

Discussion Paper No. 06-018

**Efficiency Losses from Overlapping
Economic Instruments in
European Carbon Emissions Regulation**

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Economic Research

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Non-Technical Summary

Energy markets and energy-intensive industries in all EU member states – especially in Germany – are subject to a diverse set of policies related to climate change. The main climate policy instrument within the European Union is the EU Emissions Trading System (EU ETS) which is in place since 2005. In policy practice, the launch of a new regulation in general does not (fully) replace existing policy instruments that may have been established with similar policy objectives. Thus, a new regulation often operates in parallel and interacts with previous regulation. There are several considerations as to why a mix of policy instruments might be preferable to a single instrument. Differentiated instruments can be justified if there are additional or multiple objectives to be implemented by the policy, such as political, social or technology-related criteria that may conflict with pure (static) efficiency considerations. Second-best regimes, which are characterised by initial market distortions or imperfections, e.g., provide a general argument for differentiated regulation. Such regimes include situations with uncertainty, external knowledge spillovers, initial tax distortions, market power, transaction costs, etc. In climate policy design, sector-specific differences in transaction costs have, e.g., been used as an argument for applying different climate policy instruments to different economic sectors.

The following analysis abstracts to a large extent from market distortions and instead focuses on the static efficiency implications of emission taxes imposed on energy-intensive sectors that are in addition subject to the EU ETS. The potential efficiency losses from a simultaneous application of both instruments in qualitative and quantitative terms are analysed within a partial equilibrium framework for the EU.

It turns out that those firms within the EU ETS which at the same time are subject to domestic energy or carbon taxes will abate inefficiently much while other firms within the EU ETS will benefit from lower international emission permit prices. The same logic disproves the argument that additional national emission taxes will reduce inefficiencies in abatement supposed to be resulting from allowance (over-) allocation. In essence, unilateral emission taxes within the EU ETS are ecologically ineffective and subsidise net permit buyers. Thus, all firms that are subject to emissions trading and any CO₂ emission taxes at the same time should be exempt from the latter. The foregone tax revenue could be generated by auctioning a small fraction of the permits instead. This would be cheaper for the emissions trading sectors as a whole and could be compatible even with the tight auctioning restrictions of the EU directive.

Efficiency Losses from Overlapping Economic Instruments in European Carbon Emissions Regulation

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Abstract: Energy markets and energy-intensive industries in all EU member states – especially in Germany – are subject to a diverse set of policies related to climate change. We analyse the potential efficiency losses from simultaneous application of emission taxes and emissions trading in qualitative and quantitative terms within a partial equilibrium framework for the EU. It turns out that those firms within the EU Emissions Trading Scheme (EU ETS) which at the same time are subject to domestic energy or carbon taxes will abate inefficiently much while other firms within the EU ETS will benefit from lower international emission permit prices. The same logic disproves the argument that additional national emission taxes will reduce inefficiencies in abatement supposed to be resulting from allowance (over-) allocation. In essence, unilateral emission taxes within the EU ETS are ecologically ineffective and subsidise net permit buyers. Thus, all firms that are subject to emissions trading and any CO₂ emission taxes at the same time should be exempt from the latter. The foregone tax revenue could be generated by auctioning a small fraction of the permits instead. This would be cheaper for the emissions trading sectors as a whole and could be compatible even with the tight auctioning restrictions of the EU directive.

Keywords: emissions trading, emission taxes, National Allocation Plans

JEL Classifications: D61, H21, H22, Q58

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1. Introduction

The main climate policy instrument within the European Union is the EU Emissions Trading System (EU ETS), in place since 2005 (EU 2003, 2004). In policy practice, the launch of a new regulation in general does not (fully) replace existing policy instruments that may have been established with similar policy objectives. Thus, a new regulation often operates in parallel and interacts with previous regulation (see Johnstone, 2003, or Sorrell and Sijm, 2005, for an overview).

The objective of this paper is to shed some light on the economic efficiency implications associated with the co-existence of the EU ETS and emission or energy taxes levied at the member state level. According to basic economic principles, “the use of a mix of policies” in order to pursue a single policy objective “will be at best redundant and at worst counterproductive” (Johnstone, 2003). If there is an efficient instrument to implement an environmental target, it makes little sense to introduce an additional one. Nevertheless, it is in the nature of environmental policy in a federal system such as the EU that instruments introduced on a European level are complemented by instruments of the member states.

From a more subtle theoretical point of reasoning, there are several considerations as to why a mix of policy instruments might nevertheless be preferable to a single instrument. Differentiated instruments can be justified if there are additional or multiple objectives to be implemented by the policy, such as political, social or technology-related criteria that may conflict with pure (static) efficiency considerations. Second-best regimes, which are characterised by initial market distortions or imperfections, e.g., provide a general argument for differentiated regulation. Such regimes include situations with uncertainty, external knowledge spillovers, initial tax distortions, market power, transaction costs, etc. In climate policy design, sector-specific differences in transaction costs have, e.g., been used as an argument for applying different climate policy instruments to different economic sectors.

The following analysis abstracts to a large extent from market distortions and instead focuses on the static efficiency implications of emission taxes imposed on energy-intensive sectors that are in addition subject to the EU ETS. In this context, two popular arguments in favour of an additional emission tax on residual emissions from ETS sectors will be critically discussed and finally disproved in this paper:

1. A tax would help to bring down the emissions. This would be ecologically beneficial and help to reach the emission target of the EU burden sharing agreement.
2. Given that the allocation of permits to the trading sectors has been very generous, the marginal abatement costs (in the trading sectors) can be expected to be lower than in

the rest of the economy. A tax would bring the marginal abatement costs in the ETS sectors closer to the efficient level. The tax could therefore be used as a second-best instrument to increase the efficiency of national or EU wide abatement.

