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Grandfathering, auctioning and Carbon Leakage: Assessing the inconsistencies of the new ETS Directive

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ABSTRACT

The new ETS Directive defines three different allocation rules, granting exemption from auctioning to those sectors exposed to the risk of Carbon Leakage. This article analyses the inconsistencies that characterize this new allocation rule and it concludes that the methodology designed to assess the risk of Carbon Leakage is more politically driven than economically grounded. The results of the Carbon Leakage risk assessment reveal that grandfathering is going to be the dominant allocation rule during the third phase also. However, not only the exemption from auctioning is unlikely to mitigate Carbon Leakage, instead of improving the allocation transparency and granting harmonization of higher rules but also the new ETS allocation rule is likely to increase the distortions of competition, worsening rather than improving the harmonization within the ETS.

1. Introduction

During the meeting held in Brussels on 8–9 March 2007, the European Council has declared its intention to strengthen the European climate policy beyond Kyoto. On 23 January 2008, the European Commission (EC) published a package of proposals (the so-called Climate Package) where it expressed its firm intention to cut unilaterally the European emissions by 20% below 1990 levels by 2020, in case no international post-Kyoto treaty would have been signed.[1] Moreover, the Climate Package contained a proposal for a new Directive (COM (2008a, 2008b, 2008c) 16 final) to amend the current greenhouse gas emissions trading system (EU ETS) Directive (Directive 2003/87/EC), which has been officially approved on December 2008, and finally adopted on April 2009.

The new ETS Directive is aimed at improving the functioning and effectiveness of the ETS in promoting emission reductions. Indeed, according to the EC itself "the overall functioning of the Emissions Trading Scheme could be improved in a number of aspects" (COM (2008a, 2008b, 2008c) 16 final: 2). The ETS has been criticized for failing to give effective incentives to reduce emissions, for generating undesirable distributive effects and for distorting competition applying non-harmonized rules among the ETS sectors (e.g. Johnston, 2006; Kettner et al., 2007; Neuhoff et al., 2006).

The new ETS Directive 2009/29/EC first extends the EU ETS to a third post-Kyoto trading period (2013–2020). Most importantly, it reforms the two variables upon which both the effectiveness of the ETS and its impact on the cost of the regulated sectors depends on: (1) the ETS cap level, which indicates how many emissions the ETS sectors can produce and (2) the allocation rule, which establishes how the initial amount of allowances is distributed among the ETS installations.

On the side of the *ETS cap level*, during the first pilot trading period (2005–2008) the ETS sectors' emissions have not been sufficiently capped. The lack of permits' scarcity caused the CO_2 price to fall to zero, failing to give any significant incentive to reduce emissions. The emission reduction burden imposed on the ETS sectors was too weak; indirectly, the amount of emissions the non-trading sectors should have abated to grant compliance with the Kyoto target was excessive when compared to their abatement potentialities and marginal abatement costs (Clò, 2009).

Given these former inefficiencies and in the light of the European unilateral commitment to a stricter emission reduction target, the new ETS Directive imposes for the third trading period a progressively stricter cap, making the ETS regulation each year costlier.[2]

Abbreviations: CO2, carbon dioxide; ETS, Emissions Trading Scheme; EC, European Commission; EU, European Union; GHG, greenhouse gas; MS, Member States; NAP, National Allocation Plan

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[1] The EC also declared its willingness to reduce the Community greenhouse gas emissions by 30% below 2005 levels by 2020 in case of achievement of an international "post-Kyoto" treaty that would commit the non-EU developed countries to reduce their emissions and the other economically more advanced developing countries to contribute to global warming mitigation according to their responsibilities and respective capabilities.

[2] According to the result of the EC modelling analysis, the EC has set a EU-wide cap that from 2012 will be annually reduced by 1.74% to reach in 2020 the level of 1720 Mt CO_2 (Directive 2009/29/EC, art. 9).

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On the side of the *allocation rule*, grandfathering has been criticized: the fact that electricity generators could earn windfall profits by passing through to the final price the market value of the allowances they initially received for free raised many concerns on a redistributive ground, since consumers paid for what producers received for free (Woerdman et al., 2008).

The EC increasingly supported the idea that a progressive abandon of grandfathering in favour of auctioning as default allocation rule for the third trading period would have solved the redistributive concerns, minimizing any market distortion through a wide harmonization of the allocation rule among MS and ETS sectors (e.g. SEC (2008) 52; Hepburn et al., 2006).

However, auctioning entails higher private costs for the regulated sectors, which are called both to reduce a higher amount of emissions and to buy the initial amount of allowances in an auction.

Against a stricter and costlier regulation, the ETS sectors used the "Carbon Leakage" card. Industrial lobbies claimed that the unilateral and stricter European climate policy would have imposed to high costs, worsening their market position against international competitors and forcing them either to shut down their plants or to delocalize their production activity, re-addressing their investments toward non-EU countries where stringent and costly regulations are not in place.

The conclusion is straightforward: being production based (rather than consumption based), the stricter emissions reduction target (-20%) can be achieved just by outsourcing emissions through a switch of the European production activity outside Europe (Helm, 2009). And such risk cannot be neglected: a unilateral European climate policy imposing substantial asymmetric costs on the European economic agents could be both detrimental for the European economic growth and ineffective for the environment—emissions, which would decrease in Europe, while proportionally increasing in the rest of the world.

This is where troubles begin. How to approve in a short time a credible climate policy, while at the same time ensuring political acceptability and reducing the risk of Carbon Leakage?

Renegotiating the emission reduction target was not a political option, thus the EC proposed a political compromise: to mitigate the cost impact of the ETS granting free allocation instead of auctioning to all the ETS sectors that would have been found subjected to the risk of Carbon Leakage.

In spite of the political nature of the compromise, an economic issue concerns how to determine which ETS sectors should be retained effectively exposed to the risk of Carbon Leakage and which not. The new ETS Directive includes a methodology tailored to answer to this last question.

This article has been developed within this context: first it analyses the methodology defined in the new ETS Directive to assess the risk of Carbon Leakage and then it discusses the results of the Carbon Leakage risk assessment performed by the European Commission. In particular, the aim of this article is to assess whether both the Carbon Leakage risk assessment methodology adopted in Europe and the related quantitative results can be considered economically grounded, or rather politically driven.

The general purpose of this analysis is to assess whether the new ETS Directive and the new allocation rule in particular, will improve the ETS functioning, avoiding undesirable distributive effects and granting harmonization of higher rules aimed at minimizing distortion of competition.

This article is structured into six sections. Section 2 focuses on the ETS allocation criteria. First, it shortly introduces the first allocation rule adopted in the ETS, recalling the argumentations supporting a switch from grandfathering toward auctioning. Then, it describes the new allocation rule defined by the NEW ETS Directive to be applied during the ETS third trading period.

While Section 3 introduces the phenomenon of Carbon Leakage, Section 4 describes and analyses the EC guidelines reported in the first proposal for a new ETS Directive aimed at assessing and measuring it.

Section 5 constitutes the core of this article: the final methodology adopted in the new ETS Directive to assess which ETS sectors should be considered exposed to the risk of Carbon Leakage is analysed and the results of the EC quantitative assessment are presented and discussed. Particular attention is devoted to the discussion of both the criteria and the level of data aggregation adopted to assess the risk of Carbon Leakage in order to highlight both when the defined procedures have a solid economic background and when they can be retained mainly political or extra-economically. Section 6 provides the conclusion.

