Will the energy-intensive industry profit from EU ETS under Phase 3?

Impacts of EU ETS on profits, competitiveness and innovation

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CE Delft is an independent research and consultancy organisation specialised in developing structural and innovative solutions to environmental problems.
CE Delft's solutions are characterised in being politically feasible, technologically sound, economically prudent and socially equitable.

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Summary

Recent empirical research by CE Delft has indicated that not only electricity producers but also energy-intensive industries passed through the costs of their EU emission allowances into the product prices. As they obtained such rights for free, they may have made a windfall profit during the first two phases of EU ETS. These results further question the desirability of grandfathering as allocation mechanism in an emission trading system.

The empirical study from CE Delft has been both criticized and acclaimed. This paper aims to put these results into a wider context. Is it really possible that energy-intensive industry have passed through the opportunity costs of their freely obtained allowances into the product prices? And how must we interpret the results from this study for Phase 3 when important differences with respect to allocation methods will be introduced?

The paper starts by analyzing the motives of companies that are faced with an emission trading system. An emission trading system (ETS) aims to influence company decisions at the margin: for every additional unit of production the companies must decide whether to abate emissions or to buy allowances on the market. As these additional costs are real, it influences the company's decision whether this additional unit is being produced or not. In other words, it is the real costs at the margin, not the opportunity cost that are determining the decision whether or not to augment production. If the firm decides not to produce this additional unit, supply on the product markets will fall and through this mechanism prices will rise so that companies can pass through (part of) the costs of their freely obtained allowances. This holds by definition if the ETS is implementing a binding cap for the company.

If the ETS is not binding for the company, there is a divergence between opportunity and accounting costs of the marginal unit of production. If the firm applies accounting costs, it may no longer have a reason to pass through the costs of production or reduce output. However, the firm can still increase its profitability by taking into account the opportunity costs of production and the market therefore creates an incentive for the firm to do so.
Also experimental economics of emission trading systems show that participants tend to pass through the opportunity costs instead of accounting costs.

The EU ETS in Phase 1 was not binding for non-electricity producers. The caps put on individual installations in energy-intensive industries were simply too generous to result in emission reduction. This is not remarkable as Phase 1 of the EU ETS was intended to function primarily as a learning phase. Allocation in Phase 2 intended to correct this by aiming for an emission reduction of 6.5% below 2005 levels. However, the economic crisis has most likely resulted in even sharper cuts making, at least at this moment, the caps in Phase 2 *de facto* non-binding too for most companies.

For most companies, EU ETS so far has therefore not generated costs to meet the caps. The question whether energy-intensive industry would have passed through the opportunity costs into the product prices and obtain windfall profits cannot be determined from theory alone. This was econometrically investigated by CE Delft in an earlier study. The econometric analysis analysed data covering the period between April 2005 and September 2009 and focused on a few selected products from the refineries, iron and steel and

petrochemical sectors. The estimation investigated the influence of CO_2 prices on the price developments in Europe relative to price development in the US. As EU companies over this period were faced with inclusion in the EU ETS and US companies were not, econometrics could be used to investigate if variation (and price formation) in European prices relative to US prices could be attributed to the change in CO_2 prices. The estimates found a positive influence of CO_2 prices on the product prices within the EU. Moreover, the t-statistics show that these estimates were all significant at normal confidence levels.

These estimates provide evidence that companies passed through (part of) the opportunity costs of freely obtained allowances into the product prices. The found coefficients indicate in general that probably 100% of the costs are being passed through, although products from refineries show higher cost-pass-through rates, whereas they are lower for polystyrene.

These results have been criticized on various grounds. The central claim of industry has been that the CE Delft study omits important variables, such as crude oil prices. However, there is very little reason to trust this argument as this study shows that during the time frame of the econometric estimates (April 2005-September 2009) there was very little correlation between CO_2 spot prices and the price of input variables. Inclusion of inputs, such as crude oil, would therefore not alter the conclusion that CO_2 prices are a significant variable of the European product prices, suggesting that energy-intensive companies have obtained windfall profits.

How can these results be translated to Phase 3 of EU ETS starting in 2013? Compared to the previous two phases, the EU ETS will then most likely have a binding cap, especially for the energy-intensive industry. In addition to the auctioning for the electricity producers, harmonized allocation rules introducing benchmarks and transitional free allocation schemes will result in a larger share of emission allowances being auctioned. However, the total amount of permits that will be auctioned will most likely remain relatively small, initially starting at around 10% of ETS emissions. The introduction of benchmarks will nevertheless bear on the energy-intensive marginal firm that, most likely, is already not very profitable. As the real average costs for this company will increase due to the allowances above the benchmarks that will need to be bought through the auction, this marginal company *will have to* pass through the costs of the emission allowances into the product prices or it will go bankrupt. This introduces higher prices in product markets which most likely will cause windfall profits for non-marginal companies.

While the cost-pass-through in Phases 1 and 2 could still be regarded as a potential outcome, the design of Phase 3 creates stronger pressure on the market to pass through the costs. The higher prices on EU markets will impact innovation, competitiveness and carbon leakage. Compared to Phases 1 and 2, the allocation in Phase 3 has higher stimulus for innovation due to the benchmarks. These benchmarks should be periodically lowered over the course of Phase 3 to remain effective. If innovation results in cost savings, a small positive impact from Phase 3 on competitiveness can be expected for energy-intensive industries. This is, however, counteracted by the adverse impacts free allocation has on non-energy-intensive industries and the increase in prices due to the presence of windfall profits. Since the energy-intensive companies most likely will pass through the costs of their freely obtained allowances into the product prices to obtain windfall profits, European consumers tend to pay higher costs for their consumer goods. If such higher costs are to be passed through onto the labour market, free allocation in the

EU ETS effectively may imply a shift of income from labour-intensive industries towards energy-intensive industries. This contradicts the goals of the Lisbon Strategy. Auctioning a larger share of emission allowances and reinvesting the revenues in energy saving subsidies may lower costs of complying with EU ETS and lower eventual adverse impacts on competitiveness and purchasing power of citizens.

1 Introduction

1.1 EU ETS and competitiveness

The EU emissions trading scheme (EU ETS) is the keystone of the EU climate policy. Launched in 2005, it presently covers over 10,000 energy-intensive installations across the EU representing close to half of Europe's CO_2 emissions. Each installation gets a certain amount of European Union Allowances (EUAs) that give the "right" to emit one tonne of Carbon Dioxide equivalent. By reducing the amount of allowances issued over time, the EU ETS can achieve emission reductions among its participants. By allowing the EUAs to be traded on an organized exchange, the market assures that these reductions are achieved at least cost for participants.

The EU ETS is the largest emission trading scheme in the world. Without any doubts it is an ambitious piece of environmental policy that is still under development. As its scope and scale are unprecedented, it is wise to regard the EU ETS policy framework as a learning process – a process where past experiences are being evaluated which result in policy adaptations in the future. Policy research facilitates this process: by investigating the impacts and effects of past-ETS experiences, it can show omissions and indicate which directions of improvements are possible.

Policy research on experiences of EU ETS in Phase 1 and 2 showed some omissions, such as overallocation to industry (Sandbag, 2009); non-harmonious allocation rules among member states resulting in distortive impacts (Betz *et al*., 2006); distorting entry- and exit conditions ((Ahman *et al*., 2006); windfall profits in the electricity sector (Sijm *et al*., 2006). Recent research by CE Delft (CE, 2010) added to this story by pointing out that not only the electricity sector but also the energy-intensive industries probably had made windfall profits due to EU ETS.

The insight that energy-intensive companies may have passed through the opportunity costs of their freely obtained allowances did receive mixed reactions. Economists in general were not surprised. Economic theory would predict in the end that auctioning would have the same effect as free allocation with respect to cost-pass-through and competitiveness at the margin (Tietenberg, 1984). Non-economists, however, found such results more unlikely. The question is therefore how we must interpret these results.

This report gives more detailed interpretation of the previous study of CE Delft. Is the result that the energy-intensive-industry has passed through the costs of their freely obtained allowances really unlikely? And what does this imply for Phase 3 of EU ETS where allocation rules will be harmonized and benchmarks are being introduced?

1.2 Outline

In Chapter 2 we will go into much more detail investigating the firm decisions under the ETS. How do firms decide to produce what they produce, how do they internalize the concept of an emission trading system into their decision making processes? We will do this primarily from a neoclassical economic framework, but will make side-steps into the area of business economics.

We will show here that the concept of marginal costs and marginal revenues inevitably introduces a strong motive to adjust business operations under the ETS. These business considerations will translate themselves into higher prices through the product markets. So even if a firm does not intend to pass through the opportunity costs of freely obtained allowances in the product prices, in the end it will be able to do so. This chapter is important because it shows that windfall profits may be not an intentional act from supposedly “greedy” managers but rather an inevitable side-result of the way an emission trading system impacts the decisions of firms at the margin. However, this chapter will also identify conditions under which cost-pass-through is unlikely.

Then, in Chapter 3, the empirical results will be discussed. The study of CE Delft econometrically showing that energy-intensive firms were able to pass through the costs of their freely obtained allowances has been questioned on various grounds. The remark made most often was that the results were spurious, as the model specification would have forced the data to conclude that there was cost-pass-through. It has frequently been mentioned that “omitted variables” have explained the results and that we did not measure the impact of CO_2 prices on product prices, but rather the influence from forgotten variables, such as the price of inputs (e.g. iron ore or crude oil). Do we have to take such comments seriously? This chapter will show that there is not a real case for those who try to disqualify the results of the original study.

Finally, in Chapter 4 we will investigate the future under Phase 3 of the ETS. Even if under Phase 1 and 2 some cost-pass-through may have been possible, some opponents of our work claim that under Phase 3 this surely is not the case. We will analyze the impact of benchmarks on the possibility to pass through the costs. Although the benchmarks guarantee that a larger share of the total emission allowances will be auctioned, they create an even stronger impetus in the market to pass through the costs of the share of freely obtained allowances. Therefore, the situation that windfall profits will be made is likely to continue. Impacts of this situation for competitiveness, innovation and the budget allocations in the European economies will be discussed.

Some conclusions and directions for further research will be sketched out in Chapter 5.

2 How a firm reacts on EU ETS

2.1 Introduction

Emission trading systems have been under design now for more than four decades as a way to internalize external effects (Coase, 1960; Dales, 1968). Experiments with emission trading systems started in the 1970s in the US (Tietenberg, 2006) resulting in 1990 in the SO_2 emission trading scheme. In 2005 the EU started an emission trading system for CO_2 emissions. Similar emission trading systems are in operation for a number of pollutants in countries such as Australia, Japan and New Zealand.

Most of the literature on ETS is dealing with the design and efficiency of the system. Recently more attention is being devoted to the impacts an ETS has on the economy. This chapter we will investigate, from a very simple theoretical perspective, how a firm is likely to react on the introduction of an emission trading mechanism such as the EU ETS. This chapter will outline the conditions under which costs may be passed through. First, in Paragraph 2.2, an introduction into the behaviour of the firm is given and concepts are being defined. Then in Paragraph 2.3 we will outline the consequences from introduction of an emission trading system for the decisions that a firm makes with respect to prices and outputs. Although this behavioural analysis is firmly rooted in economic theory, we aim to provide an analysis that is appealing and understandable for non-economists also by investigating various deviations from the standard economic outcome. In this paragraph we will see that cost-pass-through of freely obtained allowances is to be expected in most cases. However, the question if the firms may be able to pass through the costs will largely depend on the market conditions. In Paragraph 2.4 we will discuss these market conditions. Paragraph 2.5 concludes.

2.2 Understanding the concepts of costs and profits

2.2.1 Firm decision making

A firm can be regarded as a decision making entity. Within a firm, decisions are being made with respect to what to produce and how to produce it. According to economic theory, firms aim to maximize profits – or more precisely, to maximize the sum of present and future returns on their investments. This is not an entirely unrealistic assumption. Of course, in most firms, other values than simple profits play an important role. But if the firm is not making profits (or not enough), operations will end eventually as investors may withdraw their money. The fact that the firm is maximizing its profit over the long-run does not imply that short-term profits always prevail over other values. Rent-seeking behavior, such as maximizing short-term profits at the expense of long-term profitability, is in the end not a viable strategy for a company. Hence, a firm that is maximizing profits is not ignoring non-financial considerations, such as taking good care for its employees, its stakeholders or its surroundings, including the environment.

Profits of a firm can be defined as the difference between the total revenues and total costs. With respect to costs, one can differentiate between *accounting costs* and *opportunity costs.* Accounting costs, also called historical costs, can be perceived as explicit costs related to obtaining the possession over the resources. The accounting cost of a given machine is then, for example, the price that was paid to obtain this machine. Opportunity costs, on the other hand, are defined as the maximum value that the resources could obtain in alternative uses. The opportunity cost of this machine is, for example, what this machine would yield if was sold or rented out to other companies.

It is clear that a profit-maximizing company will make decisions based on opportunity costs instead of accounting costs. Every business entrepreneur must make a decision how to make the most money from the assets that are available. A company that is not addressing opportunity costs in the end will disappear from the market. Suppose that two adjacent UK textile firms are producing fabrics using a big weaving loom machine. They make a small profit on this. Now suppose that one manufacturer learns that shipping his machine to India, renting it out to a local factory and buying Indian fabrics to sell in his homeland would triple his profits. Of course, he will rent out the machine and make higher profits than the firm that uses his machine to produce only within the factory boundaries. In the end, the situation will be that the more profitable firm will buy the less profitable firm and immediately make this firm more profitable by also renting the machine to another manufacturer in India. If a firm neglects making decisions based on opportunity costs, it will in the long-run expose itself to the danger of losing control over its assets.

Therefore, opportunity rather than accounting costs are used as a guideline for business decisions.[1] A producer can use a given resource for production but he can also sell it instead, receiving a revenue which may be higher than the revenue he can get by using the resource in production. The notion of opportunity costs is also used in explaining the mechanism of achieving equilibrium in neo-classical economics. In the so-called “Pareto equilibrium”, all the resources are used optimally, so that opportunity costs are minimized.