The paper is structured as follows: Chapter 2 first introduces a simple model suitable to deal with the EU ETS. This will be followed by an analytical discussion of the interaction of the emissions trading system and emission taxes outside of and within the EU ETS. Chapter 3 will then present a quantitative numerical illustration for the former EU 15. The last chapter will conclude the paper and summarize the main results.

2. A model for emissions regulation in the EU member states

In the following the effects of possible overlaps of existing CO₂ emissions regulations with the EU ETS are illustrated on the basis of a simplified partial model for the emission permit market. Each member state is represented by the abatement cost functions of two sector groups. The first one (DIR sectors) includes all sectors and firms that are subject to the EU trading directive (including the power sector, oil refining, several energy-intensive industries). The second one (NDIR sectors) covers all sectors outside the scope of the directive (including private households, transport, trade). As it is prescribed by the EU trading directive, the DIR sectors are allocated their emission budget and can trade the permits thereafter. In contrast, the NDIR sectors do not participate in trade. In order to achieve their national Kyoto targets, the member states are required to take complementary action in these sectors. In the following it is assumed that the emission reductions in the NDIR sectors are implemented cost efficiently by emission taxes.¹

This section starts with a brief comment on the aggregation of individual abatement cost functions into one aggregate function (Section 2.1). Section 2.2 summarises the key issues related to designing the National Allocation Plans (NAPs) and points out how the initial permit allocation relates to the optimal use of taxes in the NDIR sectors. These introductory remarks are followed by an analysis of how permits and emission taxes interact within the European trading scheme. This is at first done for identical scopes of tax and permit regulation in all EU member states (Section 2.3) and then for the case that taxes are applied in

¹ Theoretically, in order to examine the resulting aggregate burden on both sector groups within a country, more detail on the use of tax revenues is necessary. Revenue recycling issues, however, will be ignored in the following. For reasons of simplicity, the analysis concentrates on the efficiency effects (in terms of the allocation of abatement measures) on the level of member states or the whole EU.

the DIR sectors in addition to the trading scheme (Section 2.4), also assuming first an efficient base case and then a suboptimal initial permit allocation.

2.1. Potential efficiency loss from suboptimal aggregation of marginal abatement costs

A central role in minimising the abatement costs across different sources is played by the (marginal) abatement cost functions: If marginal abatement costs of two sources are equal, then their common abatement is implemented at minimum costs. Assume that the two sectors of the economy, DIR and NDIR, are represented by the marginal abatement cost functions $C'_D(e_D)$ and $C'_N(e_N)$, respectively. The aggregated marginal abatement cost function $C'_{TOT}(e_{TOT})$ can be derived from the “horizontal sum” of the separate marginal abatement cost functions: The functions $C'_D(e_D)$ and $C'_N(e_N)$ are aggregated to $C'_{TOT\min}(e_{TOT})$ in Figure 1.

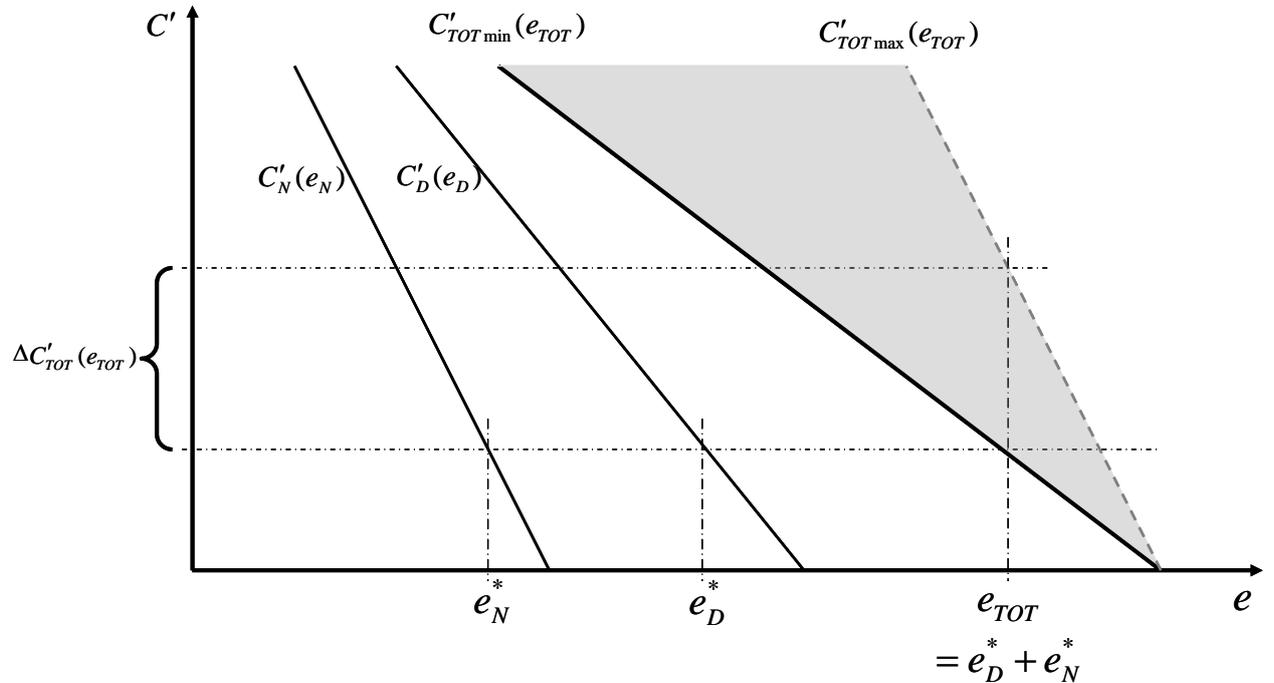


Figure 1: Aggregation of two marginal abatement cost functions.