2. ETS allocation rules: from grandfathering to (partial) auctioning

According to Article 10 of the first ETS Directive, during the first and second trading periods, at least 95% and 90% of permits have been assigned free of charge (grandfathering), respectively. Since auctioning entails higher private costs than grandfathering, the adoption of grandfathering has increased the ETS political acceptability in the eyes of the ETS regulated sectors.

However, after the first ETS pilot trading period has been launched, grandfathering has been criticized on different grounds. First, it has been blamed of causing undesired redistributive effects: many electricity generators could earn windfall profits by passing through to the final electricity price the market value of the allowances they initially received for free. The general criticism regarded the unfairness of inducing consumers to pay for what producers received for free. Moreover, it has been argued that grandfathering has been applied non-homogeneously among Member States, limiting the internal harmonization within the ETS and causing additional undesired redistributive effects. The lack of a level playing field for ETS operators distorted competition in the European market under Articles 81 and 82 of the EC Treaty (e.g. Johnston, 2006; Weishaar, 2007).

Grandfathering has been criticized also on an efficiency ground by arguing that it is equivalent to a government subsidy that creates an artificial, and undesirable, incentive for existing market participants not to exit the industry and to keep operating older and less efficient plants[3] (Nash, 2000).

Contrary to this view, which finds grandfathering inefficient *per se*, it has been argued that, once the opportunity costs of freely assigned allowances are properly taken into account, both grandfathering and auctioning are equally efficient in inducing emission reductions, while continuing to have different redistributive effects (Woerdman et al., 2008). Once a market for tradable permits where parties can freely bargain their allowances at zero transaction costs is in place, an efficient outcome is granted independently on how allowances are initially assigned. Moreover, passing the opportunity costs of the grandfathered permits to the final market price is economically correct.

[3] Moreover, different authors have argued that the way grandfathering has been implemented in the ETS created some inefficiencies (e.g. Cramton and Kerr, 2002; Demailly and Quirion, 2006). In particular, the decision to update to recent emissions the baseline adopted to grandfather allowances to the existing ETS installations created an early action problem with the risk of both postponing emissions abatement and giving a distortive incentive to keep operating polluting and less efficient plants: "*if future allowances are allocated as a function of present emission levels, firms have incentive to emit more now in order to extract a larger allocation in the future* (…); *incentives are created for plant lifetime extension rather than plant modernization or replacement*". (Hepburn et al., 2006: 142–143).

In fact, grandfathered permits can be used to cover the amount of emissions resulting from the production activity, or in case of emissions reduction, they can be sold in the ETS at the market price. When the first option is chosen, the opportunity cost of the grandfathered allowances is given by the foregone profit the firm could have earned by reducing emissions and selling the surplus of permits at the market price. Given these two alternatives uses of grandfathered permits, the ETS installations will continue to produce and to cover their emissions with the freely assigned allowances only if this option is a first best. In other words, ETS installations have to be sure that when producing and using their allowances to cover their emissions they can gain a profit which is at least as big as the one they could earn by reducing emissions (or decreasing production) and selling the exceeding amount of allowances received at no cost. This alternative use of tradable permits explains why it is correct that firms internalize the market price of freely assigned allowances into their marginal production costs, passing it into final prices. Internalizing the cost of the emission externality into the price is not only correct but also effective; as the price increases, polluting products become costlier and less attractive, whereas market competition should ensure a progressive switch toward cleaner and less expensive products and technologies.

While having the same effects in terms of market outcome, the real difference between auctioning and grandfathering is redistributive: who pays whom. The former solution implies a money transfer from the regulated sectors to the governments. In the latter solution, the ETS installations keep it. Clearly, while private companies have a preference for grandfathering, governments intented to switch toward auctioning as default allocation rule for the third ETS trading period.

The EC stressed that the role of the allocation rule is to ensure environmental effectiveness, economic efficiency, avoid any distortion of competition and undesirable distributive effects (SEC (2008) 52), concluding that only auctioning satisfies these conditions: "full auctioning of allowances scores best in increasing the efficiency of the system and taking away undesirable distributional effects" (SEC (2008) 52, 163), as it is "the only option that entirely solves efficiency problems" (SEC (2008) 52, 106), while on the other hand "the availability of free allowances reduces the financial necessity for undertakings to reduce emissions" (SEC (2008) 52, 92).

The EC position can be criticized according to the EC argumentations. However, the aim of this article is not so much to compare grandfathering and auctioning both on efficiency and equity grounds (for this topic see Woerdman et al., 2008), but mainly to verify whether the new allocation rule will really satisfy the conditions of environmental effectiveness, redistributive fairness and avoidance of competition distortion. This is crucial to assess whether the new allocation rule will effectively bring any improvement to the ETS in respect to its previous allocation rule.

For this purpose, this article focuses on the new allocation rule, analysing both the way it is going to be applied and the potential inefficiencies it could arise in the post-Kyoto trading period.

The next section describes the allocation rule adopted for the third trading period in the light of the risk of Carbon Leakage. The next sections analyse the methodology defined in the new ETS Directive to assess the risk of Carbon Leakage, discussing the results of the Carbon Leakage risk assessment performed by the European Commission.

2.1. The new allocation rule for the third ETS trading period

The EC expressed a clear intention to progressively abandon grandfathering in favour of auctioning as new ETS default allocation rule. However, at the time of approving the new ETS Directive it became clear that the new allocation rule for the third ETS trading period would have been different from *full auctioning*. Instead, three different allocation rules, which vary from full auctioning to full grandfathering, are going to be applied to three different types of sectors.

The new ETS Directive states that from 2013 onwards no free allocation will be given to energy installations. [4] This first allocation rule can be effectively considered *full auctioning*.

On the other hand, energy intensive manufacturing installations will face a progressive transition from grandfathering to auctioning. In 2013, they are going to receive 80% of the amount allowances to be assigned free of charge.[5] The initial proposal for a new ETS Directive published on January 2008 stated that the 80% of free allocation would have progressively decreased toward zero in 2020, while the new ETS Directive finally approved in December 2008 states that the same initial percentage of free assigned allowances (80%) will decrease by an equal amount each year, arriving at 30% free allocation in 2020 and reaching *full auctioning* only in 2027. This second measure is here defined as *mixed auctioning*, since it combines both grandfathering and auctioning. This slow and progressive adoption of auctioning has not been supported by any economic consideration; rather, it looks like a political compromise aimed at increasing the political acceptability of the ETS in the eyes of the regulated sectors.

Finally, those sectors found to be exposed to the risk of Carbon Leakage are exempted from initially acquiring permits in a auction, since they are entitled to receive for free allowances. We define this third and last measure as a *pure grandfathering* allocation rule. However, different from the previous ETS trading periods where allowances were grandfathered proportionally to historical emissions, during the third ETS trading period the ETS sectors exposed to Carbon Leakage receive free allowances according to a benchmark which is yet to be determined and which may be decremented along with the cap. Assigning free allowances according to a performance benchmark, rather than according to historical emissions, implies that only the most efficient plants are going to receive for free the amount of allowances they need, while more efficient plants will have to acquire some allowances from the auction or in the European exchanges Fig. 1.

The next section focuses on Carbon Leakage. After defining what it is meant with Carbon Leakage, the methodology to assess the ETS sectors' exposure to Carbon Leakage is analysed and the results of the EC quantitative assessment are going to be presented and discussed.

