocation can, in general, alter the low-carbon technological change induced by an ETS. The main question relates to the independence property discussed in the previous section: If emission cuts do not take place where they are least costly, it also means that firms' abatement technology investment decisions are affected. Another way for free allocation to impact the adoption of green technologies can be described as follows: If a firm holds a remarkable share of the allowance market and gets allowances for free, then its investment in low-carbon technology would mean a decreased aggregate demand for allowances, leading to a price drop. The price drop, in turn, would reduce the value of the freely allocated allowances held by the firm, which would imply that the incentives for the firm to invest would be weakened by free allocation.

An example of studies reviewed by Teixidó et al. (2019) and relevant especially from the perspective of free allocation is the one by Bel and Joseph (2018). They examine the overallocation of allowances in the EU ETS and its effect on low-carbon patents. Their data cover the first two phases when free allocation was a default method for allocating allowances. They conclude that oversupply of allowances negatively correlated with the number of low-carbon patents and thus seemed to hamper the technological change.

Teixidó et al. (2019) conclude that in the first two phases of the EU ETS, free allocation clearly tended to slow the transition to low-carbon technology. The main explanation, they summarize, is that the firms receiving free allowances seemed to undervalue the opportunity cost of using those allowances themselves. The opportunity cost, in this case, is the revenue that the firms would have got, had they sold their allowances on the market. This means that even if it had been more profitable for them to sell the allowances to someone else and make the required emission cuts themselves, they instead used those free allowances themselves. As a result, these firms invested less in low-carbon technology and abated fewer emissions than they would have abated in the absence of free allocation.

An important caveat here, also recognized by Teixidó et al. (2019), is that these results mainly concern Phases I and II, after which benchmarking has replaced grandfathering – a change that potentially provides firms with new incentives to adopt cleaner technologies. At the same time, the share of freely allocated allowances has decreased and continues to decrease also in the current phase.

The findings of this section are consistent with what was reported in the previous section. Those firms that received plenty of free allowances invested reluctantly in low-carbon technology. Consequently, their emission reductions were far from the optimal level. It seems that while free allocation has been a reasonable way to prevent carbon leakage, the volume – at least in the first two periods – was far too large. Therefore, before I discuss the results, I briefly survey a couple of papers that study the proper scope of free allocation.

4.3 Critique on free allocation

Free allocation has raised critique from environmentalists, politicians, citizens, and firms not deemed at risk of carbon leakage, but it has also caught a lot of attention in scientific literature. In this section, I review two articles that critically study the number of free allowances granted in the past trading periods of the EU ETS. The first one also suggests adequate rules for free allocation. I want to stress that the articles reviewed here should not be seen as critique on the current policy; rather, they describe what could have been done differently in the past phases.

Martin et al. (2014a) question the free allocation rules of the EU ETS. According to them, free allowances should be granted so that the highest marginal impact on total relocation risk is achieved. In other words, the compensation should not be based on total but marginal relocation propensities – more specifically, “an efficient compensation rule equalizes across firms the marginal propensity to relocate, weighted by how damaging their relocation is to the government’s objectives.” Based on 761 telephone interviews with managers of European manufacturing firms, the authors conclude that the relocation risk is – or was, at least by the year of publication (2014) – highly overestimated and, accordingly, free allocation was far too generous. Essentially, the free allocation rules applied in the EU ETS led to inefficient allocation.

Martin et al. (2014a) present an optimal allocation of free allowances, which would dramatically reduce relocation risk. Additionally, they consider a dual problem where a) the relocation risk is minimized but also b) the number of free allowances is minimized. In this situation, the authors argue, the amount of relocation risk tolerated in Phase III could have been maintained with a fraction of the allowances planned to be handed out for free. This would have meant more auction revenues and less costs for taxpayers.

A few things need to be pointed out. First, Martin et al.’s (2014a) paper was published seven years ago, at the beginning of Phase III. It must be kept in mind that, with the help of Market Stability Reserve and back-loading, the surplus of allowances was reacted to, so the free allocation assumptions for Phase III used by Martin et al. did not entirely come true. Despite this, the observations about an overestimated risk of relocation and oversized free allocation are likely to hold, and the changed number of allowances does not undermine the claim about equalizing the marginal propensities to relocate across the regulated firms. Second, the finding that the same relocation risk levels could be maintained with fewer free allowances is important.