Although this is common knowledge, one should keep in mind that $C'_{TOT\min}(e_{TOT})$ is already the result of minimising the sum of abatement costs for a given emission level, i.e. at $e_{TOT} = e_D + e_N$ there is $C'_D(e_D) = C'_N(e_N)$. In principle, the aggregated abatement cost function depends on both emission levels according to $C_{TOT}(e_D, e_N) = C_D(e_D) + C_N(e_N)$. Even under the constraint $e_{TOT} = e_D + e_N$ the deviation from the optimal emission levels of the single sectors will cause the aggregated marginal abatement costs to increase. In the worst case, all abatement is achieved exclusively by the sector with the higher marginal abatement

costs leading to $C'_{TOT\max}(e_{TOT})$. The shaded area in Figure 1 indicates the range of the marginal abatement costs if non-optimal allocation between the sectors is permitted.

This aggregation problem should be recalled while discussing the EU ETS, where several parts of the economy are regulated in different ways. It is in fact at least plausible that the emission regulation resulting from a political process will hardly match the optimal distribution of abatement activities among the two sectors.

2.2. The challenge of designing allocation plans in the EU ETS

It is one of the strengths of permit trading regimes that in theory the efficiency is independent of the initial permit allocation. The emissions trading scheme implements a given emission target at least costs but only *among the sectors that are trading* the emissions. Since the EU ETS does not cover the whole economy, but only the DIR sectors, the overall efficiency of emission reduction is affected by the initial allocation of emission reductions between DIR and NDIR sectors such as defined in the NAP. In this context, the regulator faces a grave information problem: To design an efficient NAP – allowing for equalisation of marginal abatement costs across these sectors and countries – the regulator needs to know the (marginal) abatement costs of the NDIR sectors in all countries. Furthermore, he has to anticipate the market price for pollution permits in order to assign the efficient amounts to the national NDIR sectors. Therefore one source for inefficiencies in abatement may already be the allocation of the emissions budget to the sectors not subject to emissions trading according to the NAP Macro plan for sectors and branches. In terms of the cost functions in Figure 1 this means, the distribution of emissions (or abatement) between the sectors DIR and NDIR can cause the total marginal abatement costs to deviate from the aggregated optimum $C'_{TOT\min}(e_{TOT})$. Obviously, at the macro level there is a trade-off between issues of competitiveness, efficiency, and compensation in designing NAPs (see Böhringer and Lange, 2005a, or Böhringer et al., 2005, for a comprehensive analysis).

However, despite the central role that the NDIR sectors (in particular private households and transport) play for the cost efficiency of the European CO₂ reduction policy, in most member states the discussion in the run-up to the NAPs was dominated by the burden on the DIR sectors. According to this, many analyses conclude that the actual NAP Macro plans contain a “too generous” allocation to the DIR sectors, leading to comparatively high reduction requirements on the part of the NDIR sectors while leaving the DIR sectors with a comparatively lax reduction requirement (e.g. Betz et al., 2004).

2.3. Taxes and EU ETS with identical scope in all EU member states

We begin with the assumption that the NDIR sectors are regulated separately (e.g. by country-specific emission taxes), while the DIR sectors in all EU member states are comprehensively subject to emissions trading and additional uniform emission taxes at the same time. This case of two overlapping emission regulating regimes with identical scope is well known in theory and turns out to be relatively straightforward: The emitters see both, the price of the permits and the tax, and abate until their marginal abatement cost equals the emission tax plus the permit price. Therefore this regime does not differ substantially from the case where only permits are issued (or only a tax is levied such that the given level of emissions is implemented) unless the tax is high enough such that the amount of permits is not binding. The permit price would then be zero and the emissions would be below the level targeted by the number of permits. In this case the tax could also be viewed as a “backstop” to ensure a minimum of abatement efforts.

Therefore, unless both instruments are binding, tax and emissions trading regimes with identical scopes do not necessarily coincide with fundamental efficiency problems. But it complicates the regulation and is thereby likely to increase the transaction costs. Most of all, it has no ecological effect since the tax is compensated by a lower permit price unless the price is zero and the permit scheme becomes dispensable.

2.4. Additional taxes within the DIR sectors in only several EU member states

Suppose again that the NDIR sectors are regulated separately. However, in contrast to the previous section and more closely mirroring reality, it is now assumed that the tax system is not introduced EU-wide but only in one or several countries. Actually, several EU countries have already introduced CO₂ or energy taxes during the last years. In Germany, for example, both the NDIR and the DIR sectors are subject to an energy tax with reduced tax rates for the DIR sectors (see BMU 2003).

First of all, it should be seen clearly that an additional tax has no ecological effect itself. This holds despite the first of the two arguments mentioned in the introduction. Recall,

1. A tax would help to bring down the emissions. This would be ecologically beneficial and help to reach the emission target of the EU burden sharing agreement.