[4] With the exception of co-generation plants that can receive an amount of free permits proportional to the heat delivered to district heating or industrial installations and to certain electricity plants located in the EU Eastern MS that respects particular conditions are reported in the points 9 and 10 of the art. 10a of the new ETS Directive. Moreover, the amendment to art. 10a of the first ETS Directive states that full auctioning should be the allocation rule for the electricity generators, for the capture, pipelines for the transport or to storage sites for carbon dioxide, while "electricity generators may receive free allowances for district heating and cooling and for heat and cooling produced through high efficiency cogeneration as defined by Directive 2004/8/EC in the event that such heat produced by installations in other sectors were to be given free allocations, in order to avoid distortions of competition" (2008/0013 (COD), 12). Moreover, the new ETS Directive grants derogate from full auctioning to some electricity generators located in certain East European MS (art. 10a, point 9. 10. 2008/0013 (COD)).

[5] The new ETS Directive specifies that grandfathering would correspond to 80% of the "amount that corresponded to the percentage of the overall Community-wide emissions throughout the period 2005 to 2007 that those installations emitted as a proportion of the annual Community-wide total quantity of allowances" (2008/0013 (COD), 12).

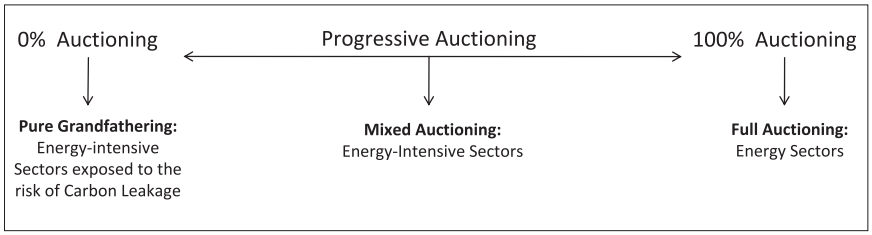

Fig. 1. 3° ETS trading period allocation rule.
Source: own elaboration.

3. Carbon Leakage: causes and preventing measures

After the CO_2 emissions have been priced, energy intensive installations face a cost increase. The ability to include this increased cost on the final price depends, among other things, on the sector exposure to international competition. Different from the energy sector, which is structurally neutralized against international competition,[6] manufacturing sectors are more exposed to it, thus facing a limited possibility to pass-through their increased costs on the final product price without incurring in a significant loss of market share against non-EU installations, which are not subjected to the same costly environmental regulation. Thus, as the European climate policy has imposed an unilateral cost to the European firms extra-EU products become relatively less expensive and more convenient. Foreign goods' substitutability for domestic production increases and it might cause imports to growth and internal production to decrease.

The European industrial lobbies claimed that an European climate policy imposing a stricter cap and switching from grandfathering to auctioning would have further worsened their competitiveness against international competitors, forcing them either to delocalize their production activity or to re-address their investment strategies toward non-EU countries where stringent and costly climate regulations are not in place. In the worst case scenario European installations might also be forced to shut down their plants with their production being replaced by the importation of cheaper extra-EU products.

Such a risk raises mainly from the fact that the European climate policy is unilateral (there are no symmetric climate policy outside Europe) and production based, rather than consumption based; the ETS regulates the emissions linked to the production of a good (production emissions), rather than the emissions linked to the final consumption of that good (product emissions). Being production based, the ETS installations can comply with the European regulation, just by switching the European production activity outside Europe.

This is to say that the main effect of a unilateral and costly European climate policy could be to outsource production and emissions outside Europe, with a detrimental effects on the European economic growth. If this case was true, a unilateral European climate policy imposing substantial asymmetric costs on the European regulated agents would not only be economically inefficient, but also environmentally ineffective. If part of the European production would be outsourced or replaced by extra-EU competitors: emissions would decrease in Europe but increase in the rest of the world.[7]

Of course, as imports from extra EU countries has increasingly replaced European production during the last decades, it is possible to deduce that, to a certain extent, Carbon Leakage has already taken place. On top of that, a stricter climate policy risks to worsen this delocalization trend.

In the light of the political will of moving beyond Kyoto before Copenhagen, 2009, The European Commission had to solve a conundrum: how to approve in a short time a credible climate policy, while at the same time ensuring political acceptability and reducing the risk of Carbon Leakage.

Renegotiating the emissions reduction target was not a political option, the EC proposed a political compromise: mitigate the cost impact of the ETS by granting free allocation according to a benchmark instead of auctioning to all the ETS sectors found to be subjected to the risk of Carbon Leakage.

In the eyes of the industrial lobbies grandfathering means lower financial expenditures, while in the eyes of the EC it means political acceptability of the new European Climate Package and reduction of the Carbon Leakage risk: "in the absence of international agreement on climate change policy, some allocation of allowances for free could be an efficient instrument to avoid net carbon leakage" (SEC (2008) 52, 163).

However, this statement is not necessarily true. Given the asymmetric and unilateral nature of the European climate policy, the risk of Carbon Leakage will persist, also because the ETS binding cap approved with the Climate Package is anyhow imposing an asymmetric costly emissions' reduction burden on the European industrial sectors.

Moreover, considering the opportunity costs associated with free allocation, one could also question whether the total exemption from auctioning would provide any real protection against leakage. The role of opportunity cost is critical to any Carbon Leakage risk assessment under grandfathering. Freely assigned allowances have an opportunity cost that installations have to take into account when deciding whether it is more convenient to produce in Europe, and use the grandfathered permits to cover the related emissions rather than delocalizing production and sell the exceeding amount of allowances at the market price. In spite of free allocation, the ETS installations could still find convenient to delocalize their plants outside Europe and selling within the ETS the total amount of allowances they have received for free.

Therefore, it is not given that the adoption of grandfathering instead of auctioning will mitigate the risk of Carbon Leakage. This decision looks more politically driven than economically grounded.

On the other hand, the risk of Carbon Leakage may be over-estimated. As previously argued, other factors that the carbon price influences are the industrial investment strategies and

[6] Electricity can be traded only if a grid infrastructure is in place and, even in this case, electricity can be transmitted only to a limited extent, as far as the grid is not congestioned and bottlenecks are avoided.

[7] As stated by professor Helm: "the extent that energy-intensive industrial production is shifting globally from developed to developing countries (which it is), the 20% target can be achieved without reducing carbon concentrations globally by the implied amount. Indeed, if the production techniques in developing countries are less carbon-efficient than in developing countries, and if we add the emissions from shipping, aviation, and other transport, it could even increase emissions" (Helm, 2009: 6).

production location. Therefore, other economic and political factors (for instance, political stability) still constitute valid reasons for keeping plants in Europe or for locating new plants in Europe even after the establishment of a costly environmental regulation. This is to say, again, that the risk of Carbon Leakage is probably affecting only a part of the ETS installations.

Thus, it becomes crucial to determine a clear methodology to assess which ETS sectors should be retained effectively exposed to the risk of Carbon Leakage and which not. The following sections analyse whether the final methodology adopted to assess which sectors should be considered exposed to the risk of Carbon Leakage has whether solid economic background, or it is mainly politically driven.

4. EC guidelines for Carbon Leakage risk assessment

The first proposal for the new ETS Directive published in the beginning of 2008 defined and introduced some general guidelines to analyse the ETS sectors' exposure to Carbon Leakage. However, the Directive abstained from specifying under which conditions (measures, thresholds) a sector could be effectively considered exposed to Carbon Leakage and thus exempted from auctioning (SEC (2008) 52).