2.2.2 Normal, economic and windfall profits

In economic theory, profits are defined as the difference between a firm's total revenue and its opportunity costs. It can be regarded as the return on invested capital stock (e.g. machinery or a factory). Economic theory has shown that profits of companies do depend on market conditions. Profits tend to be higher under monopolistic market structures than in perfect competition. According to economic theory profits of all firms in a given market tend to be reduced to zero in the long-run in perfect competition. This means that all costs of the firms, including so-called normal profits as rewards for invested capital, are covered, and no extraordinary (economic) profits are created. However in the short term such extraordinary economic profits may occur and they may become an incentive for new firms to enter the branch. Entrance of new firms will push the price of the product downwards leading to the situation where firms being at the margin of meeting their costs will leave the industry, in order to prevent losses. In such a way, a new equilibrium is achieved.

In the neoclassical economic framework a distinction is thus made between normal profit, which can be seen as a cost category (e.g. a standard net return for invested capital) and economic (extraordinary, above-average) profit, which is a type of profit that under perfect competition can occur only in the short-run. One should notice here, that in ordinary language, the distinction

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[1] According to the general accepted accounting rules, some assets tend to valuated according to their market value (e.g. opportunity costs) instead of their historical value. Despite the risk of manager bias, investors and creditors prefer to know the market values of a firm's assets - rather than their historical costs -because the current values give them better information to make decision.

between normal and economic profit is arbitrary. From statistics, for example, one cannot assess whether a company has made normal or extraordinary economic profits. While in neoclassical modelling both concepts clearly can be distinguished, there is no formal test that can be undertaken to determine if a company makes a normal or an extraordinary profit.

The same subjective element exists in the concept of “windfall profits”. Central to the concept of windfall profits is that they occur because of circumstances in a market that are out of control from the company. Such profits were unforeseen and are not related to the action of the group of companies that operate in a given market. Examples are unforeseen price rises, such as political disruption in the oil markets, or governmental regulations that have created opportunities for windfall profits. Windfall profits are regarded as “accidental profits” and they do not influence normal firm behaviour. Therefore, it has been suggested that windfall profits ought to be taxed away (see also Chapter 4). As the profits were neither expected nor a result of the efforts of the firm, taxing them should not harm the firm’s incentives to maximise future profits and thus can serve as a non-distortive tax base. The problem comes, of course, from the fact that it is not entirely clear when profits are windfall profits and when profits are “normal” profits. When politicians start taxing away normal profits by claiming they were windfall profits, the economy can be damaged.

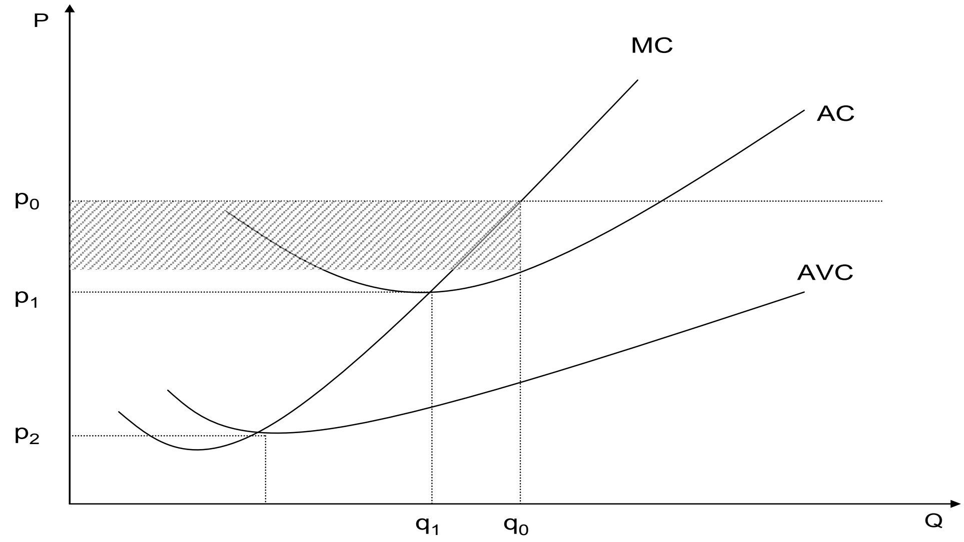
2.3 The theory of the firm and the reaction to EU ETS

2.3.1 Situation without emission trading

According to economic theory, firms produce up to the point where the costs of producing one additional unit (i.e. marginal costs) do not outweigh the revenues from selling one unit of product (i.e. price). So a steel firm may want to produce more tonnes of steel until the costs of producing one additional ton of steel does not outweigh the benefits of selling this unit. In economic language, the firm would produce up to the point where the marginal costs equal marginal revenues.

In practice, of course, production decisions are complicated by a number of uncertain factors. But the central notion is logical: companies want to expand production until it is not profitable anymore to do so. Figure 1 depicts the situation for the firm in the short-run under full competition. Here, the firm is a price-taker and in this market, the price p0 is established. This means that the firm will choose the size of production q0 where marginal costs (MC) are equal to the price (p0). If the firm would have produced less than q0 (for example at level q1), price would exceed marginal costs. Increases in output would now have increased profits as more revenues compared to costs would be added. If the firm produced more than q0, the costs of this additional production would exceed the revenues as the additional price would be smaller than the increase in costs. Thus, q0 is the profit-maximizing output.

Figure 1 **Profit-maximizing output of an individual firm in short-run under perfect competition**



This firm is a price-taker on the market and its profitability will also depend on the change in prices. If prices increase, this firm will increase output and experience more (economic) profits, if prices fall, this firm will decrease output and experience less (economic) profits. The situation for the firm becomes difficult if the price drops below the total average costs of production (below the level of p1 in the graph). The firm is not able any more to cover its costs of production. Since in the short-run the firm cannot alter its size, it will continue to produce as long as the revenues cover at least average variable costs (AVC). Once the price drops below the AVC, the firm will be better off if it stops production. Therefore, p2 can be viewed as a drop out price when the firm will go bankrupt. However, in the longer run, any price level below the average costs p1 implies that the firm has to innovate to lower its costs, or to drop out of the market.

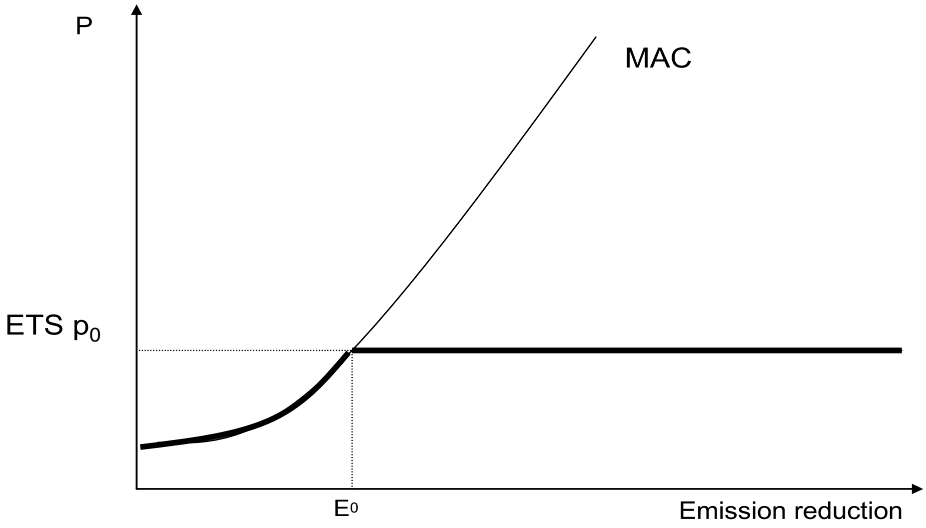
In the example from this figure the firm makes an economic profit as the revenues (the price multiplied by the quantities sold) exceed the average costs. The profit is indicated by the dashed lines. In the long-run such a situation can, according to economic theory, not be sustained as new entrants will enter the market, total supply will increase and prices may drop. This phenomenon, however, will largely be influenced by eventual entry barriers that exist in this particular market.

2.3.2 Introduction of emission trading

Now suppose that the government decided to introduce an emission trading system (ETS) to reduce emissions of CO_2. The firms that fall under the ETS most likely have to incur additional costs of complying with the ETS.
How does this affect the firm's production decisions?

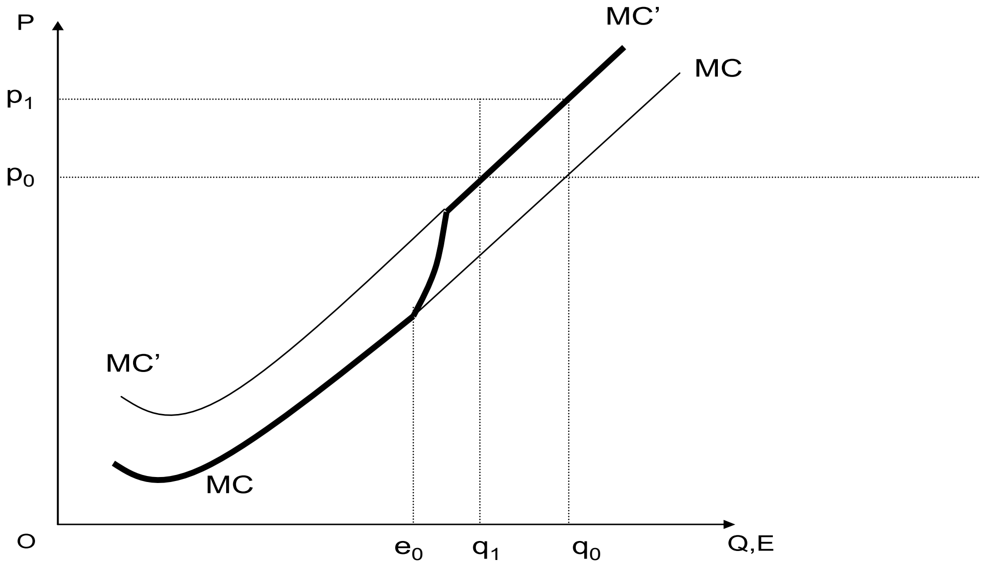
Within most companies there are options to reduce CO_2 emissions. Engineers within the firm may have discovered technical and operational measures that can reduce CO_2 emissions cost-effectively. The costs of such measures can be attributed to a marginal cost curve where the more cheap measures to reduce emissions are usually listed on the left and the more expensive measures are on the right end. Figure 2 gives the marginal abatement cost curve from the perspective of an individual firm. For an individual firm, the price on the ETS market is given (the company is a price-taker on this market). If the company has to reduce less than E_o emissions, the company will start to implement these technical and operational measures to save energy and to meet the target.[2] If the company has to reduce more than E_o emissions, the firm will buy any additional reductions from this point on the ETS market. Hence the bold line can be regarded as the marginal cost curve of emission reduction for this firm if an emission trading system is put into operation.

Figure 2 The marginal abatement cost (MAC) function of a firm under an emission trading scheme



Inclusion of the firm in the ETS will have consequences for the marginal and average cost function that determine the output of the firm. Figure 3 below shows the situation for the individual firm after inclusion in an ETS.

Figure 3 Marginal cost curve of a firm after inclusion in an ETS. The bold line indicates the marginal cost curve if the firm emission allowances are issued free of costs and the firm does not take into account the opportunity costs of its allowances (or emission abatement)



Note: For reasons of graphical simplicity, this figure assumes that emission e is equiproportional to output Q. Moreover the assumption is that average costs lay below marginal costs.

[2] Of course, a profit-maximizing firm would in this situation always reduce up to the point E0 and sell the excess allowances on the ETS market.

Due to the ETS the marginal cost curve of this firm shifts outwards from MC to MC'. The purpose of ETS is that emissions will be reduced from q_0 to e_0. The precise shape of the new marginal cost curve will now depend on a few considerations:

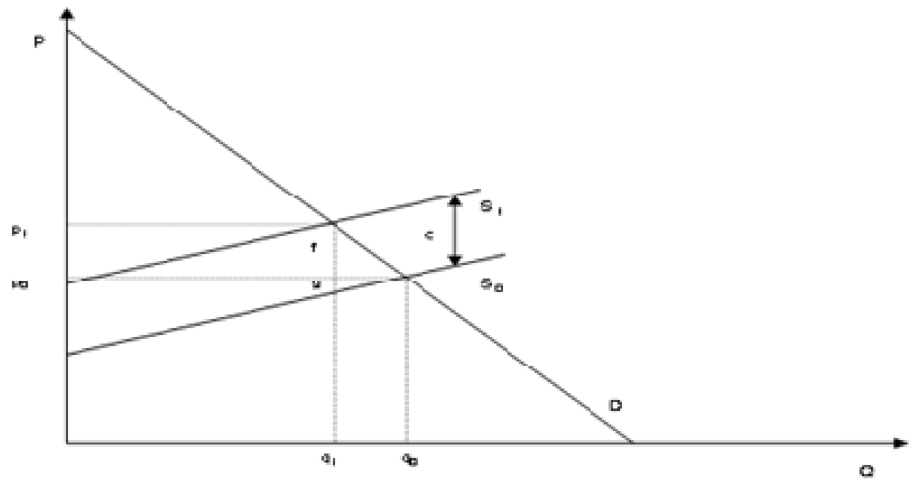
a The price of allowances at the market.
b The way the emission allowances are allocated (through an auction or free of charge).
c If the allowances are issued free of charge, the question if the firm applies opportunity costs into calculation of the optimal level of output or, instead, relies on accounting costs.

The price of emission allowances determines the upward shift in the marginal cost curve. This upward shift is similar under free allocation or auctioning if the firm applies opportunity costs in the determination of the optimal level of outcome. Irrespective of the question whether the firm pays for the allowances, the opportunity value of these allowances are always equal to the allowance price. However, if the firm applies accounting costs as a guiding principle, the situation is different. The allowances are freely allocated up to the required emission reduction, point e_0 in this figure. Up to this point, the ETS will induce no additional costs to the firm. However, for any output above this area, the firm must reduce it's emissions through the marginal abatement cost function in Figure 3. In Figure 4 this is indicated by the slow movement upwards until the marginal accounting costs reach the level where the new marginal costs are made from the old marginal cost curve plus the price of emission allowances. This situation is depicted by the bold line in Figure 4.

What becomes immediately clear is that production level q_0 is no longer optimal as the marginal costs will be higher than the revenues. The firm will therefore adjust its production by reducing it to q_1. This result holds no matter if accounting costs or opportunity costs are being used, as in both cases the firm must pay for the emission reduction achieved through ETS.