Here, it is helpful to comment on two aspects. First, once the NAPs are established, the emission budget is allocated to the DIR sectors. Any reduction efforts in the DIR sectors thereafter lead to permit transfers but they are not relevant to the target formulated in the EU Burden Sharing Agreement. Second, one of the major strengths of a permit trading system is its ecological effectiveness as it is a quantity-based instrument. Any price based mechanism

within this regime will not alter the ecological effectiveness. Additional taxes in some countries within the trading scheme will lead to permit export to other regions of the trading scheme where no tax is applied. The overall ecological effect will be zero, unless the tax is sufficiently high and applied in a sufficient number of countries such that the permit price is driven down to zero and the trading scheme is not binding anyway. The tax acts as a lower bound to the abatement expenditures.

Furthermore, starting from an EU wide efficient allocation of emission permits with equalised marginal abatement costs, it is obvious that introducing an additional emission tax in the DIR sectors in a single country would typically produce inefficiencies (in Figure 1, the resulting total marginal abatement cost curve would deviate from the minimum cost curve). The tax drives marginal abatement costs apart and introduces inefficiencies on both the member state and EU level. The open question is whether results may change when two specific cases are considered: over-allocation of permits to the DIR sectors (Section 2.4.1) and market power of the country that introduces a tax to the DIR sectors in addition to EU ETS (Section 2.4.2).

2.4.1. Assuming over-allocation to the DIR sectors

Now assume an over-allocation of emission permits to the sectors subject to the emissions trading scheme in a country. Over-allocation to the DIR sectors is defined by an inefficient allocation of emission reductions between the NDIR and DIR sector, implying higher marginal abatement costs for the NDIR sectors than for the DIR sectors (the latter are expressed by the ex-post permit price). Remember the second argument formulated in the introduction:

2. The marginal abatement costs (in the DIR sectors) are by definition too low in case of an over-allocation of permits. A tax would bring the marginal abatement costs in the DIR sectors closer to the external costs and closer to the efficient level. The tax could therefore be considered as a second-best instrument to increase the efficiency of the national or EU wide abatement.

Consider an open economy represented by the marginal abatement cost function of their DIR and NDIR sectors. According to the assumption of an over-allocation the national emission budget is allocated to both sectors such that the marginal abatement costs in the NDIR sectors, τ_N , exceed the permit price on the European market, p . For now, assume that the permit price is not significantly influenced by the domestic action (small country assumption). This situation is illustrated in Figure 2.

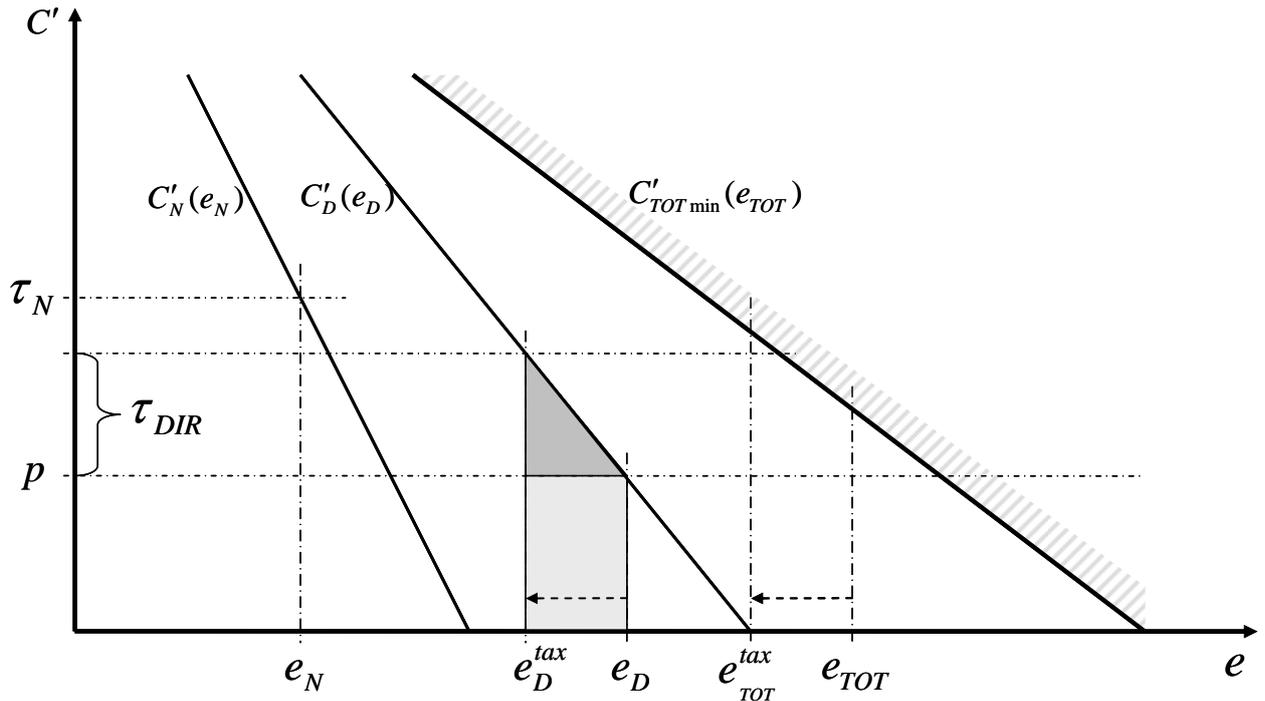


Figure 2: Unilateral emission tax in the DIR sector. The dark shaded triangle marks the efficiency costs.

In addition to the permit regime the DIR sectors are confronted with a tax τ_{DIR} . This lifts up the incentive to reduce emissions within the taxed region such that the marginal abatement costs of the DIR sectors will equal $p + \tau_{DIR}$. For a small open economy these additional abatement efforts will leave the permit price unchanged.