The first EC proposal for a new ETS Directive states that the risk of Carbon Leakage depends on the sectors' *net cost increase*: the part of cost increase caused by the ETS that the regulated installations cannot pass-through to the final product price without loosing a significant share of the market (against non-EU installations). The EC guidelines specify a two-step analysis aimed at estimating the sectors' *net cost increase* based on both carbon and trade intensities.

4.1. Carbon intensity and cost increase assessment

Assessing to which extent the ETS is likely to increase the costs of the regulated sectors constitutes the first step to estimate the industrial sectors' *net cost increase.*

After the CO_2 emissions have been priced within the ETS, energy intensive installations have to afford direct costs and indirect costs, and both of them have to be taken into consideration. First, the ETS installations are required either to reduce their emissions or to cover their emission gaps by acquiring a corresponding amount of permits in the ETS. These **direct costs** are proportional to the CO_2 price (which is likely to increase as the ETS cap is going to be reduced) and to the installations' **direct emissions**, which mainly depends on the fuel mix, on the technology efficiency, on the amount of self-produced electricity and on the industrial process emissions. The installations' **emission intensity** (tons of CO_2 emissions per ton of production) is a good proxy for the direct emissions from the industrial production process. Moreover, after the establishment of the ETS, energy intensive installations have to pay a higher price for the electricity, which is increased by the market value of the allowances passed through by the energy generators (e.g. Sijm et al. 2006). These **indirect costs** are proportional to the marginal increase of the electricity price and to the industrial process' **indirect emissions,** which mainly depend on the consumption of electricity and on the fuel mix used to generate the purchased electricity. The installations' **electricity intensity** (MWh per ton of production) is a good proxy of the indirect emissions from electricity consumption.

It is worth to notice that indirect emissions are not related only to electricity consumption, but to all the phases composing the product life-cycle: from the raw material extraction and transportation to the final product distribution and final disposal. In principle, it would be more appropriate to count for the product life-cycle direct and indirect emissions, while the EC guidelines take into account only the indirect emissions from the consumption of electricity in the production process. This is because, as previously recalled, the European climate policy is mainly production based (rather than consumption based), regulating only the emissions from production (which can be easily monitored), while not taking into account the whole product life-cycle and the whole product emissions linked to consumption (Table 1).

4.2. Trade intensity and exposure to competition assessment

Assessing the cost increase caused by the ETS is not sufficient to determine the risk of Carbon Leakage. Sectors that are not exposed to international competition can add the increased cost to the final market price without loosing market share, being neutralized against Carbon Leakage.

Thus, it becomes necessary to assess to which extent the effective exposure to international competition impedes the ETS installations to pass-through the increased cost to the final product price without any substantial loss of market share. First, a definition of the relevant market and, second, the assessment of the elasticity of the relevant market demand to marginal changes in prices would be required to measure appropriately the pass-through possibility. Alternatively, the Carbon Leakage can be estimated by means of numerical general equilibrium models (e.g. the GEM-E3); some of them have been already financed by the EC, raising the question why they have not been taken into consideration to assess Carbon leakage. Given the time constraints imposed by the political agenda, the EC designed a simplified methodology to assess the exposure of the European sectors to non-EU competition based on the import and export trade flows. The EC guidelines propose to measure the ETS sectors' exposure to international competition according to two different indicators: the *import penetration ratio* given by the ratio between the monetary value of the European import and production, and the *export ratio,* given by the ratio between the monetary value of European export over European production Table 2.

Table 2
Determinants of Carbon Leakage.
Source: own elaboration.

	Low carbon intensity	High carbon intensity
Low trade intensity	I—no risk of CL	II—low risk of CL
High trade intensity	III—low risk of CL	IV—high risk of CL

Table 1
Determinants of sectors carbon intensity.
Source: own elaboration.

	Low electricity intensity	High electricity intensity
Low emissions intensity	Agriculture (non-ETS)	Aluminium, electric arc furnace
High emissions intensity	Lime, clinker	Pulp and paper

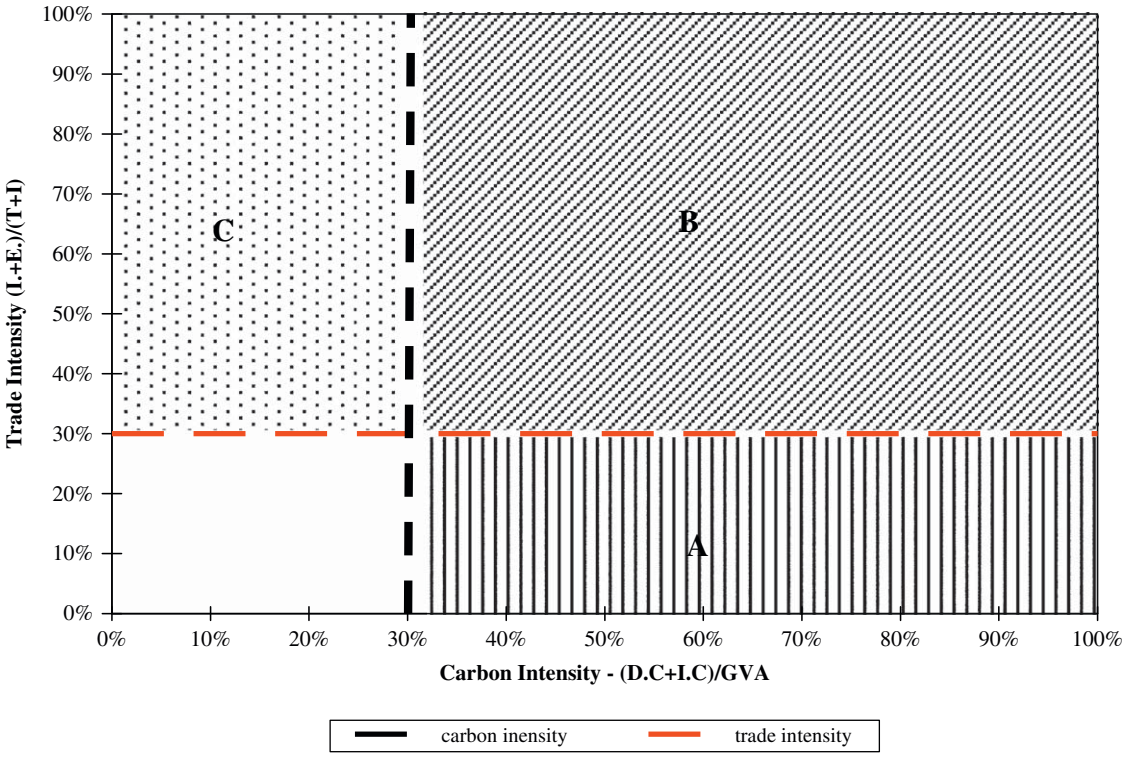

Fig. 2. Exposure to Carbon Leakage according to the "Separated Approach".
Source: own elaboration on new ETS Directive.

5. Carbon Leakage: approved methodology for risk assessment

The new ETS Directive, approved in December 2008, established the final methodology to assess which sectors could be considered exposed to the risk of Carbon Leakage. Different from the previous guidelines, this methodology identifies two different and alternative approaches to measure quantitatively the risk of Carbon Leakage.

The first approach considers an ETS sector to be exposed to Carbon Leakage if the ETS would cause a marginal increase in its direct and indirect costs higher than 30% of its Gross Value Added (carbon intensity) ***or*** if the value of its exports and imports divided by the total value of its turnover and imports would exceed 30% (trade intensity). According to this criterion, the ETS sectors are considered exposed to Carbon Leakage when they satisfy only one among the two carbon and trade intensity condition; therefore, it is here defined as "*separated approach*" and it grants exemption from auctioning to all the sectors falling in one of the three areas A, B or C of Fig. 2.