Namely, stringent climate policy is often socially unacceptable and politically hard to implement when it is related to additional costs to taxpayers and firms. If the costs of a policy can be lowered without diluting ambitious climate targets, policy measures could be easier to carry out and thus, more climate action could potentially be put into practice. Third, the same kind of results are found by Martin et al. (2014b).

Colmer et al. (2020) use data from the French manufacturing sector for each year between 1996 and 2012 and conduct a difference-in-differences analysis to inspect the effect of the EU ETS on carbon emissions, investment, and carbon leakage. They show that the ETS has helped to mitigate climate change by inducing investment, thus lowering emissions in regulated firms. However, they make an important finding when studying whether the treatment effects on carbon emissions, carbon intensity of production, and capital vary depending on the initial allowance allocation. Encouraging results observed in the full sample are primarily driven by those firms that were initially short of allowances.

This finding by Colmer et al. (2020) indicates that emissions were cut mostly in those firms that did not enjoy generous free allocation. On the other hand, the authors note that the observed heterogeneity in outcome variables cannot directly be interpreted as causal. This is because free allowances were not handed out randomly to the regulated installations. Hence, the firms receiving free allowances might have had some other common features that affected the observed outcome. Nevertheless, the authors conclude that – unlike the independence property predicts – the initial allocation of allowances seemed to matter in the EU ETS between 1996 and 2012.

Colmer et al. (2020) only use data from French manufacturing firms. This is a rather narrow sample of the firms covered by the EU ETS. The authors also admit this caveat, stating that allowance allocations and market structure, for example, may differ across member states. Therefore, external validity is a strong assumption indeed. Despite this, Colmer et al. explore what their results would imply at the EU level and conclude in the abstract of the paper that "the EU ETS induced global emissions reductions."

The two papers reviewed above dig deeper into the scope of free allocation in the previous trading periods of the EU ETS to show that the number of allowances given out for free was too high. Moreover, the allocation of those free allowances was not optimal at least in the first two periods, and the same outcome could have been achieved with less cost. The studies by Martin et al. (2014a) and Colmer et al. (2020) confirm quantitatively the findings of the previous sections. However, the papers also provide a reason for optimism: Grandfathering has been replaced by benchmarking, the number of free allowances continues to decrease, and the European Commission is proposing the Carbon Border Adjustment Mechanism to fix the weaknesses of the ETS.

5 Discussion

Before I conclude, I want to reflect on the findings of this review and present some thoughts about them. More specifically, I compare the results to the proposition of Naegele and Zaklan (2019) discussed in Section 4.1.2, the model by Schmidt and Heitzig (2014) from Section 2.2, and the arguments of Bayer and Aklin (2020) from Section 4.1.1. But first, I consider the challenges that emerged when answering the research question.

The articles studying free allocation in the EU ETS often examine either a) whether there is evidence of carbon leakage or b) whether the emissions have declined in the installations located in the EU area. It is hard to find literature that would combine these two aspects in the same paper: If the emissions have declined, is it because of carbon leakage? Or, if there is no evidence of significant carbon leakage, is it because the regulated firms have not reduced emissions enough inside the EU borders? This means that it is not straightforward to find out the overall effect on *global* greenhouse gas emissions. In this thesis, I have tried to bring these two components together to shed light on the aggregate impact of free allocation in the EU ETS.

An additional challenge is the swiftness and dynamicity of climate policy. Climate policy is under continuous change. As opposed to other fields of policy, such as social welfare or culture, climate-related policy decisions rely on continuously improving understanding of Earth, its climate and ecosystems, and their complex interaction. Also, climate policy is a relatively young area of public policymaking (e.g., Huitema et al., 2011). All this implies that literature on climate policy always lags behind the real world, making it challenging to judge the current policy.

The findings of this review suggest that the EU ETS has reduced emissions compared to the world without the policy. Still, most studies do not find significant evidence of carbon leakage. The main reason for this seems to be free allocation of allowances, which has had remarkable distributional impacts among businesses but likely among households as well. Indeed, some firms have benefited from the policy, while for others it has meant additional costs. At the same time, free allocation has been too generous also from the perspective of climate. Net subsidies that the ETS has brought to many firms might be an indication of this. Moreover, many studies reviewed in this thesis observe that the independence property did not fully hold in the past phases of the EU ETS: the companies that received plenty of free allowances have reduced their emissions less. At least in the EU, this threatens the credibility of free allocation, even though it has been a powerful instrument to prevent carbon leakage.