The shaded areas in Figure 2 illustrate the tax-induced efficiency effects. On the one hand, reducing emissions from e_D to e_D^{tax} will lead to a surplus due to the sale of permits (light shaded rectangular area). For reasons of simplicity, we assume that the use of these revenues at the firm level does not have any efficiency implications. On the other hand the additional abatement costs are given by the area under the abatement curve (dark triangle plus light shaded rectangle). Per saldo, the tax leads to additional efficiency costs, represented by the dark shaded triangle.

The EU ETS implements any given EU-wide target for the DIR sectors at minimum costs – independent of whether the country-specific NAP leads to over-allocation or not. An additional tax within the trading scheme cannot change the distribution between the DIR and NDIR sectors ex post. It brings the marginal costs closer to what would have been the optimal level across all emitters in the EU given that the NAPs had been designed in a cost-efficient manner, but only in the region where the tax is applied. Due to the strict division of the DIR

and NDIR parts of the economy, taxes do not act as an instrument to implement a second-best solution.

Therefore, a unilaterally introduced tax drives apart the marginal abatement costs within the DIR sectors of the different regions and leads to efficiency losses.

To conclude: An additional tax on firms of the DIR sectors in a single member state (which does not have any market power on the EU permit market) is costly for the member state, increases the EU overall implementation costs of the emissions target and has no ecological effect.

2.4.2. *Assuming a large economy with market power*

We now relax the assumption of a small member state. This means that the tax-induced increase of permit supply on the EU permit market will lower the EU-wide permit price. As in the case of a small open economy, the additional tax will drive apart the marginal abatement costs within the DIR sectors of the different countries and therefore generate a cost burden for the EU as a whole.

A large open economy may under specific assumptions benefit from the introduction of a small tax.² If the member state imposing the tax (i) is a net permit importer (before and after implementing the tax), (ii) has relatively flat marginal abatement costs in the DIR sectors and (iii) generates a sufficient amount of emission reduction by the tax so that the market price for permits falls substantially, then the lower import price for permits and the reduced amount of permits to be imported can compensate for the increased abatement efforts such that the country can make a net profit from introducing the tax.³

Figure 3 illustrates this point. The ex ante permit allocation to the DIR sectors is denoted by e_D^{alloc} . Before introducing the tax the emission level is such that the marginal abatement costs of the DIR sector equal the permit market price p , i.e. e_D . The introduction of a tax τ_{DIR} will act as an additional reduction incentive on top of the permit price, the emissions fall to e_D^{tax} and the lower permit demand causes the price to fall to the after-tax level p_{tax} .

² This effect is well known in the literature on international trade, where an import duty in a big country may lower domestic import demand and world market prices, leading to a net gain for the country (“beggar-thy-neighbour-policy”).

³ Note that it is undetermined whether the sector itself benefits. The way the tax revenues are recycled can have an impact on the overall costs of a regulation as is demonstrated in Goulder (1995) or Bovenberg (1999).

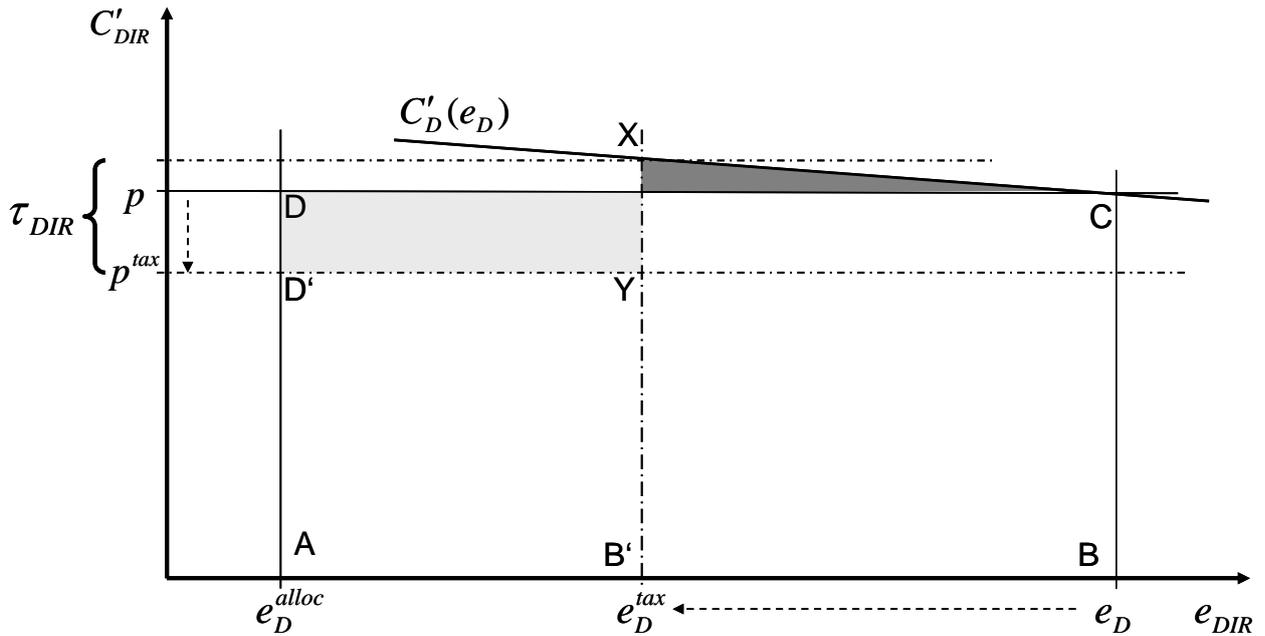


Figure 3: A large net permit importer may benefit from a unilateral emission tax.