Second, a sector is fully exempted from auctioning if its carbon intensity (sum of direct and indirect cost divided by the gross value added) exceeds 5% ***and*** if its trade exposure (value of its exports and imports divided by the total value of its turnover and imports) exceeds 10%. This second criterion is here defined "*integrated approach*" since exemption from auctioning occurs only if both the carbon-trade intensity conditions are satisfied simultaneously. The *integrated approach* grants exemption only to the sectors falling in the area D of Fig. 3.

The EC has been charged of establishing according to at least one of the two (separated and integrated) approaches on which sectors should be exposed to the risk of Carbon Leakage.

Moreover, the new ETS Directive established that the list of sectors found to be exposed to Carbon Leakage according to the quantitative assessment could be supplemented after completion of a qualitative analysis focused on both the sectors' technological potential to reduce either emissions or electricity consumption and on the sectors' current and projected market characteristics.

5.1. Analysis of the Carbon Leakage risk assessment results

On 29 April 2009, the EC officially published the list of industrial sectors found to be exposed to the risk of Carbon Leakage. These preliminary results refer to 257 industrial sub-sectors analysed by the European Commission at a NACE 4 digit level of disaggregation.[8]

The NACE 4 sub-sectors' carbon intensity has been estimated on the basis of historical emissions registered in the Community International Transaction Log (CITL) and, when it was required, with information provided by Member States and by the industrial association themselves.[9]

The ETS NACE-4 sectors' direct costs increase has been estimated assuming that all the emissions would have been covered acquiring permits at a price of 30 €/ton. Indirect costs have been estimated multiplying the amount of electricity consumed by the marginal increase of electricity price under the assumption that the 30 €/ton price is fully passed through into

[8] NACE is the statistical classification of economic activities in the European Community. The number of digit of the code specifies the level of classification system and the level of sector integration.

[9] The emissions produced by those sectors and plants that are going to participate in the ETS only from the third trading period (2013–2020) are not reported in the CITL; thus they have been prevalently estimated applying to the fuel mix combustion level the related emissions factors and summing up the industrial process emissions weighted by the historical level of production.

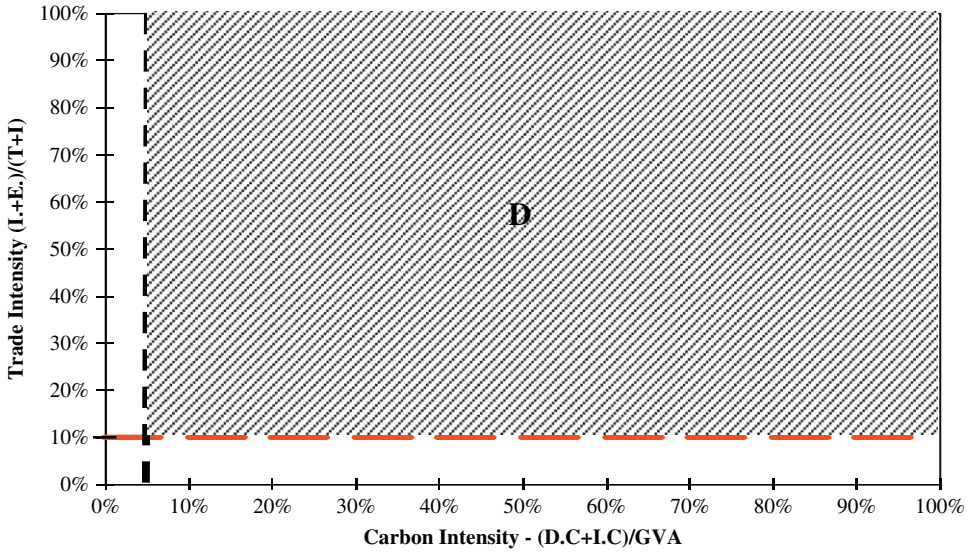

Fig. 3. Exposure to Carbon Leakage according to the "Integrated Approach".
Source: own elaboration on new ETS Directive.

electricity prices (e.g. Reinaud, 2007; Reinaud, 2008; EC DG Environment et al., 2006).[10]

Out of the 257 NACE 4 examined sectors, 98 sectors did not result to be exposed to the risk of Carbon Leakage, 19 sectors have not been examined because of the lack of official and reliable data, while 140 sectors (56%) have been found exposed to the risk of Carbon Leakage.

In particular, out of these 140 NACE-4 sectors exempted from auctioning, three sectors comply only with the requirements imposed by the integrated approach ($5\% < CI < 30\%$ ***and*** $10\% < TI < 30\%$), other three sectors have been considered exposed to Carbon Leakage according to the separated approach because of their high Carbon Intensity ($CI > 30\%$ and $TI < 10\%$), while 134 sectors (98% of the exempted sectors) have been found exposed to Carbon Leakage according to the separated approach because of their high trade exposure ($TI > 30\%$). As shown in Table 3, the majority of these 134 sectors are not carbon intensive at all: 83 over the 134 sectors would face a (direct + indirect) cost increase lower than 1% of their Added Value; 92 sectors would face a cost increase lower than 1.5% of their Added Value. Only 39 exempted sectors would face a cost increase between 1.5% and 5% of their Added Value, while the last three sectors would face a cost increase higher than 5%, thus resulting to be exposed to Carbon Leakage according to both the integrated and separated approaches.

In other words, if the *integrated approach* was the only criterion adopted to assess quantitatively the ETS sectors' exposure to Carbon Leakage, just six out of the 140 NACE-4 exempted sectors would have been found exposed to the risk of Carbon Leakage: just six sectors out of the 257 analysed sectors would have been entitled of receiving free allowances, and auctioning would have been the dominant allocation rule. However, 134 more sectors have been found exposed to Carbon Leakage according to the *separated approach*.

Given the huge amount of sectors exempted from auctioning, the central role of this allocation rule during the third phase needs to be questioned. To answer to this issue, we assume that the amount of allowances that will be either assigned free of charge or auctioned during the ETS third trading period will be proportional to the percentage of emissions produced by the ETS manufacturing sectors, which have been found exposed (and not exposed) to Carbon Leakage.

Table 3
Results of the Carbon Leakage quantitative assessment.
Source: data elaboration based on European Commission, 2009

	Number of sectors
Not evaluated sectors	**19**
Sectors not exposed to Carbon Leakage	**98**
Sectors exposed to Carbon Leakage	**140**
$CI > 5\%$ and $10\% < TI < 30\%$ (integrated approach)	3
$CI > 30\%$ and $TI < 10\%$(separated approach)	3
$TI > 30\%$ (separated approach)	134
$TI > 30\%$ and $CI < 1\%$	*83*
$TI > 30\%$ and $1\% < CI < 1.5\%$	*9*
$TI > 30\%$ and $1.5\% < CI < 5\%$	*39*
$TI > 30\%$ and $CI > 5\%$ (both separated and integrated approaches)	*3*

Unfortunately, assessing how many emissions have been historically produced by the ETS sectors exposed and not exposed to Carbon Leakage is puzzling. In fact, while the Carbon Leakage has been assessed quantitatively at a NACE 4 level, the emission data are collected at an installation level and then aggregated in the CITL registry in 9 different categories which do not correspond to the NACE code classification (Table 4).