In the product markets, all firms together are now being faced with a lower level of optimal production. The lower production of all firms together reduces supply. In the product markets, this reduction in supply will result in higher prices. Figure 4 shows this situation in perfect competition. The carbon costs for this firm equals c. However, unless demand is inelastic, only an amount of *f* can be passed through, where the cost-pass-through rate equals (*f/c%*). Thus in most competitive markets, the ETS induces an increase in prices because profit-maximizing firms may reduce supply. The increase in prices can be regarded as *unintentional* and is completely the result of the way product markets react on the higher (opportunity) costs of the ETS. The question *if firms are able* to realize such a higher price will depend, amongst others, on the elasticities of demand and supply, the market structure (Sijm *et al.*, 2009) and the ability of competitors that do not fall under an ETS to augment market share at the expense of the producers that fall under an ETS (see Paragraph 2.4). However, the impact of this is that the chance is high that prices rise more than average costs. This would indicate windfall profits due to the ETS.

Figure 4 **Pass through of carbon costs under perfect competition, facing variable marginal costs and linear demand**

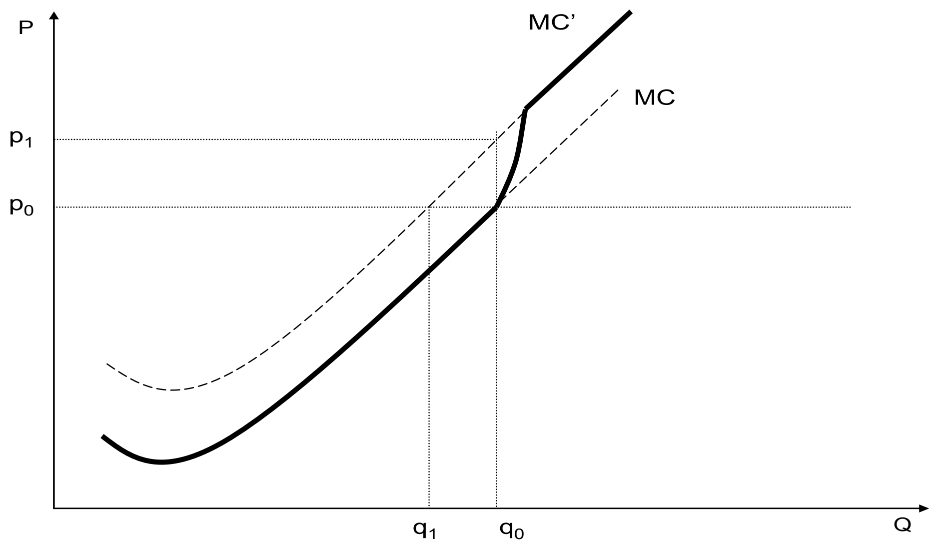


2.3.3 The situation under ETS with a non-binding cap

The above obtained result may be different if the ETS does not have a binding cap for its participants. With a non-binding cap we mean that the ETS system is not achieving reductions. The question is of course why an ETS would be installed if its aim is not to reduce emissions. But in practice there are a number of external circumstances (like economic crisis, misinformation and autonomous technological breakthroughs) that can make a cap that once was binding not binding anymore. This clearly was the case during Phase 1 of ETS, and most likely still plays a role for Phase 2 (see also Chapter 3).

If the ETS cap is not binding for the company and grandfathering applies, the results obtained in the previous subparagraph are a bit different. Figure 5 gives this result.

Figure 5 **Marginal cost curve if ETS reductions are not binding for the firm. The bold line indicates the marginal cost curve if the firm emission allowances are issued free of costs and the firm is not engaged in opportunity cost pricing**



In this case emission allowances up to the level required to produce q_0 are issued free to the company. Now all of its emissions are being grandfathered at the point where the firm would choose its optimal production level.
In that case there is no need for the firm to reduce its emissions and no additional direct costs are associated with production. This is true if the firm applies accounting costs. However, if the firm would apply opportunity costs in making its optimal decisions, the marginal cost curve would still shift outwards. The freely obtained allowances are indeed used in production and have a value on the ETS market. A profit-maximizing firm would have to take this fact into account and would therefore still shift the marginal cost curve outwards and reduce supply.

Again, the precise increase in price will depend on the possibilities at the product markets. If the firm applies opportunity costs, any increase in price can be regarded as a windfall profit.

2.3.4 Non-competitive markets

The analysis above discussed the fact that firms may not intentionally decide to raise prices, but that this is rather a reaction from the market on the lower output from companies. The fact that firms adjust their output when costs rise and the price is given, is central in economic theory. Sometimes this is difficult to understand for non-economists. They tend to refer more to average costs than to marginal costs and may claim that under free allocation, average costs do not increase so much.

But also under such a view there may be a mechanism that results in higher prices – especially if the market is dominated by a few larger companies.
At every market there is one producer for whom price and pricing strategies matter a lot. This is called the marginal producer: the company that has the highest cost structure and is barely able to be profitable. In non-competitive product markets, this company can be regarded as the price-setter on the market. This company can only sell its products at a price that would cover its average costs. If the price level would drop below its average cost, this company would have to close its operations.

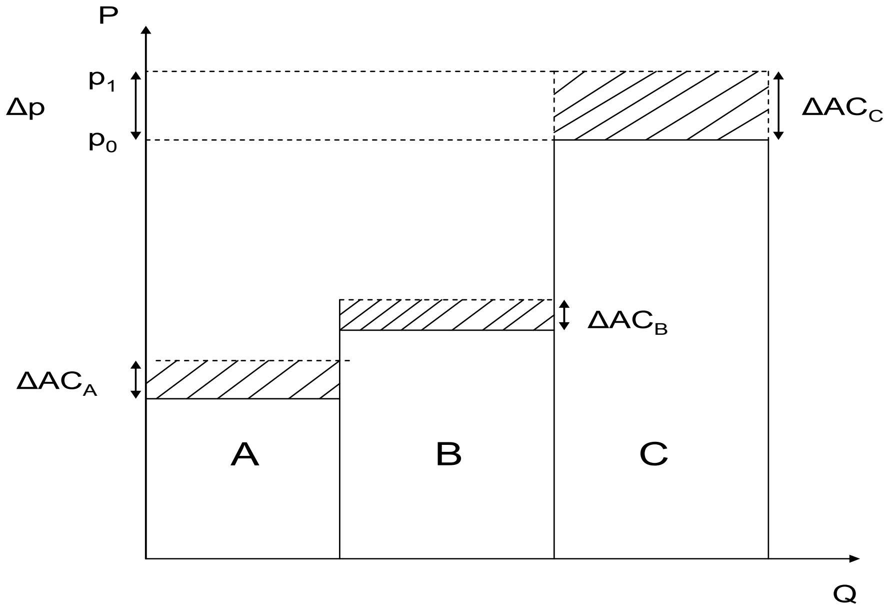
From this perspective, Figure 6 below shows the average costs compared to the price of three exemplary companies, A, B and C, with the firm C being the price-setter where the initial price level p0 is at the level of it's marginal and average costs. This firm is typically using obsolete technologies that consume relatively large shares of intermediates and can be perceived as relatively carbon-intensive. Introduction of an ETS now implies a different change for these firms. Firm B, which is the least carbon-intensive, faces a relatively small increase in average (opportunity) costs. Firm C, which is the most carbon-intensive, experiences now an increase in average costs equal to ΔAC_c. If the allowances are issued under an auctioning regime, firm C *must* pass through these costs, otherwise it will go bankrupt. If the firm is somehow the price-setter in this market, it will be able to do so and the other firms will experience an increase in price *larger* than their increase in average costs, indicating windfall profits. Again no single firm in this framework deliberately decides to raise prices and obtain windfall profits. The construction of this particular market, however, assures that windfall profits will be made.

If the ETS issued the allowances free of charge, firm C has a choice:
if it applies opportunity costs it should raise its price to the level of p1.
In that case all firms will have a cost-pass-through rate larger than 100% and obtain windfall profits. If the firm does apply accounting costs to determine its

price level, the price will stay at p0 *if the ETS does not result in costs for the marginal company.*

Hence only in the situation that the ETS does not result in additional costs for the marginal company and this company determines accounting costs for its optimum, free allocation does not result in additional windfall profits.

Figure 6 Increase in price and average costs of exemplary companies



2.4 Development at the product markets

Paragraph 2.3 showed that firms have an incentive to pass through the costs in most situations. This implies that they will make windfall profits. How much windfall profits they make depend on the developments on the product markets. The product markets determine, in the end, the price increase that will be possible. In CE Delft (2010a) we identified the criteria under which product markets allow firms to pass through the costs. There has been a rich area of literature in these matters that boil down to the following important aspects that are summarized in the box below.

Elements that enable product markets to achieve higher prices

The following aspects have been identified in the literature that would enable product markets to pass through the costs of ETS allowances:

1. Market structure. Sijm *et al*. (2009) derive the result that in general cost-pass-through in competitive markets can be higher than in monopolistic markets. The monopolist aims to maximize profits and is therefore willing to sacrifice output. On oligopolistic markets the ability to pass through the costs will depend on the pricing strategy and the utilisation rates. If capacity is fully utilized, full cost-pass-through is likely. It is also conceivable that price increases are not immediately passed over to the customers, but price decreases of inputs are then used as balancing mechanism (Conforti, 2004).
2. Elasticities of demand and supply. Sijm *et al*. (2009) show that the less elastic the demand curve is and the more elastic the supply curve, the higher the ability of pass through of carbon costs. Under iso-elastic demand curves, cost-pass-through can be higher than 100%.
3. Transport and transaction costs. These can be important barriers allowing to raise prices without adverse impacts from suppliers not facing an ETS.
4. Increasing returns to scale. Increasing returns to scale in production can be the cause of a market power; however their effect on price transmission may be different from that on market power (Conforti, 2004).
5. Product homogeneity and differentiation. The degree of substitutability affects the process of price transmission. According to so-called Armington assumption, goods produced in different countries are not perfectly substitutable (Armington, 1969; IEA, 2005).
6. Exchange rates. Changes in the exchange rates cannot always be easily passed through on output prices. Costs related to exchange rates fluctuations can be viewed as a type of transaction costs, with an element of uncertainty.
7. Border and domestic policies. Trade policies such as import tariffs and quota affect spatial price transmission directly but also domestic policies affecting price formation such as taxes and subsidies may have influence on the process of market integration.

These influences may imply that the dampening impact of non-EU suppliers on EU prices can be smaller than stipulated and that markets would allow a certain degree of cost-pass-through. However, in integrated markets there will always be a risk of market penetration from non-EU suppliers leading to lower prices and loss in market shares of EU suppliers. In CE (2010a) it has been argued that a limited loss of market share is even profitable: firms would enable higher profits by passing through the opportunity costs and accepting a small loss in market shares.

All these arguments merely form a theoretical explanation that, to a certain degree, cost-pass-through on domestic markets is likely. However, the question whether firms are able to pass through the costs is ultimately not a theoretical but rather an empirical question (see Chapter 3).

2.5 Conclusions and discussions

This chapter has investigated the theoretical background towards firm behaviour under ETS. It was shown that firms most likely do pass through the costs of an ETS. However, this mainly depends on two conditions:

a If the firms apply accounting or opportunity costs for their firm decisions.
b If the ETS is binding or non-binding.

Table 1 gives the possible outcomes.

Table 1 **Pass through of costs under an ETS**

ETS is / Cost concepts	Binding	Non-binding
Accounting costs	Pass through likely	Pass through not likely*
Opportunity costs	Pass through likely	Pass through likely

This chapter has argued that profit-maximizing firms have a strong impetus to include opportunity costs in their firm operations; otherwise they will not be profit-maximizing. This should not come as a surprise. In a questionnaire, held by Ecofys and McKinsey in 2005/2006, about half of the companies are said to "price in" the value of CO_2 and about 70% of them were intending to do so in the future (McKinsey/Ecofys, 2006). Also in recent research, Wrake *et al.* (2010) give experimental evidence on the learning process in a setting similar to the EU ETS. Participants of the experiment had to act as if they were producers being faced with an emission trading system with free allocation of the allowances.[3] In the experiment it was evident that the subjects learned to consider the opportunity cost of permits in their profit-maximizing decisions.[4]

Hence both economic theory, economic experiments and questionnaires point at the direction that firms have a strong impetus to pass through the opportunity costs of their freely obtained allowances into the product prices. However, the analysis in this chapter also indicated that it is too short sighted to "accuse" companies for making windfall profits. Companies may not deliberately decide to increase prices to obtain windfall profits. Rather than an act, it is a cause of market conditions in which firms aim to maximize profits. The extent to which they are able to pass through the costs is also dependent on market conditions. Theoretical analysis fails short here as the question whether they are able to do this, is only to be answered empirically.

[3] Participants acted as producers, with capacity to produce up to three units of a product in each of ten rounds. Each production unit required one unit of fuel and one permit. Marginal costs of production were increasing from 1 for the first unit to 5 for the third unit. Eight treatments of the experiment were performed; in some of them three permits were given for free and in others they had to be purchased. There was a single constant market price for permits and market price for a product was selected randomly for each round. The participants automatically received the market price for any unused permits.

[4] In the experiment, a production decision that failed to maximize profits was classified as an error. Thus a decision when marginal cost (including opportunity cost of a permit) was above the market price or a decision not to produce when marginal cost was below the market price would be seen as an error. Both for free allocation and for auctioning options the number of erroneous decisions was decreasing as more rounds of the experiment were implemented, however for free allocation, the number of errors in almost all rounds (eight out of ten) was higher than for the auctioning option. At the end of the experiment (tenth round) the average percentage of erroneous decisions for all participants converged for both options and was significantly lower than in the first round (especially for the free allocation option).

3 Empirical evidence on cost-pass-through

3.1 Introduction

The previous chapter identified that economic theory would predict that emission rights obtained for free would always be passed through in the costs of products. This is because an emission trading system influences company decisions at the margin. Only in the case of non-binding emission trading schemes, where firms would not have to incur costs to reduce emissions, there can be a case that companies do not pass through these costs. However, that would require that companies are “blind” for the opportunity costs of their allowances and include only accounting costs in their prices. Both economic theories as economic experiments show that such behaviour is unlikely, although it cannot be ruled out altogether.

There have been studies that demonstrated that electricity producers had passed the opportunity costs of their freely obtained allowances through in the price of their products during Phase 1 and Phase 2 of the emission trading system (Sijm *et al.*, 2005 and Sijm *et al.*, 2008). Such ex-post studies were lacking for industrial products until recently. The literature was flooded with studies that took an ex-ante perspective, hypothesizing whether they *might* be able to pass on the costs, often financed by industry. As a literature review by CE Delft (CE, 2008) showed, the results from these studies were so mixed that it was almost impossible to derive any relevant conclusion on whether industry might be able to pass through the costs of their EUAs.