We now compare the two situations before and after the tax is imposed. Before, the import expenditures of the country are illustrated by the rectangular area $ABCD$. The increased reduction effort and the lower permit price after the tax is introduced impose (abatement) costs on the DIR sector equal to the area $B'BCX$. On the other hand the import expenditures are reduced, and the new expenditures are represented by the area $AB'YD'$. Therefore, whether the country benefits from the tax or not is now determined by the dark and the light shaded areas. If the light shaded rectangular area exceeds the dark shaded triangular area – as is the case in Figure 3 – then the country benefits from the tax in the DIR sectors.

It is a matter of quantitative analysis whether the conditions are met by any EU member state. However, the conditions appear restrictive since countries with flat (marginal) abatement cost functions tend to turn out permit exporters rather than importers. Moreover, it is questionable whether any of the EU member states has a sufficient market share to substantially drive down the permit price by unilateral action. Germany, for example, as the biggest market, represents roughly a quarter of the whole European permit market.

3. Quantitative illustration for the EU 15

In this section, the effects of the hypothetical introduction of an additional CO₂ tax in selected countries will be analysed using a simple numerical partial equilibrium model of the EU carbon market. After a brief description of the model parameterisation in Section 3.1 simulation results of a set of scenarios will be presented and discussed in Section 3.2.

3.1. Permit market model

The model used includes the EU 15 carbon market. All member states are represented by separate marginal abatement cost curves for the sectors covered by the emissions trading directive (*DIR*) and the sectors *not* covered (*NDIR*).

Marginal costs of emission abatement may vary considerably across countries and sectors due to differences in carbon intensity, initial energy price levels, or the available carbon substitution possibilities. Basically, the derivation of continuous marginal abatement cost curves requires a sufficiently large number of discrete observations for marginal abatement costs and the associated emission reductions. These data can be generated by technology-oriented partial equilibrium models of the energy system (such as the POLES model by Criqui and Mima, 2001, or the PRIMES model by Capros et al., 1998) or by computable general equilibrium (CGE) models (see e.g., Eyckmans et al., 2001). In this paper, a reduced form of complex CGE interactions in terms of marginal abatement cost curves is generated. Strictly speaking, marginal abatement cost curves for the *DIR* and *NDIR* sectors across EU countries are derived from the PACE model - a standard multi-region, multi-sector CGE model for the EU economy (for a detailed algebraic exposition see Böhringer, 2002). PACE is based on recent consistent accounts of EU member states' production and consumption, bilateral trade and energy flows for 1997 (as provided by the GTAP5-E database – see Dimaranan and McDougall, 2002). With respect to the analysis of carbon abatement policies, the sectors in the model have been carefully selected to keep the most carbon-intensive sectors in the available data as separate as possible. The energy goods identified in the model include primary carriers (coal, natural gas, crude oil) and secondary energy carriers (refined oil products and electricity). Furthermore, the model features three additional energy-intensive non-energy sectors (iron and steel, paper, pulp and printing, non-ferrous metals) whose installations – in addition to the secondary energy branches (refined oil products and electricity) – are subject to the EU emissions trading system. The remaining manufacturers and services are aggregated to a composite industry that produces a non-energy-intensive macro good, which together with final demand captures the activities (*NDIR* segments) that are not included in the EU trading system.

To generate the reduced form model, a sequence of carbon tax scenarios for each region is performed where uniform carbon taxes (starting from 0 € to 200 € per ton of carbon in steps of 1 €) are imposed. The outcome is a large number of marginal abatement costs, i.e., carbon taxes, and the associated emission reductions in *DIR* and *NDIR* sectors. Then a least-square fit by a polynomial of third degree is applied (see Böhringer et al., 2005).

When presenting the following simulation results one has to keep in mind that the quantitative model results mainly depends on the specification of the (marginal) abatement cost curves together with the effective reduction requirements for *DIR* and *NDIR* sectors. Furthermore, it should be considered, that market interactions and spillover effects are neglected. Apart from terms-of-trade effects, other potentially important general equilibrium interactions concern revenue-recycling. This is, however, not the subject of this analysis. For the present illustrative purposes where market shares and the shape of marginal abatement cost functions matter most, a partial permit market model seems to be justified.

3.2. Scenario for implementing additional CO₂ taxes in the DIR sector

This section illustrates the effect of a unilateral tax on the emissions of the DIR sectors in Germany, a country with a comparatively large market share on the CO₂ market. The initial allocation of the emission permits represents a homogeneous 90 percent of the baseline emissions to the DIR sectors of all member states. By doing this the abatement requirement in the NDIR sectors is sufficiently strict such that the necessary abatement would lead to marginal abatement costs substantially above the permit price on the market (this was denoted as an over-allocation to the DIR sectors, see Section 2.4.1). Then a unilateral emission tax in the DIR sectors in Germany is introduced which increases stepwise from 0 to 5 €per ton of CO₂ emissions.

Figure 4 shows, as was expected from the analysis in the previous section, that the overall EU-wide compliance costs increase with the tax rate. Therefore, despite the presumed over-allocation, unilateral taxes which move the marginal abatement efforts in Germany closer to what they would have been in the optimum do have a negative effect on the EU as a whole.