These different data aggregation criteria create some problems. First, the combustion installations' emission data reported in the CITL (Table 4, category 1) aggregate emissions produced by all the installations with a thermal capacity higher than 20 MW which belong to many sectors. Thus, it is not possible to assess which percentage of emissions produced by the combustion installations can be brought back to the sectors exposed to Carbon Leakage. Even if we separate the emissions produced by the energy sector,[11] which is required to acquire permits in a auction, from the emissions produced by all the other manufacturing

[10] "Reinaud assumes that electricity pricing would lead to a full pass-through of the carbon opportunity cost in power prices. A EUR20 per tonne of CO_2 would result in a 21% price increase in Continental Europe (or an increase of EUR10/MWh). McKinsey and Ecofys, (2006) follow the same methodology and also estimate that a EUR20/t CO_2 price will increase in electricity prices by EUR10/MWh" (Reinaud, 2008)

[11] We can subtract from the combustion installations' aggregated emission data the amount of emissions produced by the Public Electricity and Heat Production fuel combustion activities, which are registered in the European Environment Agency GHG inventory reports.

Table 4
ETS verified emissions per sector t CO2 eq—EU 25.
Source: CITL.

	2005	2006	2007	2008
1. Combustion installations	1.458.440.788	1.469.722.527	1.482.556.567	1.434.380.809
2. Mineral oil refineries	150.018.675	148.543.346	148.440.503	147.831.560
3. Coke ovens	19.193.122	21.301.035	22.073.888	20.984.289
4. Metal ore roasting or sintering	12.638.622	14.048.755	14.610.022	9.646.738
5. Pig iron or steel	129.292.592	132.899.646	132.240.627	132.897.010
6. Cement clinker or lime	177.537.990	182.078.934	190.653.632	177.543.699
7. Glass including glass fibre	20.113.068	20.027.365	19.953.995	21.164.105
8. Ceramic products by firing	14.732.205	14.884.435	14.275.761	12.655.292
9. Pulp, paper and board	29.905.467	30.001.704	28.964.649	30.718.015
10. Other activity opted-in	2.143.082	2.142.936	2.180.743	1.478.693
Total	2.014.015.611	2.035.650.683	2.055.950.387	1.989.300.210

Table 5
EU 25 GHG emissions from combustion installations (t CO_2 eq).
Source: CITL and EEA 2009.

	2005	2006	2007
Combustion installations	1.458.440.788	1.469.722.527	1.482.556.567
Energy sector (public electricity and heat prod.)	1.171.588.399,50	1.177.863.590,91	1.191.771.838,14
Manufacturing sectors	286.852.389	291.858.936	290.784.729

installations with a total rated thermal input exceeding 20 MW, we cannot assess how many emissions have been produced by those sectors exposed to Carbon Leakage. In fact, the *combustion installations*' *emission data* belong to different NACE 4 sectors and cannot be easily disaggregated among different sectors. Thus, estimating how many allowances will be allocated for free to the combustion installations is not possible Table 5.

In second place, many NACE-3 macro-sectors corresponding to the CITL categories (Table 4: category 7. glass, category 8. ceramic, category 9. pulp and paper) are composed by some NACE-4 sub-sectors that have been exempted from auctioning and other NACE 4 sub-sectors that have not. However, since the emissions data are collected at an installation level and aggregated at a sector level without giving any NACE 4 specification, within a NACE-3 macrosector it is not possible to separate the emissions produced by the NACE 4 sectors exempted from auctioning from the emissions produced by the NACE 4 sectors that have not been exempted.

The difficulties that emerge when trying to estimate how many emissions have been historically produced by the sectors exempted from auctioning raises a problem of data aggregation, which is going to be discussed and analysed in more detail in Section 5.3.

Given these constraints, if we limit to select only the CITL categories that entirely participated in the ETS during the past trading periods and whose NACE 4 sub-sectors have been entirely exempted from auctioning (category 2. Oil refineries, category 3. coke ovens, category 5. iron and steel, category 6. cement, clinker or lime), it is possible to conclude that at least 57% of the permits to be allocated to the industrial manufacturing sectors will be assigned free of charge.

This is a precautionary under-estimation of the role of grandfathering during the third trading period, since it takes into account neither the sectors that present only some NACE 4 sub-sectors exposed to Carbon Leakage (and thus entitled of receiving free permits) nor the fact that even the sectors not exposed to Carbon Leakage will receive anyway a progressively decreasing percentage of free permits (80% in 2013 and 30% in 2020).

However, these considerations are sufficient to conclude that during the third trading period auctioning is going to be the default allocation rule only for the energy sector. On the contrary, free assignment of permits will remain the dominant allocation rule for the ETS manufacturing sectors, as the industrial lobbies desired (Table 6).

Table 6
Emissions from sectors exempted and not exempted from auctioning.
Source: own elaboration based on European Commission, 2009.

ETS manufacturing sectors	(ton CO_2 eq.)	(%)
ETS manufacturing sectors		
Exempted from auctioning	476.042.379	57%
Partially exempted	366.384.833	43%
Total	842.427.212	100%

5.2. Analysis of the Carbon Leakage risk assessment methodology

The methodology defined to assess Carbon Leakage is based on two alternative approaches that differ substantially. The *integrated approach* takes simultaneously into account both the carbon and trade intensities, and both the cost increase and the possibility to pass-through this increased cost to the product price, which depends on the sector's exposure to international competition. Each of these conditions is necessary but not sufficient for a sector to be considered exposed to Carbon Leakage; the intersection of both the carbon intensity and trade intensity criteria identifies the areas of exemption from auctioning A1, B, C1 and D of Fig. 4.

On the contrary, according to the *separated approach* Carbon Leakage is assessed either on a "cost increase" basis or on a "trade exposure" basis. Above the 30% carbon intensity threshold a sector is automatically exempted from auctioning independently on both its effective exposure to international competition and on its pass-through possibility (areas A1, A2, B of Fig. 4). Similarly, above the 30% trade intensity threshold a sector is exempted from auctioning independently on the impact of the ETS on the production costs (areas B, C1, C2 of Fig. 4).