The study by CE Delft (CE, 2010a) was the first study to investigate ex-post whether energy-intensive industries (in particular refineries, steel and petrochemicals) were able to pass through the costs of their freely obtained allowances into the product prices. This study concluded that the energy-intensive industry most likely was able to pass through the opportunity costs of their freely obtained allowances into the product prices, therefore giving support to the economic theory that told us that this would be the case.

These results have not passed unnoticed. However, the results were not uniformly accepted. Especially the energy-intensive industry doubted the methodology that was followed. They claimed that the impact of CO_2 that our empirical work measured was biased and actually caused by other “omitted” variables. How seriously must we take such criticism? This chapter reaffirms the empirical groundings behind the CE Delft study (CE, 2010a).
First, we discuss the CO_2 market into more detail in Paragraph 3.2.
In Paragraph 3.3 we discuss how we empirically explored whether the CO_2 costs were passed through in the product prices. Subsequently we address the criticism (Paragraph 3.4). Paragraph 3.5 addresses the potential consequences from such higher prices based on empirical literature. Paragraph 3.6 concludes.

3.2 A market for CO_2 emissions

3.2.1 Market analysis

Since 2005 over 10,000 European energy-intensive installations fall under the Emission Trading Directive (EC 2003/87/EC). The first phase opened in 2005 and closed in December 2007. This phase was an exploratory phase – CO_2 emission reduction was not among its main priorities. Allocation of emission allowances was the responsibility of member states and each member state had to submit a proposal for allocation to the European Commission in a so called "NAP" (National Allocation Plan). In many cases, especially from the new member states, the Commission corrected the NAPs, making the allocation more stringent. However, about a year after the markets opened, it emerged that allocation was too generous and prices for Phase 1 almost fell to zero as allowances could not be banked for use in Phase 2.

The second trading period started in January 2008 and will end in December 2012. Given the verified emission data and experience gathered, the Commission was in a much better position to ensure that national allocation plans result in real emission reductions. Approved NAP decisions showed an absolute emission reduction of 6.5% compared to 2005 verified emissions which would imply that Phase 2 would deliver "tangible" emission reductions for its participants. However, the economic crisis of 2008-2010 has reduced CO_2 emissions from energy-intensive installations most likely even further, probably making also this target obsolete. The reason that prices did not fall to zero is due to the possibility to bank allowances for use in the subsequent Phase 3 (2013-2020).

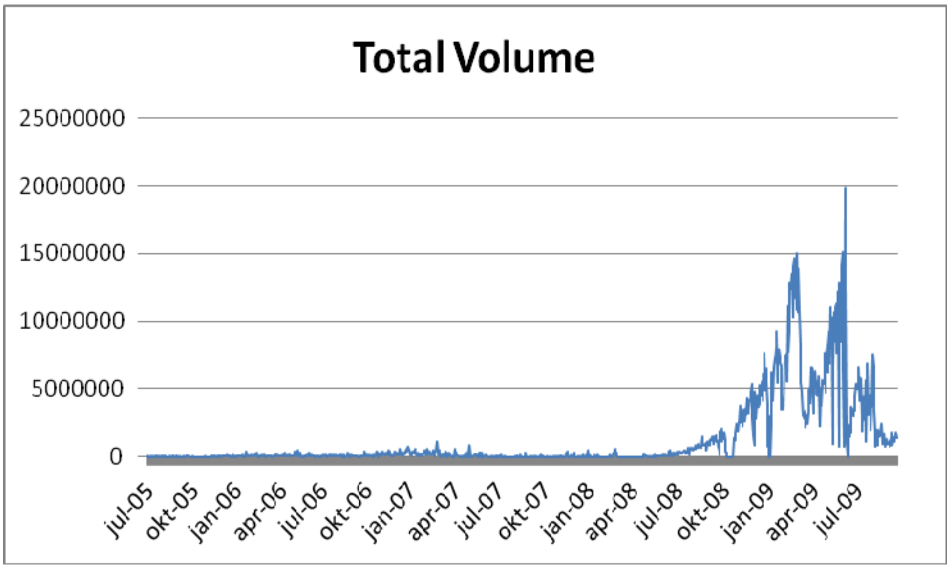
Figure 7 The developments of the CO_2 spot prices over time

Source: Bluenext trading data.

This graph shows that in April 2006 the price reached its maximum around € 30/t CO_2. The subsequent fall was due to the publication of market analysis claiming that the market was too wide. Since April 2008, a spot price for the second phase is established. The impact of the financial crisis is visible, with CO_2 prices having more than halved over a time span of a few months. Prices have more or less stabilized around € 15/t CO_2 since the beginning of 2009.

BlueNext is the most liquid spot contract trading market for carbon dioxide emission rights. The trading volumes of BNS EUA 05-07 and BNS EUA 08-12 are presented in Figure 8.

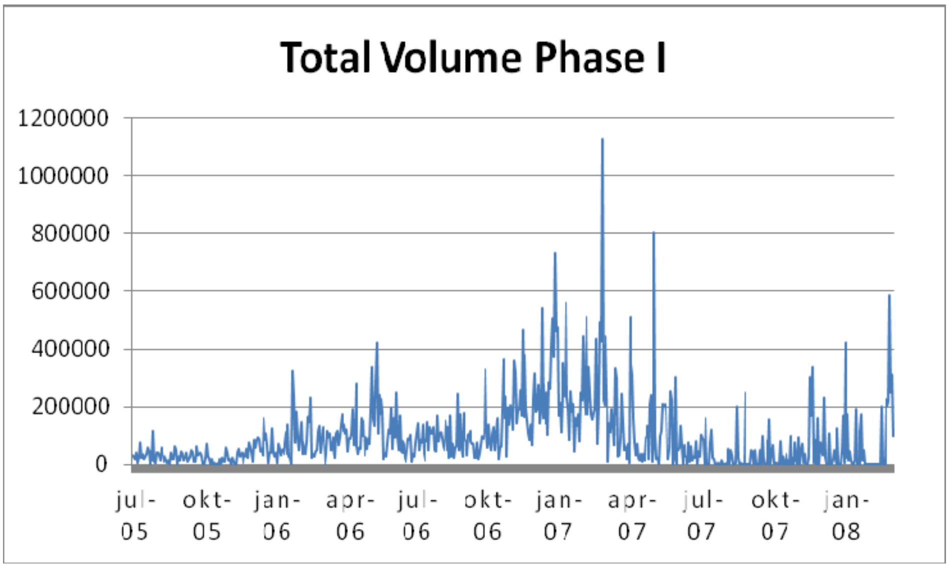
Figure 8 Total volumes in trading on Bluenext, 2005-2009



The CO_2 price trading volumes increased, both in volume and frequency in the second trading period. The activity became more profound after the start of the credit crisis. Furthermore Phase 2 shows trading volumes that are very irregular.

Figure 9 presents the CO_2 price trading volumes of Phase 1 that are not visible in Figure 8.

Figure 9 Total Volume in trading on BlueNext, 2005-2009



The volumes slowly increase towards the peak period between the third quarter of 2006 and the first quarter of 2007. After that, volumes decrease and trading activity becomes very infrequent. At the time that the first trading period finishes, volumes of 2005-2007 emission rights are still traded until the end of February 2008. This is probably caused by a lag in the monitoring system. Shopping at a CO_2 price of almost zero, the installations that fell short in their rights in this period can be called "lucky buyers".

3.2.2 Binding or non-binding caps

For an empirical elaboration it is also important to understand whether energy-intensive companies have perceived the caps on their CO_2 emissions as binding or non-binding. One of the main criticisms of the ETS during Phase 1 and Phase 2 are that a few studies indicated that the system may not have achieved any reductions. Sandbag (2009) pointed at the large overallocation that has taken place in both phases.

Kettner *et al*. (2008), for example, consider it as unlikely that the EU ETS has created incentives to reduce investment in the first trading years. They claim that the carbon price would be too low to induce investments. CO_2 prices have fluctuated around € 20/t CO_2. This price is roughly equal to $ 10/barrel oil and is therefore limited compared to the fluctuations in oil prices in recent years (between $ 50 and $ 160 per barrel). However, Ellerman and Buchner (2008) note that 2005 and 2006 emissions were lower than the historical baseline emissions used in the development of the first National Allocation Plans despite continuing economic growth in the EU and increases in oil and natural gas prices that could be expected to increase demand for coal-fired generation. Using a very simple counterfactual based on the extrapolation of pre-2005 emission trends and observed growth in economic activity, they conclude that abatement in 2005 and 2006 was "probably between 50 and 100 million tons in each of these years." Such results were challenged in Anderson *et al*. (2009) that concluded that both emissions avoidance and allowance inflation has occurred in the EU ETS, resulting most likely in a net increase of emissions compared to BAU under the first phase. Inflation in emissions would occur because of perverse incentives for the practical application of the EU ETS. In the first trading period (2005-2007), the freely allocated rights were based on their historical emissions. Because of uncertainty about the allocation mechanism in the next period (2008-2012), companies may have had an incentive to emit more instead of less to receive more allowances during the next trading period (see also Grubb and Neuhoff, 2006). The relatively large allocation of allowances made this effect actually possible.

Such perverse incentives were corrected during the Phase 2, but the economic crisis has probably again made the allocation too generous (CE, 2010b). However, the situation is most likely still that the ETS still does not result in a binding policy instrument for energy-intensive companies. In terms of the discussion in Chapter 2, this indicates that companies will pass through the costs of their freely obtained allowances if they apply opportunity cost pricing, but may not pass through their costs if they would apply accounting costs as their guiding mechanism for decision making.

3.3 Empirical analysis of cost-pass-through

Having a clear indicator of CO_2 prices, the spot prices at the market, the question is how one can assess whether these spot prices have been forwarded into the product prices empirically. Such an ex-post analysis was conducted with the aim of econometric time-series analysis in CE (2010).

This study uses econometrics to analyze the price movements in markets in some selected products, both in the EU and non-EU in combination with price movements in the CO_2 markets. The selected products are: gasoline, diesel, gasoil, hot rolled coil, cold rolled coil, polystyrene, polyethylene and polyvinylchloride. This study has therefore analyzed the possibilities to pass through the costs in the refineries, iron and steel and chemicals sectors.

Econometrics as a special variety of statistical techniques

Econometrics is the science that combines economic theory with statistics to analyze and test economic relationships. Although many econometric methods represent applications of standard statistical models, there are some special features of economic data that distinguish econometrics from other branches of statistics. Economic data are generally observational, rather than derived from controlled experiments. Moreover, the observed data tend to reflect complex economic equilibrium conditions where individual influences cannot be singled out. Consequently, the field of econometrics has developed methods for identification and estimation of simultaneous equation models. These methods allow researchers to draw conclusions on the nature of the economic processes they observe.

Special attention in econometrics is given to the development of variables over time. Time-series analysis is a field that developed during the 1970s, finally resulting in the breakthrough in the concept of cointegration analysis developed in the 1980s by Engle and Granger (1987). Cointegration is a statistical property of time-series variables that allows them to be jointly incorporated in advanced econometric techniques. Two or more time-series are said to be cointegrated if they each share a common type of (stochastic) pattern. Typical examples of cointegrated series are the co-development of prices on two geographically separated markets. For their work, Engle and Granger received the Noble prize in 2003.

The ex-post analysis runs from the start of the EU ETS in 2005 until September 2009. The econometric analyses aimed to investigate the influence of the price of CO_2 on the price of products in Europe. However, the price development of products in Europe depends on over a thousand of factors (e.g. costs of intermediate inputs, labour costs, capital costs, market conditions, etc.) which all are very volatile over time. Using a simple regression where product prices are regressed on CO_2 prices is then not meaningful. The inclusion of all the input prices is simply too time-consuming.

However, market behaviour is often similar on various markets. The developments in EU markets also depend on the developments of the US markets for many products and vice versa. Therefore, the analysis has been conducted on the actual difference in market behaviour between the US and the EU. Since 2005, companies in the EU were faced with legislation due to inclusion in the EU ETS and this may potentially have resulted in passing through the opportunity costs of the freely obtained allowances. In the US, companies were not faced with such policies. The econometric analysis therefore examined whether the variation in European prices relative to US prices could be attributed to the change in CO_2 prices.

Two types of models were estimated in the econometric estimates. The first model is the one that investigates differences in market behaviour. In this approach both the EU and US markets are simultaneously estimated and the differences in market behaviour are tested for their significance of CO_2 spot prices. If the price developments in the US and EU markets are dependent on each other we can say that both markets are integrated. In econometrics, statistical tests have been developed that distinguish integrated from non-integrated markets. If the markets are integrated and a long-term equilibrium relationship between both markets exists, a so-called Vector Error Correction model can be estimated.[5] If no long-term equilibrium relationship between prices can be defined but the prices nevertheless influence each other, a VAR model can be applied.[6] Such models can be applied if the markets in one way or another are co-dependent on each other. However, if there was no relationship between these markets and the tests failed, more restrictive (and simple) models have been applied, such as time-lagged OLS[7] models. In such models only the significance of CO_2 emissions is being tested on the differences between prices in the EU and the US.

Detailed outcomes of the regressions can be found in CE (2010a). Here we only focus on the outcomes of the regressions with respect to the variable of interest (the CO_2 spot prices) are summarized in Table 2.

Table 2 **CO_2 prices significant in all estimates from CE (2010a)**

Product	D(CO.)	T-statistics	Lag (weeks)	Preferred model	%cost-pass-through
Diesel	0,0071	1,838*	2	VEC	350%
Gasoline	0,0080	1,990*	2	VEC	500%
Gasoil	0,0090	3,260**	0	VEC	NA
Hot rolled coil	2,193	2,300*	1 month	VAR	120%
Cold rolled coil	2,206	2,292*	1 month	OLS	110%
PE	2,230	1,924*	4	OLS	100%
PS	1,106	1,722*	3	OLS	33%
PVC	1,595	2,067*	8	OLS	100%

Note: T-stats indicate the significance of the found variable. *=significant at the 5% level (one-sided test); **= significant at the 1% level (one-sided test).