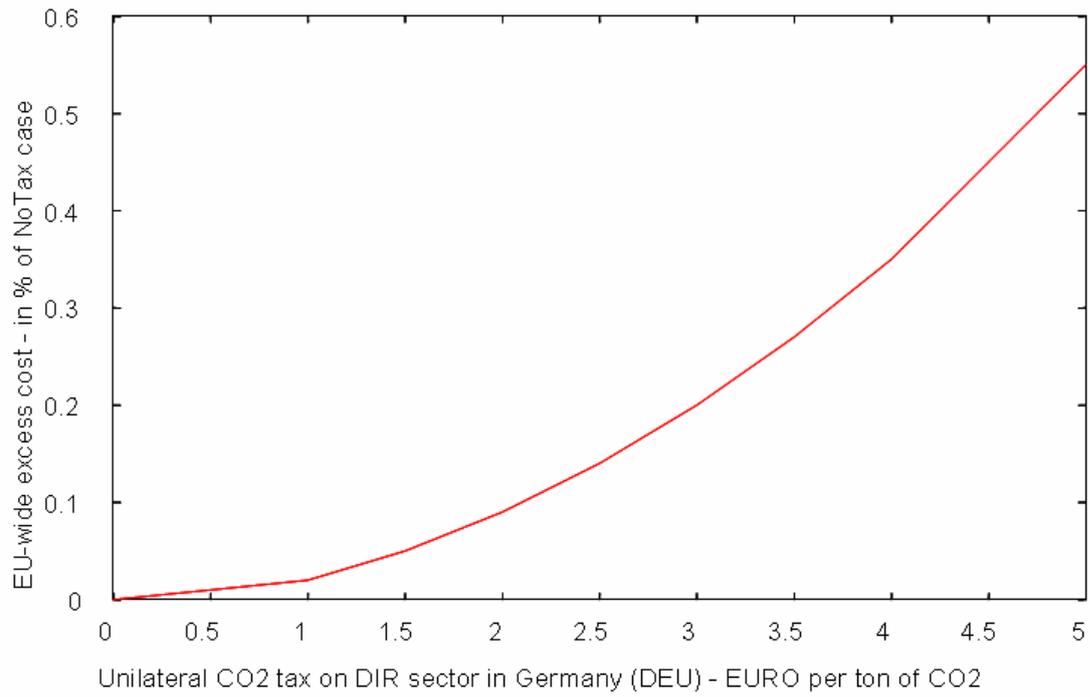


Figure 4: Excess cost burden of a unilateral tax on the EU as a whole.

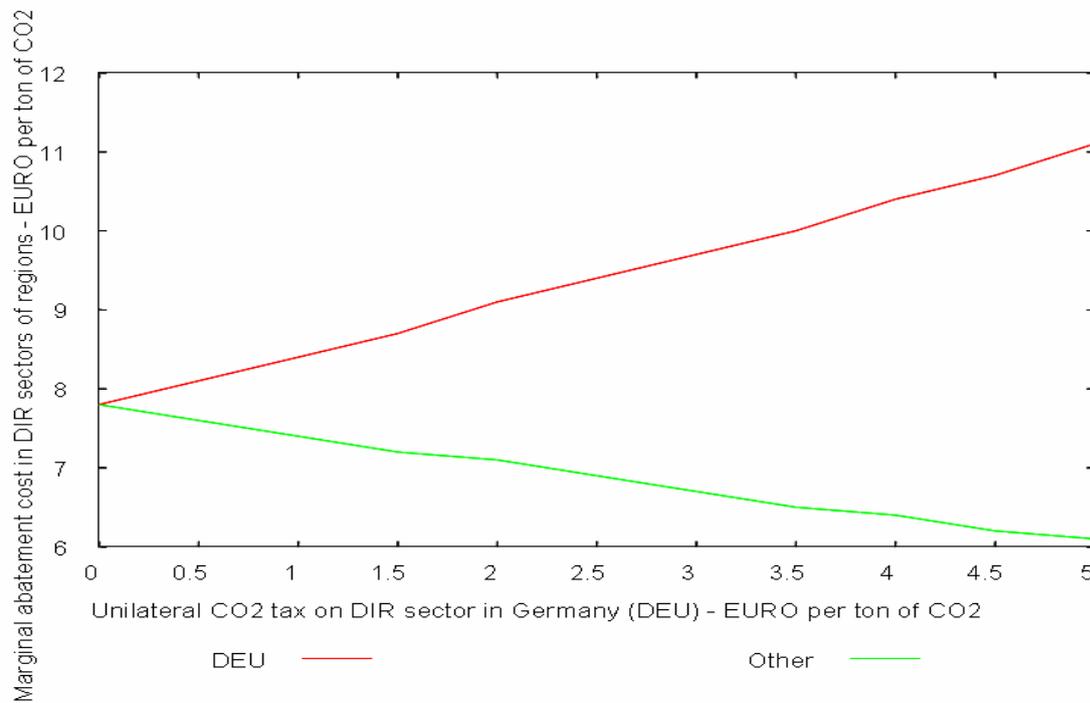


Figure 5: Resulting permit price and marginal abatement costs if a unilateral tax is introduced.

Individual countries could on the other hand benefit from the unilateral tax in Germany. This is due to the falling permit price that is induced by the increased supply from the additional German abatement. Figure 5 shows the permit price (falling curve) and the marginal abatement efforts in Germany composed of the market permit price plus the emission tax (rising curve). The falling permit price can be expected to benefit the net importers of permits. This explains that some countries may benefit, while others lose from the unilateral tax. Figure 6 illustrates the compliance costs of different countries with a rising unilateral tax in Germany. Note, that the increase of the national compliance costs relative to the case without a unilateral emission tax can be larger for a country that exports permits than for the country that introduces the tax itself.