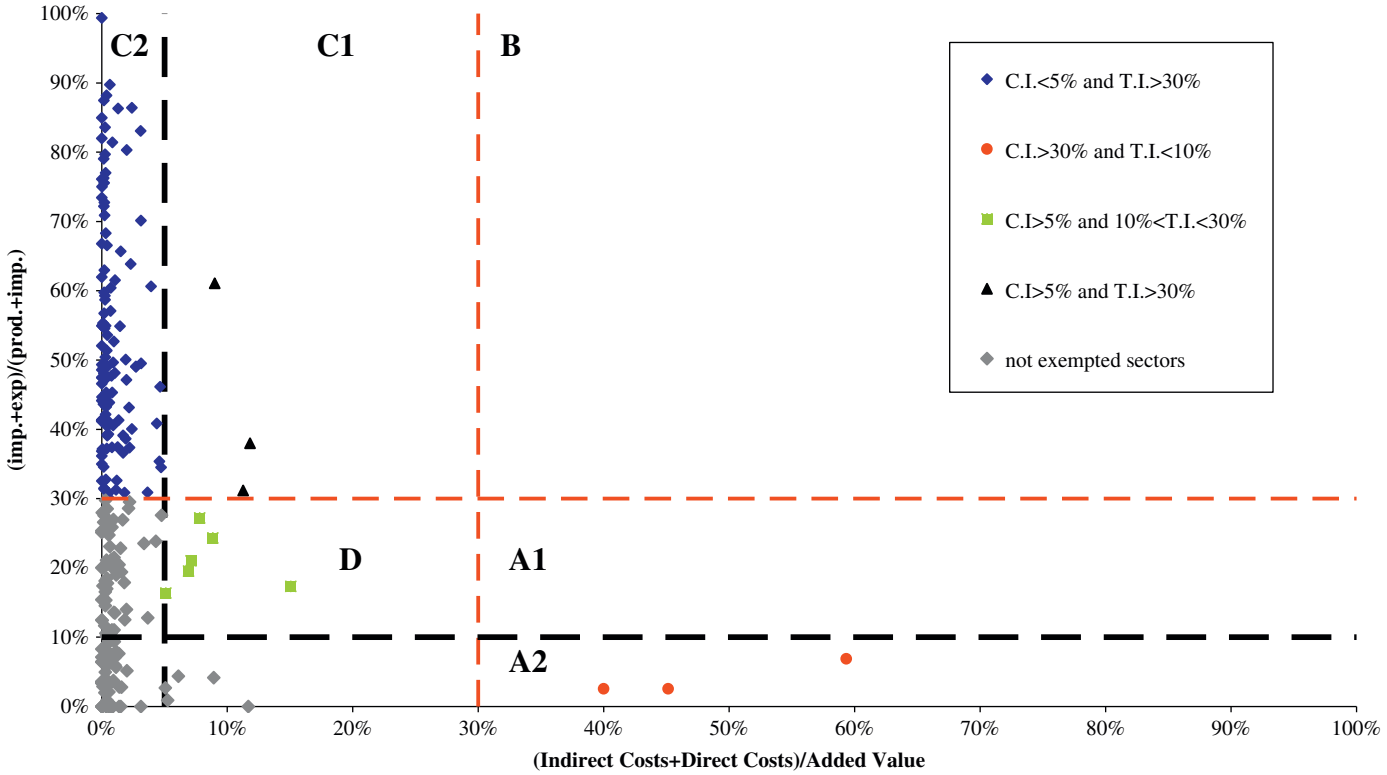

Fig. 4. Areas of exposure to Carbon Leakage.
Source: own elaboration on European Commission, 2009

Despite their substantial differences, these approaches partially overlap: three of the five exemption areas defined by the *separated approach* are also identified by the *aggregated approach* (A1, B, C1). The unique contribution of the separated approach to the Carbon Leakage risk assessment is to grant exemption from auctioning to those sectors falling in the two areas A2 and C2, which are either highly exposed to international trade without facing any substantial cost increase (131 sectors located in the area C2) or highly carbon intensive but with some possibilities to pass through their cost increase to the final market price without loosing any significant market share ensured by their limited exposure to international competition (3 sectors located in the area A2).

It is possible to conclude that the *separated approach* is a distortionary criterion that is not sufficiently economically grounded. It looks more like the final result of a political compromise aimed at limiting the impact of the European regulation – via exemption from auctioning – to the vast majority of the regulated sectors independently on their effective exposure to Carbon Leakage.

Based on an integrated analysis of both carbon and trade intensities the *integrated approach* is the unique criterion suitable for assessing the risk of Carbon Leakage.

After discussing the effectiveness of both the approaches defined to determine which sectors should be exempted from auctioning, the rationale behind the defined thresholds needs to be considered.

First, the EC does not explain why the chosen thresholds should be tailored to evaluate the risk of Carbon Leakage. It is not clear whether the 5%, 10% and 30% thresholds have been set arbitrarily or whether they have been specified according to some economic principles. Moreover, deciding on a threshold basis whether permits should be assigned for free or auctioned, implying that sectors can be either fully exempted from auctioning or not exempted at all, will impose a regulatory measure which is not proportional to the sectors' effective exposure to the risk of Carbon Leakage and might give them a distortive incentive to adopt opportunistic behaviour.[12] Alternatively, rather than assessing Carbon Leakage according to a discrete threshold, free allocation could be granted proportionally to a continuous variable proportional to the degree of carbon and trade intensities.

5.3. Relevant market and optimal level of data aggregation

While the previous section has analysed the effectiveness of the criteria defined by the EC to assess the risk of Carbon Leakage, this section focuses on the level of data aggregation adopted by the EC to assess the sectors' exposure to Carbon Leakage, in order to assess whether data have been collected coherently with the definition of relevant market and with the basic principles of the European climate policy.

Data have to be aggregated both at a geographical level (national or European—horizontal aggregation) and at a industrial level (NACE 3 or NACE 4—vertical aggregation). The degree of exposure to the risk of Carbon Leakage can vary depending on how data are collected. Therefore, it becomes necessary to define the more appropriate level of horizontal and vertical data aggregation (Table 7).

When evaluating the optimal level of data aggregation two opposite considerations should be borne in mind: first, the higher the degree of data disaggregation, the higher the risk of applying

[12] For instance, fully exempting a sector whose carbon and trade intensities are 5.1% and 10.1%, respectively; while at the same time not exempting at all a sector whose carbon and trade intensities are 4.9% and 9.9% might not induce effective behaviour on behalf of the not exempted sector, which could increase its emissions aiming at passing the given threshold.

Table 7
Levels of data aggregation.
Source: own elaboration on Directive 29/2009.

		Horizontal aggregation	
		European level	**National level**
Vertical	NACE-3 Code Aggregation	I	II
Aggregation	NACE-4 Code Aggregation	**III**	IV

different allocation criteria that undermine the harmonization of the regulation among sectors and countries. On the other side, the more data are aggregated, the higher the risk that the Carbon Leakage assessment does not reflect the technologies, industrial processes and market characteristics of the regulated sectors.

The new ETS Directive states that "the Carbon Leakage risk (…) should be assessed, as a starting point, at a 3-digit level (NACE-3 Code) or, where appropriate and where the relevant data are available, at a 4-digit level (NACE-4 Code)" (2008/0013 (COD), 14). The EC used European data disaggregated at a NACE 4 level, without specifying the reason why it should be more appropriated to assess the risk of Carbon Leakage on the basis of industrial data disaggregation at a 4-digit level, and geographical data aggregation at a European level.

It is not clear whether the decision regarding the level of data horizontal aggregation and vertical disaggregation has been taken according to the principles of competition policy. In order to fill this legal gap this article proposes a uniform criterion to determine the optimal level of data aggregation: the risk of Carbon Leakage should be assessed on the basis of data aggregated *consistently with the relevant product and geographical market where the regulated sectors compete*.[13] This criterion is coherent with the qualitative assessment guidelines, which state that the Carbon Leakage assessment should take into account the sectors' *current and projected market characteristics.* Potential distortions of competition deriving from the European regulation would be minimized if the installations competing in the same relevant market were subjected to a uniform allocation rule. First, the relevant product and geographic market where the ETS installations compete should be assessed[14] and, then, exposure to the risk of Carbon Leakage should be estimated using data aggregated consistently with the relevant market assessment.

When deciding the most appropriate level of *horizontal-geographical data aggregation* it is necessary to evaluate to which extent data aggregated at an European level can represent the relevant market where European installations compete, reflecting the exposure to international competition faced by installations or sectors located in specific geographic areas.[15] When deciding the optimal level of *vertical-industrial data aggregation* it is necessary to evaluate which NACE classification better represents the relevant product market where the ETS installations compete.

On one side, a 3-digit level analysis risks to aggregate sectors characterized by different industrial processes with specific energy or emission intensities required to produce goods which, despite belonging to the same NACE classification, are characterized by different degrees of quality (such as primary and secondary aluminium, BOF and EAF steel). Despite having similar physical characteristics, products belong to different relevant markets if they have different quality.