The estimates found a positive influence of CO_2 emissions on the product prices within the EU. The t-statistics give an indication of the confidence of the found estimates. The t-statistics show that the impact of CO_2 prices was highly significant: for all products we found significant results at the 5% confidence level. Prices of CO_2 were only in the case of gasoil directly forwarded in the product prices. For the other products we found a delay of several weeks.

5 A Vector Error Correction model is a model where a long-term equilibrium between both markets feeds into the short-run dynamics in each market. Johansen trace tests were applied to determine whether the two markets were characterized by a long-term equilibrium between the prices on both markets.

6 VAR = Vector Autoregression. The test for a VAR model is the Granger Causality test.

7 OLS = Ordinary Least-Squares.

Econometric estimates like the ones presented in CE (2010) in essence test whether the CO_2 prices are statistically significantly different from zero. These estimates provide evidence that companies passed through some of the opportunity costs of freely obtained allowances into the product prices. Of course, this raises the question how much exactly has been passed through. This cannot be stated directly, as such final influences must be calculated using impulse-response functions where the estimated parameters are put into a model. Such an effort has not been undertaken in the present research.

However, we did compare the estimated initial coefficients to the values that one would expect from life cycle analysis. For PE, PVC, hot rolled coil and cold rolled coil, the estimate of the CO_2 variable indicated that about 100% of the costs of freely obtained allowances were passed through.[8]. For PS the estimate pointed at about one-third of the costs. As the costs in the petrochemical industries are passed through into product prices with quite a lag, it could be the case that this industry merely is passing through the higher costs of inputs (e.g. naphtha and electricity) into their product prices instead of making windfall profits themselves.

For the products from the refineries sector much higher cost-pass-through rates were found, in the range of 350% for diesel to 500% for gasoline.[9] Such high cost-pass-through rates are, of course, unlikely. But one should not forget that econometrics in the first place is a test whether the coefficients are statistically significantly different from zero. The values of the estimators that are being revealed by econometrics are themselves also due to "confidence intervals". Applying these confidence intervals to the estimates teaches us that a 100% cost-pass-through lays within the confidence intervals for the products from the refineries sector.

The fact that the estimates are surrounded by confidence intervals also should warn against a too direct use of these estimates for determining the total amount of costs that were passed through. In essence one cannot determine exactly by using econometrics that the cost-pass-through rates are x% due to uncertainties involved in the estimation of these coefficients. One can only say with certainty that the estimated models prove that CO_2 costs have been passed through. This is not surprising as economic theory would have predicted that companies would have preferred to do so (see Chapter 2). The exact amount of costs passed through is only possible to assess under additional assumptions or simplifications. However, we notice that in virtually all academic economic research such point estimates are directly used in economic models.[10] If we must make a best guess which amount of costs were passed through, we would stick here to the general picture of these estimates and conclude that companies were able to pass through all of their opportunity costs in the product prices, even though from a very strict pure scientific point of view this cannot be stated.

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8 For hot rolled coil, one would also need to apply an impulse response function for the VAR. This showed that prices of hot rolled coil in the long-run may even rise more than 100%, although uncertainty also tends to increase over time.

9 These relate to the short-term impacts. The long-term impacts can only be estimated using so-called impulse-response functions where the total model is being tested for external shocks. For gasoline, an impulse response function was created (not given in CE (2010)) that shows that even higher cost-pass-through rates would prevail after three months.

10 In other words: confidence bounds are not being used in e.g. the empirical derivation of price, income or Armington elasticities.

3.4 Critiques to the results from CE Delft (CE, 2010a)

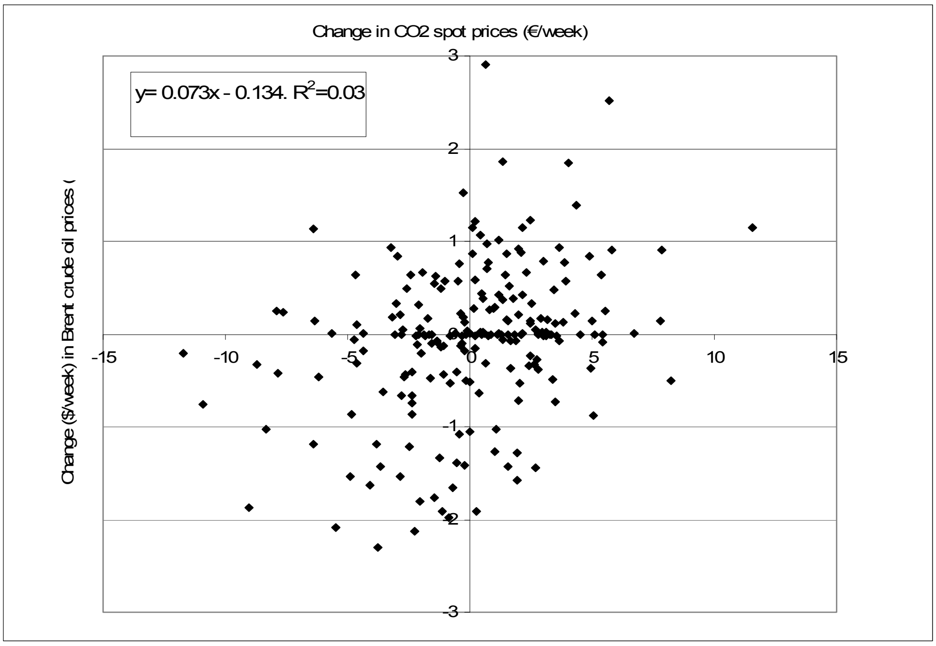
So far no official critiques have appeared on the methods and results from the CE Delft study (CE, 2010). However, we have collected some critical remarks, mostly from enterprises or consultants paid by industry, on these results. Most boils down to the following two aspects:

1. The impact of CO_2 prices is spurious: in fact another important omitted variable has caused these results.
2. More sophisticated methods should be used to analyze the impacts of CO_2 on product prices.

The first criticism is surprising. Spot prices of CO_2 show a very uncommon pattern in economics: over time they can be depicted as an M-shaped figure. It is very difficult to envision a variable that depicts a similar M-shaped pattern. Crude oil prices, for example, did not fall to zero in 2007. Prices of cokes used in steel making did not fall to zero in 2007. As a matter of fact, the price developments on the CO_2 markets are so unique, that the chances are very low that another variable is able to exhibit a similar pattern.

Some people have indicated that crude oil prices can be perceived as a "header" for the CO_2 market. While this is actually true during part of the second phase of EU ETS, the pattern in the first phase of EU ETS is completely different. We want to emphasize that our time frame of analysis includes both the first and second phase of EU ETS, but that the first phase has much more observations. Figure 10 below shows the relationship between the weekly changes in oil prices and the weekly changes in CO_2 prices. As can be seen from the scatter plot, between these two variables there is not much relation at all. As a matter of fact, a linear regression showed a very low R^2 of 3.6%. Therefore the suggestion that the significance of our CO_2 variable was in fact caused by the change in crude oil prices is erroneous.

Figure 10 Relationship between weekly change in prices of CO_2 and Brent crude oil prices



Note: Outliers in CO_2 prices have been omitted from this graph but not from the econometric estimates as presented in Paragraph 3.3.

The second critique is on our econometric estimation methods. While we acknowledge that our estimation methods could be further improved by allowing for structural breaks, estimation of various log-linear forms, inclusion of new variables in multiplicative or additive forms, construction of impulse-response function, etc., it is unlikely that this will fundamentally alter the conclusions derived in the empirical research. One should notice that the empirical research was not undertaken to maximize the R^2 of the econometric estimates: the goal was to find a plausible way to test the economic theory that companies would pass through the costs of their freely obtained allowances into the product prices. Applied econometrics often works this way. We do not need to estimate models as complete as possible as long as our models exhibit certain characteristics (e.g. that the errors are white noise) that allow us to employ these econometric methods and interpret the results. The fact that CO_2 prices were significant is not disputed on econometric grounds. Although we would welcome more detailed analysis we would not think that the conclusion that CO_2 allowances were passed through into the product prices would really change under such more detailed analysis.

3.5 The impact of the higher prices

The study by CE (2010a) has not investigated the eventual consequences from the higher prices at EU markets. However, the empirical literature on "trade and the environment" is rich and it is possible to derive some conclusions from this literature.

One of the first papers has been by van Beers and van den Bergh (1997) who tested the hypothesis of impact of environmental stringency on trade flows on a set of OECD countries. They constructed an index of environmental stringency based mainly on energy intensities and recycling rates. This approach has later been refined by Harris *et al.* (2002). Especially the latter study showed that exports are significantly negatively affected by more stringent regulations resulting in higher costs for companies, but do not find negative significant results for the imports. Some other studies, however, do find a small significant effect of costs of environmental regulations on net imports. Jug and Mirza (2005) give a few examples of such studies, which used data from different states of the US. For example, Ederington and Minier (2003) and Levinson and Taylor (2004) found a high positive effect of the US abatement costs on US imports. They also pointed out that environmental regulations and trade are endogenous to each other.

Jug and Mirza show that the fact that in international studies the impact of environmental regulations was found to be weak or insignificant was related to measurement errors and the estimation of the wrong model (endogeneity arising due to pooling of countries or industries). After controlling for these biases, the authors obtained a significant elasticity of import demand to the stringency of regulation. The authors used European abatement costs data as a measure of environmental stringency. They found that environmental stringency matters more for Eastern European exporters, since EU importers might be more sensitive to the perceived lower quality of products and lack of variety in relation to this region.

Jug and Mirza point out in conclusions that the effect measured as elasticity of imports to stringency of environmental regulations is the result of a pure cost effect. However there might be many other positive effects on trade that are related to more stringent environmental regulations, such as increase in perceived quality by the consumer or investment in new low pollution technologies by producers – these two factors that could be favourable both to trade and welfare. In the end, production costs of European manufacturers may even decrease as environmental regulations do steer innovation, as hypothesized by Porter (1991). In CE (2010a) a more detailed elaboration of the Porter hypothesis in relation to environmental costs is given.

In addition to an impact on trade flows, it has often been suggested that environmental regulations may have an impact on investments. Several studies investigated the potential of capital flight due to environmental regulations. The idea is that environmental regulations negatively impact on direct investment, creating so-called capital flight to locations with less stringent regulations. Several studies reported in Jaffe *et al.* (1995) suggest that stringency of environmental regulation has little or no effect on location of new industrial plants. This result was not being challenged in newer research (see e.g. Brunnemeier *et al*., 2004).

3.6 Conclusions

Economic theory would predict that the chances are high that companies would pass through the costs of their freely obtained allowances into the product prices. This is clearly the case if the ETS system results in a binding cap for companies. But even if the EU ETS does not result in a binding cap for companies, it can be expected that companies would still pass through the opportunity costs into their product prices.

For electricity producers, there have been studies that showed that such costs had been passed through. So far, such ex-post studies were lacking until recently for industrial products. The literature, often financed by industry, was flooded with studies that took an ex-ante perspective, hypothesizing whether companies *might* be able to pass on the costs. As a literature review by CE Delft (CE, 2008) showed, the results from these studies were so mixed that it was almost impossible to derive any relevant conclusion on whether industry might be able to pass through the costs of their EUAs.

The study by CE Delft (CE, 2010) was the first that investigated ex-post whether energy-intensive industries (in particular refineries, steel and petrochemicals) were able to pass through the costs of their freely obtained allowances into the product prices. It concluded that the energy-intensive industry most likely was able to pass through the opportunity costs of their freely obtained allowances into the product prices, therefore giving support to economic theory.

Overall, we agree that estimation methods could be improved in further research and the overall fit of the model could be enhanced. However, it is unlikely that this will alter the conclusions on the significance of the CO_2 emission prices. The suggestion that we did not measure the impact of CO_2 prices but rather the impact of crude oil prices is erroneous given the absence of a relation between crude oil prices and CO_2 spot prices during Phase 1 of EU ETS. Moreover, as econometric results are in line with what economic theory would predict one would not expect that such conclusions fundamentally alter in new research.

Finally, we need to emphasize that the empirical work so far has only focused on the possibility that the costs of the freely obtained allowances are passed through in the product prices in EU markets. Eventual consequences from these higher prices, such as increase in imports, higher profits, attracting foreign investments in energy-intensive production units, have not been taken into account. However, the existing empirical literature points at the likeliness that the higher product prices have result in an increase in imports and a decrease in exports, although the impacts are likely to be small.

4 Estimated impacts in Phase 3

4.1 Introduction

The theoretical analysis in Chapter 2 showed that passing through the costs of freely obtained allowances is likely in most situations. Chapter 3 presented the empirical evidence obtained so far that energy-intensive industries indeed have passed through their costs of freely obtained allowances into product prices in Phase 1 and 2 of the EU ETS. However, in 2013, Phase 3 of the EU ETS will start and some drastic changes have been proposed compared to Phase 2. The question is: what will these changes imply for the potential cost-pass-through of energy-intensive industries? Is there a chance that the observed cost-pass-through will be lower under Phase 3? And what will this do to the windfall profits? This chapter elaborates on these issues. First, in Paragraph 4.2 we outline what the ETS in Phase 3 looks like. Then in Paragraph 4.3 we show the impacts on prices, profits, innovation and competitiveness. Finally in Paragraph 4.4 we shortly identify options for improving the currently estimated impacts of EU ETS.

4.2 EU ETS in phase 3

In 2013 the third trading period of the Emission Trading Scheme will start. In this period the allocation method of the emission allowances will differ fundamentally from that of previous trading periods. From 2013 onwards, the revised EU ETS Directive provides for a centralised EU-wide cap on emissions, which will reduce annually by 1.74% delivering an overall reduction of 21% below 2005 verified emissions by 2020. A much larger share of allowances will be auctioned: in total about 50% of emissions will fall under an auction regime. Virtually all emissions from electricity production will be auctioned. Energy-intensive industrial installations will, however, receive allowances for free up to a certain product benchmark. These benchmarks will be set on the basis of the average of the top 10% most greenhouse gas efficient installations in the EU. This situation will hold for all sectors that are deemed to have a significant risk to carbon leakage. Sectors not deemed at significant risk of carbon leakage will receive 80% of their benchmarked allocation for free in 2013, declining to 30% in 2020 and 0% in 2027.

The allocation of the free allowances in Phase 3 has to be carried out on the grounds of harmonised Community-wide ex-ante benchmarks. A benchmark will specify an amount of CO_2 allowances that a firm will be able to receive for free, depending on its activity level in a certain period. An example: when for a sector a benchmark of 0.5 ton CO_2/ton output was specified and the activity level of an installation of this sector was 200 ton output in the baseline year, then this firm would get 100 allowances for free.[11] For each ton CO_2 that the installation does emit above these 100 allowances, the firm would have to buy allowances on the market.