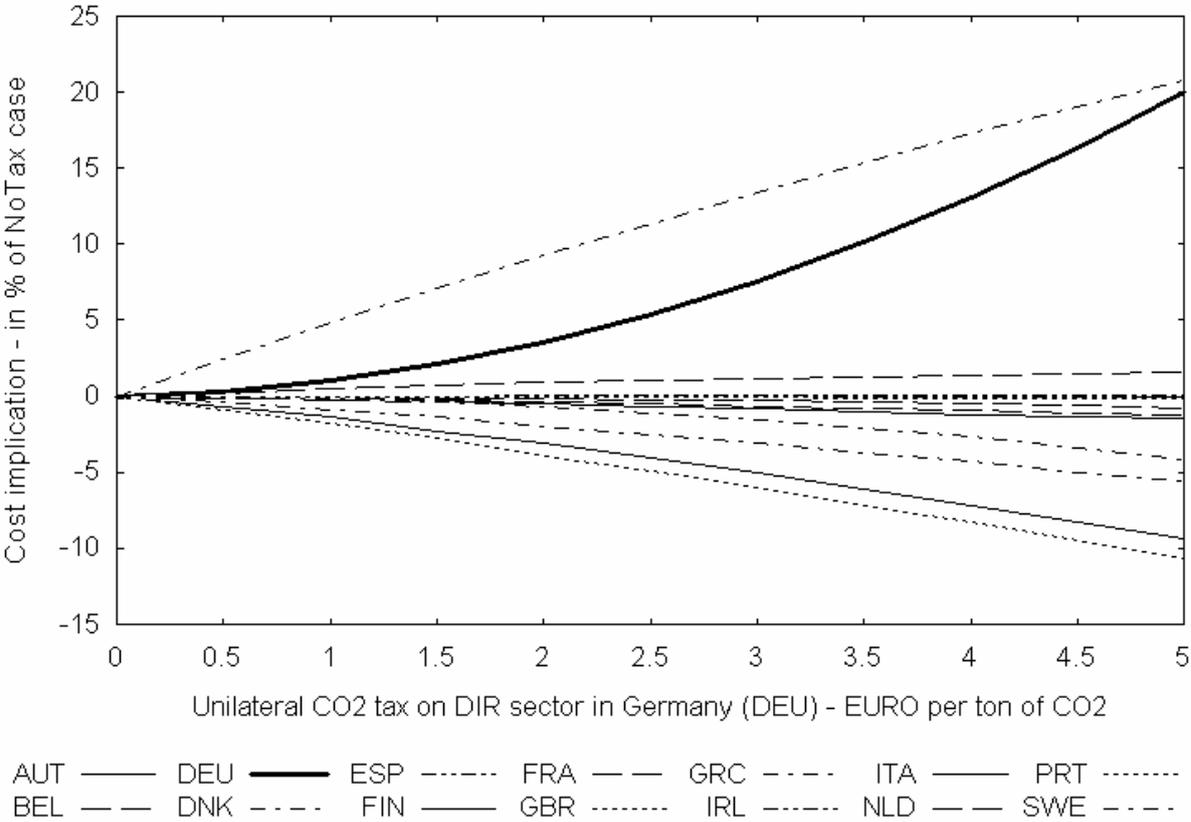


Figure 6: Cost implications on the separate member states.

4. Concluding remarks

This paper sheds some light on the debate of the appropriate instrument mix in climate policy. In particular it analyses whether the European Union emissions trading scheme should be

complemented by additional emission taxes. It turns out that combinations of a quantity based instrument – such as a permit trading scheme – with a price based instrument – such as emission taxes (or, in principle, subsidies) – have to be designed carefully. For the European permit trading regime one has to take into account some of its specific design issues. These are (i) the limited scope of the permit trading scheme and (ii) the multi-jurisdictional framework governing parts of the trading scheme and most of the regulation complementary to the permit trading. Emission taxes are typically a matter of the member states' legislation. Any additional regulation within the sectors covered by the emissions trading directive has to consider that it will act *within* an ecologically effective regime, meaning that the overall emissions are determined by the amount of permits on the market. Once the initial allocation of the permits is fixed, additional regulation within the trading sectors can have distributional effects or it can alter the permit price, but it will not change the overall emissions. The only exception would be a permit price driven down to zero in case of comprehensive and sufficiently high emission taxes.

Emission taxes can be used in an EU wide efficient manner to regulate the emissions in the sectors that are not covered by the trading scheme. When applied *within* the trading sectors, however, unilateral taxes in member states increase the EU overall costs of implementing a given emissions target. Typically such taxes also increase the costs for the country that introduces the tax since the additional abatement expenditures exceed the revenues generated from the emission permits made available by the reduction.

The case of an additional unilateral tax in the emissions trading sectors in Germany was illustrated using a simple partial market model for emissions trading. In the model a fictitious unilateral tax on the DIR sectors in Germany of 5 € per ton of CO₂ would increase the compliance cost in the whole EU by about half a percent. For individual countries the effect ranges from increasing the costs by about 15 percent to reducing compliance costs by about 10 percent relative to the case without a tax.

Obviously, an exporter does not profit if he introduces a unilateral tax which brings down the permit price. On the other hand unilateral emission taxes can be beneficial for the country introducing the tax – while still being costly for the rest – if the country has a large share in the permit market, has comparatively flat marginal abatement costs in the sectors subject to emissions trading, and is at the same time a net permit importer. The reason is that the reduced domestic permit demand can lower the market price for permit and thereby lower the country's import expenditures.

Therefore taxes within the part of the economy that is regulated by the permit trading system should be handled with great care. If they are used they should be justified by other reasons than implementing the commitments of the first Kyoto period in a cost efficient manner.

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