On the other side, a Carbon Leakage assessment based on data disaggregated at a 4-digit level might have the undesired effect of applying two different allocation rules to different sub-sectors which *de facto* compete in the same relevant market.[16] Moreover, an analysis at 4-digit level risks to give non-significant and misleading results also in the case installations produces simultaneously different products which are classified in different NACE-4 categories and might have been regulated by different allocation criteria despite being produced by the same installation. In cases like this, the related plants' emissions and energy consumption data cannot be disaggregated easily among the different NACE-4 levels. The higher the data disaggregation level, the higher the risk of using not representative data and obtaining biased results, suggesting that an analysis at a 3-digit level would be more appropriated.

The EC did not give any clarification regarding how aggregated data from plants producing simultaneously different goods have been disaggregated at a NACE 4 level, another point that stresses the lack of transparency in the EC Carbon Leakage quantitative assessment.

In conclusion, the Carbon Leakage quantitative assessment should be improved by a qualitative valuation concerning the appropriate NACE level of data aggregation. It would be more appropriate to use 4-digit level data when this degree of aggregation better reflects the characteristics of the relevant market where installations compete. Indeed, distortions of competition in the European markets would be minimized if the risks of Carbon Leakage were assessed using data aggregated according to the relevant market where sectors compete.

6. Conclusions

The experience gathered from the past ETS trading periods suggests that the ETS effectiveness could be improved on different grounds. To this purpose, the Directive 2009/29 has amended the first ETS Directive 2003/87 to improve its functioning, by enhancing higher harmonization within the ETS, avoiding undesirable distributive effects and reducing the market distortions compared to the previous trading periods.

This article has focused on the new allocation rule, concluding that most of these desired improvements have not been achieved. To the contrary, many inconsistencies have emerged.

We have highlighted how and why the new allocation rule is likely to worsen, rather than improving, the harmonization within the ETS.

In particular, during the third post-Kyoto trading period (2013–2020) the previous allocation rule – grandfathering – is going to be progressively replaced by three different allocation criteria: allowances are going to be fully auctioned to the energy

[13] According to the European Commission "The relevant market combines the product market and the geographic market, defined as follows: a relevant product market comprises all those products and/or services which are regarded as interchangeable or substitutable by the consumer by reason of the product characteristics, their prices and their intended use; a relevant geographic market comprises the area in which the firms concerned are involved in the supply of products or services and in which the conditions of competition are sufficiently homogeneous" Official Journal C 372, 09/12/1997, pp. 0005–0013, available at 〈http://europa.eu/scadplus/leg/en/lvb/l26073.htm〉.

[14] The Commission attempts to define the product market by investigating whether product A and product B belong to the same market. It also tries to determine the geographic market by producing an overview of the breakdown of the market shares held by the parties in question and by their competitors, the prices charged and any price differentials. Official Journal C 372 , 09/12/1997, pp. 0005–0013, available at 〈http://europa.eu/scadplus/leg/en/lvb/l26073.htm〉.

[15] For instance, when analysing sectors producing goods whose transportation costs significantly impact on the final price (cement), it can be observed that sectors located in continent countries are less exposed to international competition than sectors located in sea countries.

[16] For example, in the case where the two NACE 4 sub-sectors' *manufacture of ceramic tiles and flags* and *manufacture of brick tiles and construction products in baked clay* were producing substitute goods competing in the same market, then these sectors should be homogeneously regulated and subjected to the same allocation criterion. In this case, the qualitative analysis would suggest a unique Carbon Leakage assessment based on NACE 3 aggregated sectors.

sectors and progressively auctioned to the ETS industrial sectors, while exemption from auctioning and free allocation according to a benchmark is going to be applied to the industrial sectors which are found to be exposed to the risk of Carbon Leakage. Therefore, Carbon Leakage has been discussed, identifying three main causes behind such a risk. First, the risk of Carbon Leakage may increase because the EU climate policy imposes three types of costs on the regulated sectors: a direct cost deriving from the duty to reduce emissions, which increases as the ETS cap is going to be lowered during the next ETS phase. Another cost deriving from the duty to acquire the initial amount of permits in a auction and, finally, an indirect cost caused by the electricity price which is increased by the cost of the CO2 emissions. The second reason is the asymmetric nature of the European climate policy: being unilateral, it creates an incentive for normative arbitrage, inducing the regulated sectors to move where no stringent regulations are in place. Finally, and most importantly, the risk of Carbon Leakage raises mainly from the fact that the European climate policy, and the ETS in particular, is *production-based*, rather than *consumption-based*: regulated agents can comply with the EU regulation either buying allowances in the ETS or reducing internally their direct emissions within their production process. However, the ETS fails to give any monetary incentive to reduce indirect emissions, that is, whenever emissions would be reduced in a different economic sector from the one undertaking the abatement investment.[17] The ETS internalizes the negative externality deriving from direct emissions *within* the production process, while failing to internalize positive externality deriving from any emissions abatement *outside* the production process. This shortcoming creates inefficiency whenever reducing direct emissions within the production process is more expensive than reducing the same amount of emissions in other economic sectors outside the production process. Most of all, because of the production-based nature of the EU regulation, compliance with the ETS can be ensured just by switching production outside Europe (outsourcing emissions).

In the light of these multiple causes behind the risk of Carbon Leakage, this article has first concluded that the adoption grandfathering instead of auctioning is not likely to mitigate such a risk, since the more stringent ETS cap of the third trading period is anyhow imposing an unilateral, asymmetric and costly emissions' reduction burden on the European industrial installations.

Another inefficiency of the new allocation rule concerns the definition of an appropriate methodology to determine which ETS sectors should be retained effectively exposed to the risk of Carbon Leakage and which not. This article has verified whether the Carbon Leakage risk assessment methodology adopted in the new ETS Directive can be considered economically grounded, or rather politically driven. The ex-post analysis of the results of the Carbon Leakage risk assessment performed by the EC has shown that, instead of improving the allocation transparency and granting harmonization of higher rules, the EC has defined highly arbitrary and inefficient criteria to assess which sectors are entitled of being exempted from auctioning.

This article has shown that the methodology adopted to decide which allocation rule to be applied to the different ETS sectors is quite arbitrary and not sufficiently economically grounded, as it ends up favouring and protecting the vast majority of sectors, which have been exempted from auctioning according to a criterion (separated approach) which fails to consider simultaneously both the sectors' carbon and trade intensities and, therefore, independently on their effective exposition to the risk of Carbon Leakage.

In spite of the EC declarations and intentions in favour of auctioning, this article has shown that free assignment of permits will remain the dominant allocation criterion for the ETS manufacturing sectors even during the third ETS trading period.

Moreover, the analysis conducted by the EC is based on data aggregated in a discretionary way, which does not reflect the relevant market where ETS sectors compete and the basic economic principles of competition policy, thus failing to improve the harmonization within the ETS by minimizing any possible market distortion.

In conclusion, the new ETS Directive has defined a procedure to allocate allowances among ETS sectors according to arbitrary and distortionary criteria, which do not have solid economic foundation, failing to improve the harmonization of the rules within the ETS.

[17] For instance, if a ETS installation improves its plant electricity intensity, total emissions are likely to decrease, but the ETS installation emissions gap is not. Equally, if a firm decides to switch from wheel to rail transportation, overall emissions are likely to decrease, while the firm' emissions gap is not.

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