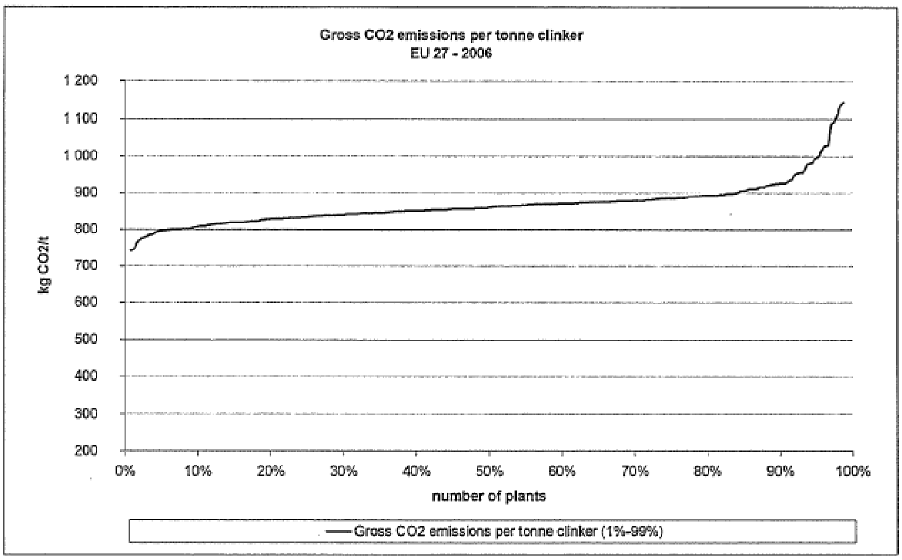
[11] To insure that the emission cap is not violated a correction factor may have to applied.

The specific benchmarks are not specified in the Directive 2009/29/EC, however, some criteria that the benchmarks have to satisfy are given:
1. For each sector and subsector, in principle, the benchmark shall be calculated for products rather than for inputs, in order to maximise greenhouse gas emissions reductions and energy efficiency savings throughout each production process of the sector or the subsector concerned.[12]
2. The starting point of the ex-ante benchmark should be the average performance of the 10% most efficient installations in a sector or subsector in the Community in the years 2007-2008.
3. Allocations must be fixed prior to the trading period so as to enable the market to function properly.
4. A uniform cross-sectoral correction factor shall be applied if necessary.

The European Commission has been working with the major sectors to establish the basis for these benchmarks, using actual installation data. The historical baseline activity levels to which the benchmarks will be applied to determine the actual amount of free allocation are still under discussion. The benchmark values that have been proposed for thirteen different sectors are from Ecofys (in cooperation with Fraunhofer Institute for Systems and Innovation Research, and Öko-Institut).[13]

As an example we investigate here the situation in the cement sector. Ecofys *et al*. (2009) have proposed to apply a 780 kg CO_2 /t clinker as a benchmark. The choice of this benchmark can be illustrated by means of Figure 11. In the graph you can see for the different carbon intensities the share of plants (in terms of numbers) that have a carbon intensity that is equal to or lower as the carbon intensity given on the vertical axis. 10% of the plants thus have a carbon intensity of about 815 kg CO_2 per tonne clinker or lower.

Figure 11 Gross CO_2 emissions per tonne clinker in the EU-27



Formula of the linear regression between 10% and 90%: y= 1,17 x + 802

Source: Ecofys *et al.* (2009).

[12] For emissions not covered by a product benchmark (because the installations are units for the combustion of fuel or because a reliable product benchmark cannot be determined) there are three fall-back options such as a heat production benchmark or a fuel mix benchmark.

[13] See: http://ec.europa.eu/environment/climat/emission/benchmarking_en.htm.

This graph further illustrates that the 10% most CO_2 efficient installations (in terms of numbers) have on average a CO_2 efficiency of about 780 kg CO_2/t clinker. This benchmark has therefore been proposed by Ecofys *et al*. (2009).

4.3 Impacts of the changes in Phase 3

What are the impacts of the drastic changes that EU ETS undergoes in Phase 3? In this paragraph we will examine the consequences for:
- Cost-pass-through rates.
- Windfall profits.
- Innovation.
- Competitiveness.

4.3.1 Cost-pass-through

Chapter 2 showed that opportunity costs of freely obtained allowances will always be passed through. Only if the firm applies accounting costs in its management decisions and if the ETS does not result in a binding cap, there could be a case where the opportunity costs of freely obtained allowances will not be put forward in the product prices by the firm. The empirical evidence presented in Chapter 3, denied this possibility and showed that even in non-binding targets firms tended to pass through the opportunity costs of their freely obtained allowances into the product prices.

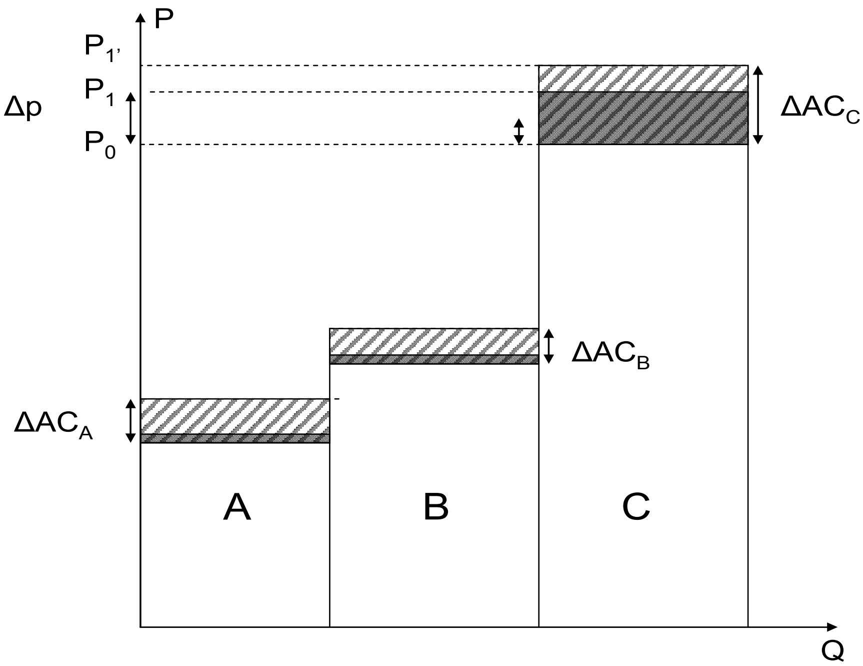
In Phase 3 the likeliness of companies *not* passing through the opportunity costs is further reduced, as Phase 3 will imply a binding cap for most companies as Phase 3 will result in annual reduction equivalent to 1.74%. For industrial installations, the EU ETS will very clearly imply a binding cap. During Phases 1 and 2 of the EU ETS, electricity production was a net buyer of allowances that were granted too generously to industry (Sandbag, 2009). In Phase 3, the situation will most likely be reversed (CE, 2010b; SNM, 2009). Electricity producers will most likely be faced with stringent goals and policies stemming from the renewable energy directive (2009/28/EC). The impact of such plans most likely will create a surplus of credits for electricity producers (SNM, 2009) that could even make the total EU ETS non-binding. However, this largely depends on the effectiveness of the national action plans to meet the renewable energy directive. If such plans are not effective, the ETS will still yield additional reductions and the cap will be binding.

So while we may conclude that the firms have under Phase 3 of the EU ETS even more incentives to pass through the costs, the question if they will be able to do so depends on market conditions (market structure, elasticities of demand and supply and competition from suppliers that do not face carbon policies). It is difficult to envision why this would be fundamentally different from the period 2005-2009. Market structures will not change from full competition towards monopolies (which would limit the likeliness for cost-pass-through as outlined in Paragraph 2.4). Elasticities of demand and supply will not change very dramatically either. In general, elasticities of demand of energy-intensive base products, such as for cement, tend to be fairly low (Cook, 2009).

However, one may point at the fact that the economic crisis has left production capacities, world wide, not fully utilized, giving an impetus to lower prices in order to cover up fixed costs. While this is true in general, it must be acknowledged that this can be a temporary phenomenon only. In the longer run, production volumes must correspond to the rule that marginal costs equal marginal revenues, otherwise firms will be priced out of the market. A binding ETS scheme will increase marginal (and thus also average) costs of production by the amount of (opportunity) costs of abatement. This increase in costs will depend on the technology, i.e. the firms using more carbon-efficient technologies will experience less increase in costs due to the ETS. This effect can influence the process of market adjustments: on the one hand, the firms where the increase in costs is the highest may drop out of the market and on the other hand, the firms using highly carbon-efficient technologies may see an opportunity to enter the market. The firms that fall under EU ETS therefore receive a clear incentive to innovate, in order to lower their costs of production.

Both the incentive to innovate and the necessity to pass through the costs are enhanced by the introduction of benchmarks in Phase 3. This can be explained by reference to the marginal firm: the firm that operates in a given market and has the highest cost structure. Chapter 2 identified this firm as the (implicit) price-setter on the market as this firm *must* increase its price to cover up the average costs. While one may argue that under Phase 1 and 2 of the EU ETS, there was not a large increase in average accounting costs for the marginal firm, this situation will change with the introduction of benchmarks. Figure 12 shows this phenomenon. The marginal firm C is the firm with the highest cost structure. As energy costs are an important cost item for energy-intensive industries, the marginal firm most likely is also the firm that is among the most energy-intensive. Such firms typically fall above the proposed benchmarks. In Phase 3 such a firm has to buy a considerable amount of allowances for the emissions above the benchmarks as the emissions above the benchmarks will be auctioned. Therefore, the introduction of benchmarks in Phase 3 implies an increase in average accounting costs. To remain profitable, the firm now *must* raise its prices to cover up the increase in *average* accounting costs. So even if the firm does not pass through the opportunity costs of production, the prices on the markets have to be higher for this firm to remain in the market.

Figure 12 **Accounting and opportunity cost increase of firms in a given market in Phase 3 of EU ETS. The dashed areas give the increase in opportunity costs, while the dark areas give the increase in accounting costs**



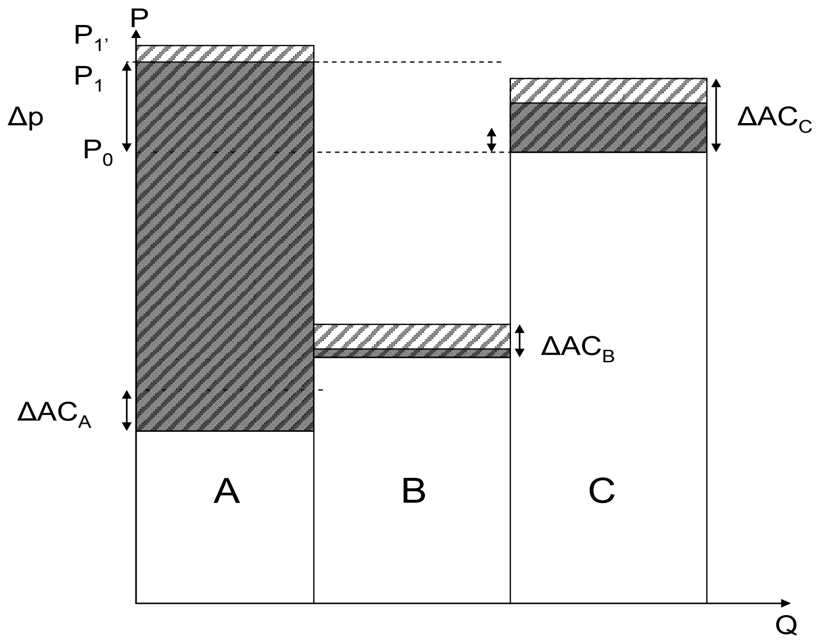
Therefore the prices have to rise from P0 to P1 even if the marginal firm is not passing through its opportunity costs. This price increase allows the other firms to make additional windfall profits, as the price increase at the market is larger than their increase in average accounting costs. Clearly these firms have lower increases in average costs, as they use a less energy-intensive production technology. However, as long as the price increase at the market is lower than their increase in marginal opportunity costs, they will not have an impetus to augment market shares at the expense of the marginal firm.

If the marginal company is a price-setter, it most likely will change its price from P0 to P1’ so that also the opportunity costs are being covered. The other firms may now have an impetus to augment market shares as their increase in marginal opportunity costs is lower than that of the marginal firm. They can compete with a lower price and consequently, the marginal firm C is forced to lower its prices to cover its average accounting costs.

Using this mechanism we can also show that the introduction of EU ETS can also correct misguided prices in the market. Suppose now for example that energy is too low priced, so that not energy but other costs, such as labour costs, determine the height of the average costs of the firms involved.

We can note that in case if one of the non-marginal firms, e.g. the firm A is using a technology that is highly carbon-intensive, the increase in marginal (and thus also average) costs due to compliance with ETS may be so high that it may start to incur losses in the situation if the new average costs will exceed the new price. This situation is shown in Figure 13.

Figure 13 Accounting and opportunity cost increase of firms in a given market in Phase 3 of EU ETS and the change in order. The dashed areas give the increase in opportunity costs, while the dark areas give the increase in accounting costs



In such a situation, not firm C but firm A is most likely to drop out of the market unless it changes production technology. In this way, ETS incentivizes removal of the least carbon-efficient technologies from the market.

4.3.2 Windfall profits

Under Phases 1 and 2, companies have passed through the opportunity costs of their freely obtained allowances. As the companies were not making real costs of emission reduction, windfall profits were equivalent to the amount of costs that was passed through. The econometric estimates showed that a cost-pass-though rate of 100% is a likely estimate, although there is a significant confidence interval around it.

The situation in Phase 3, however, will change, as a larger share of emissions for energy-intensive industries will be auctioned. The impact of auctioning for firms that fall under the scheme of transitional free allocation will be limited as these are only responsible for a very small amount of total emissions.[14] However, the impact of benchmarks is much larger. There is to our knowledge currently no study that has estimated the total amount of emissions that will fall under a benchmark. Visual inspection of, for example, the cement study by Ecofys (2009) shows that less than 10% of total emissions in the cement sector will, finally, be auctioned. So one may conclude that only a small fraction of total emissions for industry will, after 2013, fall under an auctioning regime.