Naegele and Zaklan (2019) argued that many ex-ante models of carbon leakage rely on unrealistic assumptions. I believe these models might guide the public discussion to the direction where the threat of carbon leakage is overestimated and those firms lobbying for free allocation are treated unnecessarily gently. Generous free allocation may have originated from lobbying, but also from an exaggerated concern of carbon leakage, which is partly a result of unrealistic ex-ante models.

Continuing to the next remark, a model by Schmidt and Heitzig (2014) captured the relocation decision of firms under an emissions trading system. The authors predicted that grandfathering can prevent relocation even after it has been phased out. They highlighted a gradual and predictable way of phasing out grandfathering, as well as the importance of future carbon prices, which need to be high enough. In the context of the EU ETS, grandfathering has not been the only method for free allocation, but the same reasoning can be applied. The pace of abandoning free allocation has been slow enough to give firms time to react and invest in low-carbon technologies. In addition, the system has remained credible despite the temporal oversupply of allowances. Firms have believed that the prices will eventually rise – and this is exactly what has happened. While the pace of phasing out free allocation in the EU has been even too slow, Schmidt and Heitzig's lock-in hypothesis may have applied, and the firms have stayed in the EU with their newly adopted technology.

Finally, the role of the system's credibility and firms' anticipation of future price increases was also what Bayer and Aklin (2020) stressed. I argue that one reason for success in managing firms' interpretation of future prices has been convincing communication. The EU has succeeded in maintaining the credibility of the ETS. When flaws have been spotted, the EU has reacted to them – as when the Market Stability Reserve and back-loading were introduced to counteract the oversupply of allowances. Throughout the years, the EU has articulated its commitment to gradually tighten the rules of the ETS and its climate policy overall, giving firms and citizens a reason to believe in future price rises. Thus, not only high carbon prices but also estimated high carbon prices in the future have urged firms and other economic actors to take action towards the ambitious climate targets of the EU.

6 Conclusion

This literature review has studied the effect of free allowance allocation in the EU ETS on greenhouse gas emissions. Evidence suggests that the ETS has led to emission reductions in the EU, and no significant carbon leakage has occurred. While free allowances have had an important role in preventing carbon leakage, they have also been a potential obstacle to further emission cuts. At least in the first two phases of the ETS, the number of free allowances could have been decreased without affecting the risk of relocation.

One implication of a generous free allocation has been that instead of being forced to pay for polluting, many firms have received a net subsidy from the ETS. Further, the emissions have been cut primarily in firms that have not benefited from free allocation, indicating that the outcome in the EU emission allowance market has not been independent of the initial allocation. This finding contradicts the independence property and raises a question about the economic efficiency of the EU ETS in its past phases. This conclusion, however, does not mean that the theory in general fails, because there are so many context-specific factors affecting the results. Lastly, the fact that some sectors have benefited from the system means that free allocation has had remarkable distributional impacts: some firms and taxpayers have paid the subsidies received by the other firms. This may erode the support for ambitious climate policy.

On the other hand, most articles focus on the earlier phases of the EU ETS. After Phase II, the rules for free allocation have changed, the number of free allowances has declined and the price for carbon has risen. From Phase III on, benchmarking has replaced grandfathering as a method for free allocation. These changes have substantially increased firms' incentives to adopt low-carbon technologies and reduce emissions. In the current phase of the ETS, the number of freely allocated allowances continues to decline annually, and the revised ETS Directive sets even stricter rules for free allocation. Thus, the results obtained by using data on earlier phases do not reflect the current situation. This gives a reason for optimism: Perhaps increased carbon prices and changes in free allocation imply that during the more recent years, the EU ETS has encouraged firms to abate emissions at a more rapid pace.

Future research is needed to investigate the impact of the EU ETS in recent years, and it should address the question of what has been the effect of introducing benchmarking as a method for free allocation in 2013. Theory predicts that, compared to grandfathering, benchmarking provides firms with additional incentives to cut emissions, but in the context of the EU ETS, empirical studies are few so far. In addition, further research is required to study the impact of the annually declining number of free allowances on carbon leakage and emissions. Has the EU managed to prevent relocation in Phases III and IV while phasing out free allocation? Finally, once there are enough data available, a topic for future research is how the Carbon Border Adjustment Mechanism will succeed in addressing the shortcomings of the ETS after 2026 – in case the mechanism will be implemented according to what the European Commission has proposed.

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