As we would expect that companies still would pass through the opportunity costs of their freely obtained allowances in Phase 3, total windfall profits will be diminished by the small amount of allowances that will fall under an auctioning regime.

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[14] In CE (2010c) we estimate that only 2% of industrial emissions in the Netherlands will fall under the scheme of transitional free allocation.

4.3.3 Impacts on innovation

Phase 3 will have more positive incentives for innovation due to the existence of benchmarks. The benchmark will act as a direct stimulus to reduce industry's emissions up to the benchmarked values. EU industries compete at the margin with world industry. Therefore, in addition to the loss of competitiveness due to higher product prices, there will be a gain in competitiveness due to a greater cost reduction as the result of innovation (see Paragraph 2.5). This impact is the strongest at the start of the system. However, as autonomous technological progress is advancing, the benchmarks should be lowered over time to provide a continuous stimulus to industry.

Innovation and competitiveness of EU firms may be further improved if there is a continuing incentive to reduce emissions, also for emissions that do not fall under the benchmarks. In theory, the incentives between a system of grandfathering and auctioning should give the same stimulus to reduce emissions as the firm, according to neoclassical theory, has the same impetus to reduce emissions at the margin. Under an auctioning regime this is to avoid costs of buying allowances at the auction and under grandfathering this is the additional impetus to gain profits by reducing emissions and selling the excess allowances on the market. However, such marginal decisions in most firms are not being made at the same department. The decision to abate emissions is most likely taken at the environmental department while decisions with respect to price and output are taken at the sales department. Moreover, the decision to abate emissions is a non-marginal decision involving large investment costs. It is therefore logically that the firm, at the marginal decision, tends to overlook opportunities to reduce its emissions at a price cheaper than the price at the ETS market. For these reasons may an auction regime impose a more direct stimulus to innovation, as the costs of inclusion in the ETS market is now directly felt in the profitability of the firm.

This is not only a theoretical idea. Some studies have shown large potentials for energy savings that can be made at no cost for the firm (see e.g. Blok *et al.*, 2004). Obviously firms are not perfectly informed agents and may overlook certain potentially profitable investments. An ETS may decrease the financial risks for the firm of investing in resource saving technologies. DeCanio (1993) showed that firms typically establish internal hurdle rates for energy efficiency investments that are higher than the cost of capital to the firm. Therefore, the establishment of an ETS may result in cost savings for companies.

Also in the long-run there could be benefits from ETS by forcing companies to develop more clean technologies. This idea was put forward by Michael Porter in his famous "Porter hypothesis". According to conventional economics, environmental regulations are a cost to the firm which may slow down productivity growth and harm competitiveness. However, Porter emphasized that environmental regulations induce innovations that are in the end lowering production costs and/or increasing the attractiveness of products. In his paper, Porter described a few cases of firms where such a mechanism has been effective and resulting in cost-savings. The Porter hypothesis has been extensively tested in empirical work (see e.g. Brannlund and Lundgren, 2009). In general the empirical work gives mixed results and the Porter hypothesis therefore cannot be taken as a universal rule. However, there seems to be a clear relationship between environmental policies and indicators of innovation, as measured by investment in R&D and successful patent applications (e.g. Jaffe and Palmer, 1997; Brunnermeier and Cohen, 2003). The impact of such innovations on productivity growth at the level of individual sectors or nations remains unclear, however, in the empirical literature.

4.3.4 Impacts on competitiveness

The higher prices at product markets will still result in some trade impacts. So far we lack insight on the potential magnitude of this effect. The empirical literature, however, has pointed out that these impacts are small (see Paragraph 3.5). Several economic modelling studies also show very moderate impact under an auctioning regime (e.g. CPB, 2008). As at the margin, the cost increase for auctioning and free allocation appears to be the same, we would expect a similar small effect of EU ETS in Phase 3 with free allocation as under the first two Phases of EU ETS: increase in product prices at the domestic markets which result in a loss of competitiveness. However, in the long-run there may be a gain in competitiveness due to innovation. At present it is not possible to balance both impacts in an empirical manner.

4.4 Remedies against windfall profits

This study has shown that windfall profits are likely to occur as long as emissions are allocated free of charge. Economists tend to view this primarily as a problem of equity rather than a problem of efficiency. If the companies act as perfectly rational and informed producers, decisions at the margin will be similar under auctioning and free allocation.

However, in the long-run, there may be differences due to the differences in behaviour in other markets. Windfall profits due to free allocation in essence imply that a transfer of income from consumers to the energy-intensive industry. Such a transfer may have negative consequences for the future of economic growth in the EU. As the costs of living of EU citizens will rise, EU citizens may want to pass these costs onto their employers (by demanding compensation for inflation). In that case, the EU ETS would imply a transfer of money from the labour-intensive industries towards the energy-intensive industries. This is counter-productive for any policy aiming to stimulate the EU as a knowledge economy. As such, this strategy is opposed to the goals of the Lisbon Strategy.

Therefore, there may be a rationale for the EU to investigate possibilities to reduce the windfall profits of energy-intensive industry. Below we explore two specific options.

4.4.1 Auctioning a larger share of emissions

A commonly advocated remedy for windfall profits is auctioning allowances instead of allocating them freely to existing units (Sijm, Neuhoff and Chen, 2006). Contrary to common belief, auctioning only diminishes windfall profits but does not need to tax them away completely. This is because the companies which can reduce emissions at a cost below the market price will do so up to the point where MAC equals price of allowances. The difference between the (opportunity) costs of allowances and the actual costs of abatement for a given firm can be seen as windfall profit[15]. Figure 14 shows in the dashed area the windfall profits that a company will make under auctioning if it has to reduce its emissions to E0.

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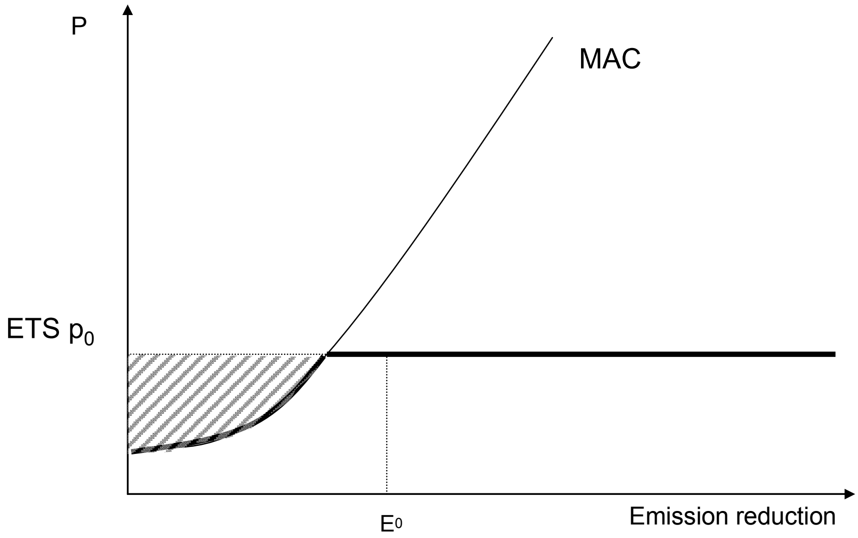
15 If we apply the definition that windfall profit occurs if additional revenue earned from the pass through of CO_2 (opportunity) costs to consumer prices exceeds the level of compliance costs incurred under that scheme by the producer (Point Carbon, 2008) and if we assume that the full (opportunity) cost is passed on in the new price of the product (so that $\Delta p = p_{CO2}$.

Figure 14 Marginal cost curve and potential windfall profits under auctioning



Nevertheless, auctioning will reduce windfall profits considerably and result in additional benefits for the functioning of EU ETS, such as:

4.4.2 Windfall profit tax

Windfall profits typically occur as a result of changes in governmental policy. In the past, there were a few cases where windfall profits were taxed, and even more where such a tax was postulated or being considered. The most prominent examples of applying windfall profit taxes come from Great Britain and the United States.

In Great Britain, the labour government imposed in 1997 a windfall tax on 33 private utilities privatized since 1983. The tax was designed to raise, in two equal instalments (in December 1997 and December 1998) £ 5.2 billion, to be used to fund the Welfare-to-Work programme, helping the young and long-term unemployed back into work.

Another example of windfall profit tax comes from the United States, where from 1980 to 1988 a tax on domestic oil production was levied as a way to compensate abolishing price controls that were in existence from 1971.
In April 1979 President Carter introduced plans to lift price controls gradually over the subsequent 18-month period. In tandem, he offered a new tax on oil production. "Unless we tax the oil companies, they will reap huge and undeserved windfall profits," Carter declared in a nationwide address. Americans had a right to recapture some of that windfall and put it to good use. Carter suggested that the revenue be earmarked for mass transit, oil price relief for poor families, and the development of alternative energy sources (Thorndike, 2005).

The US windfall profit tax on oil companies was in essence an excise tax, imposed on the difference between the market price of oil and a pre-determined base price. The base price was derived from 1979 oil prices, and it required annual adjustments for inflation and state severance taxes. The tax was designed to be temporary and was repealed in 1988. In its eight years of existence, the tax raised $ 79 billion in revenue but since those payments were deductible against income, effectively the net yield was reduced to about $ 40 billion.

Since 1988, no windfall profit tax has been enacted in the US, however, when gas prices were rising, there was renewed pressure on the US government to bring back the tax. In the two years running up to the 2008 presidential election, President Barack Obama routinely promised to enact a windfall profits tax on the oil and gas industry to fund a $ 1,000 per household energy rebate. Shortly after being elected, President Obama quietly dropped the promise from his agenda.

4.5 Remedies against carbon leakage

From various empirical and modelling studies it is shown that potential carbon leakage from unilateral climate policies is most likely to be small. However, from an economic and environmental point of view, it is wise to investigate how this risk can be minimized. In the revised Directive on EU ETS (2009/29/EC), free allocation was presented as a way to tackle carbon leakage. However, the assumption under which free allocation can be a remedy for carbon leakage is that companies do not pass through the opportunity costs of their freely obtained allowances into their product prices. Otherwise, they would obtain windfall profits and no change in competitive situation compared with auctioning. The empirical and theoretical research so far shows that free allocation does not serve this goal: product prices have been increased as opportunity costs were passed through in product prices. The question is therefore whether alternatives can be developed that do give companies a better protection against carbon leakage.

4.5.1 Auctioning and subsidizing innovation and energy savings

There is a non-legally binding commitment from EU member states to spend at least half of the revenues from auctioning to tackle climate change both in the EU and in developing countries. One of the ways to tackle carbon leakage would be to increase the share of auctioning and reinvest the revenues in measures that would make EU industries more competitive and at the same time cleaner.

In CE (2008) it was investigated whether the revenues from an auctioning scheme could be recycled to industry for subsidizing the unprofitable top of investments in energy saving measures. The study concluded that this would considerably lower the costs of complying with EU ETS for various sectors, especially those sectors where options for reduction of energy consumption exist. This may lower emission prices and therefore have a mitigating effect for all sectors that fall under the EU ETS. However, the study points out that the efficiency of the whole system would be lower than in the case of auctioning with lump-sum recycling of revenues, as technical measures to reduce emissions are then favoured over reductions in output. More studies seem to be needed to investigate the impacts of such a scheme.

4.5.2 Border tax adjustments

Border tax adjustments are fiscal measures which 1) enable exported products to be relieved from the taxes charged in the exporting country in order to alleviate the difference with the price of similar products in the destination country or 2) enable imported products to be charged with some or all of the tax that is charged in the importing country in respect to similar domestic products. In short, border tax adjustment can take a form of export subsidies and import tariffs or quotas. The subsidies may be applied for the exporters who are obliged to comply with CO_2 abatement policy in their home country while no such requirements are binding abroad. Alternatively, import tariffs may be imposed on imports of products which are not burdened with the costs of carbon.

The application of trade measures could serve as a sanction for countries that do not want to contribute to protect the global climate, but rather “free ride” on the efforts made by others. According to many, WTO law would provide justification for such a behaviour: if a given a set of preconditions are fulfilled, such discrimination could be undertaken to protect a global resource.

Border tax adjustments may be applied only to the sectors that are at most risk of carbon leakage. The sectors that are most often identified as being at risk of carbon leakage in modelling studies of the EU ETS are the steel, cement and aluminium sectors (Dröge and Cooper, 2010).

Border tax adjustments (BTA) can most efficiently be applied if all rights would be auctioned as a mean to alleviate the impacts on competitiveness. An efficient system of border tax adjustments consists of a combination of export subsidies and import tariffs. Companies from EU countries which export to other countries get a refund for the costs of CO_2 allowances they incurred during production according to a benchmark, e.g. the CO_2 emitted to produce the product according to the best available technology. A charge is imposed on imported products from non-EU countries according to the same benchmark.

In the case of border tax adjustments according to a benchmark, the way it works is the same as free allocation of allowances on the basis of a benchmark, except for the important fact that the working is refined to production for the exports and imports only. Production by the exposed sectors for the internal market is *not* subsidized but companies can now pass on the costs of allowances into their prices. Therefore, border tax adjustments are in theory more efficient than benchmarking, by confining the potential inefficiency to the smallest share of total production, though the politics is admittedly very complex.

4.5.3 Shifting the base from production to consumption

The problem of carbon leakage stems from the fact that capital is a mobile production factor seeking the highest profits. However, the fact that capital is internationally mobile poses a threshold on the use of economic instruments that aim to add costs to production. Obviously, fiscal instruments do raise costs for companies and therefore be adding to the problem of shifting the environmental burden instead of alleviating it.

Therefore, a reconsideration of the fiscal tax regime should be considered where it is investigated whether the current environmental tax base (pressing mostly on *production*) could not be altered towards *consumption*. Consumption based taxes have the advantage of giving the right incentives at the consumption level but at the same time not aggravating the relocation of dirty industries towards other countries. Consumption based taxes can add towards a better level playing field between EU and non-EU industries as their products fall equivalently under the tax regimes.

This is especially pressing in specific environmental problems like CO_2.
At present the progress on CO_2 reduction policies is severely hampered by the fact that unilateral climate change policies may result in relocation of energy-intensive industries and thereby resulting in carbon leakage. This undermines the effectiveness of these policies at the global scale. Moreover, it reduces the willingness of politicians in developed economies to accept more stringent reduction targets.

At present, the most successful policies for CO_2 reduction largely press on companies (like with the EU ETS). Ultimately, however, a transformation to a low carbon economy should also be achieved through consumption. Consumer decisions are based on relative prices and preferences on which they spend their income. It is therefore important that environmental policy that is aimed at producers will be translated into price changes at consumer level.

One way to achieve this would be to introduce an explicit tax on carbon consumed. This could be done with analogy to the value added tax and is proposed in a few papers (but not really developed): a tax on the Carbon Added (CAT) of products. The system of CAT works in essence similar to the tax system of a VAT. Under a CAT only the input of carbon is being taxed, while in a VAT in essence the input of labour and capital are being taxed (see De Bruyn, 2010).

Although this may seem a promising direction of long-term climate policies, it does not resolve any concrete impacts of the ETS now in the immediate future.

4.6 Conclusions

Phase 3 of EU ETS will start in 2013. The question is whether the changes in allocation rule make a different situation with respect to the possibilities of windfall profits of energy-intensive companies.

Compared to the previous phases, the EU ETS will now most likely result in a binding cap, especially for the energy-intensive industry. In addition to the auctioning for the electricity producers, harmonized allocation rules introducing benchmarks and transitional free allocation schemes will result in a larger share of emission allowances to be auctioned. However, the total amount of emissions that fall under an auctioning scheme most likely is still relatively small, about 10%. The introduction of benchmarks nevertheless presses especially on the energy-intensive marginal firm that, most likely, is already not very profitable. As the real average costs for this company increase due to the allowances above the benchmarks that have to be bought on the emission market, this company *must* pass through the costs of the emission allowances into the product prices or it will go bankrupt.

While the cost-pass-through in Phases 1 and 2 could still be regarded as a rational company decision aiming to maximize profits, it can be regarded in Phase 3 as a rational company rule. The higher prices on EU markets will have impacts on innovation, competitiveness and carbon leakage. Compared to Phases 1 and 2, the allocation in Phase 3 results in a greater stimulus for innovation due to the benchmarks. These benchmarks should be periodically lowered over the course of Phase 3 to remain effective. If innovation results in cost savings, a small positive impact from Phase 3 on competitiveness can be expected for energy-intensive industries. This is, however, counteracted by the adverse impacts free allocation has on non-energy-intensive industries. Since the energy-intensive companies pass through the costs of their freely obtained allowances into the product prices to obtain windfall profits, the European consumers are paying the bill by paying higher costs for their consumer durables. As such higher costs tend to be passed through onto the labour market, free allocation in EU ETS effectively implies a shift of income from labour-intensive industries towards energy-intensive industries. Such an impact contradicts the goals outlined in the Lisbon Strategy.

5 Conclusions

The EU emissions trading scheme (EU ETS) is the keystone of the EU climate policy and the largest emission trading scheme in the world. As its scope and scale are unprecedented, it is wise to regard the EU ETS policy framework as a learning process – a process where past experiences are being evaluated which result in policy adaptations in the future. Policy research facilitates this process: by investigating the impacts and effects of past-ETS experiences, it can show omissions and indicate which directions of improvements are possible. Recent empirical research by CE Delft showed that one of these omissions is the generation of windfall profits in energy-intensive sectors.

This paper investigated the motives of companies that are suddenly faced with an emission trading system. Profit-maximizing firms have a strong impetus to include opportunity costs in their firm operations; otherwise they will not be profit-maximizing. This result is also shown in questionnaires and experimental economics. The possibilities to pass through the costs, however, fully depend on the characteristics of the product markets. Although the theoretical literature identified a number of arguments why firms can pass through (part of) their opportunity costs into the product prices, this question can only be addressed through empirical work.

The earlier empirical research by CE (2010) showed that energy-intensive companies in general were able to obtain higher prices in the EU by passing through these opportunity costs. In this way they have obtained a windfall profit due to EU ETS. This result was not obtained by “omitting an important variable”, as some have claimed as the input prices in production show very little correlation at all with CO_2 spot prices.

In Phase 3 such windfall profits are most likely to continue. This is because the marginal company operating at the market most likely faces the highest cost increase due to the introduction of benchmarks. These costs must be covered; otherwise the company will go bankrupt. Hence, the marginal company, which can be regarded as the price-setter on some markets, has to raise its prices to cover the higher costs of buying emissions allowances above the benchmarks.

While the cost-pass-through in Phases 1 and 2 could still be regarded as a potential outcome, the design of Phase 3 creates stronger pressure on the market to pass through the costs. The higher prices on EU markets will impact innovation, competitiveness and carbon leakage. Compared to Phases 1 and 2, the allocation in Phase 3 has higher stimulus for innovation due to the benchmarks. These benchmarks should be periodically lowered over the course of Phase 3 to remain effective. If innovation results in cost savings, a small positive impact from Phase 3 on competitiveness can be expected for energy-intensive industries. This is, however, counteracted by the adverse impacts free allocation has on non-energy-intensive industries and the increase in prices due to the presence of windfall profits. Alternatives, such as auctioning a larger share of emissions and recycling the revenues to energy saving subsidies may lower costs of complying with EU ETS and lower eventual adverse impacts on competitiveness and purchasing power of citizens.

Literature

Åhman ***et al.*****, 2006**
M. Åhman, D. Burtraw, J.A. Kruger, L. Zetterberg
A Ten-Year Rule to guide the allocation of EU emission allowances
In : Energy Policy, vol. 35, no.3 (2006); p. 1718-1730

Anderson ***et al*****., 2009**
B.J. Anderson, C. Di Maria and F. Convery
Abatement and Allocation in the Pilot Phase of the EU ETS
S.l. : Fondazione Eni Enrico Mattei (FEEM), 2009
Available at : http://ssrn.com/abstract=1417962

Van Beers and Van den Bergh, 1997
C. van Beers, J.C.J.M. Van den Bergh
An Empirical Multi-Country Analysis of the Impact of Environmental Regulations on Foreign Trade Flows
In : Kyklos, vol. 50, no. 1 (1997); p. 29-46

Betz R., Rogge K., Schleich J., 2006
EU Emissions Trading: An Early Analysis of National Allocation Plans for 2008-2012
In : Climate Policy 6 (4), pp. 361-394

Blok ***et al*****., 2004**
K. Blok, H.L.F. de Groot, E.E.M. Luiten, M.G. Rietbergen
The Effectiveness of Policy Instruments for Energy-Efficiency Improvement in Firms: The Dutch Experience
Dordrecht, Boston, London : Kluwer Academic Publishers, 2004

Brannlund and Lundgren, 2009
R. Brannlund, T. Lundgren
Environmental policy without costs? A review of the Porter hypothesis
S.l. : Sustainable Investment Research Platform, 2009
http://swoba.hhs.se/sicgwp/abs/sicgwp2009_001.htm

Brunnermeier and Cohen, 2003
S.B. Brunnermeier and M.A. Cohen
Determinants of environmental innovation in US manufacturing industries
In : Journal of Environmental Economics and Management 45 (2003); p. 278-293

Brunnermeier and Levinson, 2004
Smita B. Brunnermeier and Arik Levinson
Examining the Evidence on Environmental Regulations and Industry Location
In : Journal of Economic Development, vol.13, no. 1, (2004); p. 6-41

De Bruyn, 2010
Economische wetenschap en handelingsperspectieven: meer dan een energieheffing! (in Dutch)
http://www.klimaatmatrix.nl/images/publicaties/20100920%20am%20geloofsbrief%20economie.pdf

CE, 2008
Sander de Bruyn, Dagmar Nelissen, Marisa Korteland, Marc Davidson, Jasper Faber, Gerdien van de Vreede
Impacts on Competitiveness from the EU ETS
An analysis of the Dutch Industry
Delft : CE Delft, 2008

CE, 2010a
Sander de Bruyn, Agnieszka Markowska, Femke de Jong, Mart Bles
Does energy-intensive industry obtain windfall profits through the EU ETS?
An econometric analysis for products from the refineries, iron and steel and chemical sectors
Delft : CE Delft, 2010

CE, 2010b
Sander de Bruyn, Agnieszka Markowska, Marc Davidson
Why the EU could and should adopt higher greenhouse gas reduction targets
A literature review
Delft : CE Delft, 2010

Coase, 1960
R.H. Coase
The problem of social cost
In : Journal of Law and Economics, 3 (1960); p. 1-44

Conforti, 2004
Piero Conforti
Price transmission in selected agricultural markets
Rome : FAO, Commodities and Trade Division, 2004
ftp://ftp.fao.org/docrep/fao/007/j2730e/j2730e00.pdf

Cook, 2009
Gregory Cook (Carbon Counts Ltd)
Climate Change and the Cement Industry : Assessing emissions and policy responses to carbon prices
Cambridge : Climate Strategies, 2009

Cournot, 1971
A.A. Cournot
Researches into the mathematical principles of the theory of wealth 1838
With an essay, Cournot and mathematical economics and a Bibliography of mathematical economics
New York : A.M. Kelly,1971
In : Asche *et al.*, 2004

Dales, 1968
J.H. Dales
Pollution, Property and Prices
Toronto : University of Toronto Press, 1968

DeCanio, 1993
S. DeCanio
Barriers within firms to energy-efficient investments
In : Energy Policy vol. 21, no.9 (1993); p. 906-914

Dröge and Cooper, 2010
Susanne Dröge and Simone Cooper
Tackling Leakage in the World of Unequal Carbon Prices: A study for the Greens/EFA group, May 2010

Ecofys *et al*., 2009
Ecofys, Fraunhofer Institute for Systems and Innovation Research, Öko-Institut
Methodology for the free allocation of emission allowances in the EU ETS post 2012 : Sector report for the cement industry
S.l. : European Commission, 2009

Ederington and Minier, 2003
J. Ederington, J. Minier
Is Environmental Policy a Secondary Trade Barrier?
An Empirical Analysis In : Canadian Journal of Economics, vol. 36, no.1, (2003); p. 137-154
In : Jug and Mirza, 2005

Ellerman and Buchner, 2008
A.D Ellerman and B.K Buchner
Over-Allocation or Abatement? A Preliminary Analysis of the EU ETS Based on the 2005-06 Emissions Data
In : Environmental and Resource Economics, vol. 41, no.2 (2008); p. 267–287

EU, 2005
McKinsey/Ecofys
Review of EU Emissions Trading Scheme: Survey Highlights
Brussels : European Commission, Directorate General for Environment, 2005

Grubb and Neuhoff, 2006
M. Grubb and K. Neuhoff
Allocation and competitiveness in the EU emissions
trading scheme : policy overview
In : Climate Policy, no.6, vol.1, p. 7-30, 2006

Harris *et al*., 2002
M.N. Harris, L. Konya, L. Matyas
Modelling the Impact of Environmental Regulations on Bilateral Trade Flows OECD, 1990-1996
In : The World Economy, vol. 25, iss. 3 (2002); p. 387-405
In : Jug and Mirza, 2005

Jaffe *et al*., 1995
A.B. Jaffe, S.R. Peterson, P.R. Portney
Environmental Regulation and the Competitiveness of U.S. Manufacturing: What Does the Evidence Tell Us?
In : Journal of Economic Literature, American Economic Association, vol. 33, no. 1 (1995); p. 132-163

Jaffe and Palmer, 1997
A.B. Jaffe and K. Palmer
Environmental Regulation and innovation: a panel data study
In: Review of Economics and Statistics, Vol. 79, No.4 (1997); p. 610-619

Jug and Mirza, 2005
J. Jug, D. Mirza
Environmental Regulations in Gravity Equations : Evidence from Europe
In : The World Economy, vol. 28, no. 11 (2005); p. 1591-1615

Kettner et al, 2008
C. Kettner, A. Köppl, S. Schleicher, and G. Thenius
Stringency and distribution in the EU Emissions Trading Scheme: first evidence
In : Climate Policy, Vol.8, No. 1 (2008); p. 41-61

Levinson and Taylor, 2004
A. Levinson, S. Taylor
Unmasking the Pollution Haven Effect
Cambridge, MA : National Bureau of Economic Research, Inc., 2004
In: Jug and Mirza, 2005

Sandbag, 2009
Anna Pearson and Bryony Worthington
ETS S.O.S.: Why the flagship "EU Emississions Trading Policy" needs rescuing
http://sandbag.org.uk/files/sandbag.org.uk/Sandbag_ETS_SOS_Report.pdf

Sijm *et al*., 2005
J.P.M. Sijm, S.J.A. Bakker, Y. Chen, H.W. Harmsen, W. Lise
CO_2 price dynamics: The implications of EU emissions trading for the price of electricity
Petten : Energieonderzoek Centrum Nederland (ECN), 2005

Sijm *et al*., 2006
J. Sijm, K. Neuhoff, Y. Chen
CO_2 cost-pass-through and windfall profits in the power sector
In : Climate Policy, vol. 6 (2006); p. 49-72

Sijm *et al*., 2008
J. Sijm, S. Hers, W. Lise, B. Wetzelaer
The impact of the EU ETS on electricity prices
Petten : Energieonderzoek Centrum Nederland (ECN), 2008

Sijm *et al*., 2009
J. Slijm, Y. Chen, F. Hobbs
The impact of power market structure on the pass-through of CO_2 emissions trading costs to electricity prices – A theoretical approach
Paper: presented at the 17^{th} Annual Conference of the European Association of Environmental and Resource Economics (EAERE), Amsterdam, June 24-27, 2009

SNM, 2009
The impact of the Renewable Energy Sources Directive (RES) on the European Emission Trading Scheme (EU ETS)
Utrecht : Stichting Natuur en Milieu (SNM), 2009

Stigler, 1969
G.J. Stigler
The Theory of Price
London : Macmillan, 1969

Tietenberg, 1984
T.H. Tietenberg
Environmental and Resource Economics
Illinois : Scott, Foresman and Company, 1984

Thorndike, 2005
Joseph Thorndike
Historical Perspective: The Windfall Profit Tax – Career of a Concept
http://www.taxhistory.org/thp/readings.nsf/cf7c9c870b600b9585256df80075b9dd/edf8de04e58e4b14852570ba0048848b
Accessed on 13 September 2010-09-14

Wrake *et al*., 2010
Markus Wrake, Erica Myers, Dallas Burtraw, Svante Mandell, Charles Holt
Opportunity Cost for Free Allocations of Emissions Permits: An Experimental Analysis
In : Environmental & Resource Economics, European Association of Environmental and Resource Economists, vol. 46, no.3 (2010), pages 331-336