Emissions Trading in a Dilemma about the Policy Objectives: EU Emissions Trading Scheme Is Giving Up Efficiency

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Abstract

How the allocation of allowances has been carried out in the EU ETS is examined from the viewpoint of policy objectives. The conditions for the cost minimization for reducing emissions are formulated, and it is demonstrated that allocation according to historical emissions or historical production quantities leads to violation of those conditions. The allocation method in the EU ETS is charactarized as (i) depending on historical emissions or historical productions and (ii) including recurrent reallocations over the phases as well as within one phase. These characters suggest that the EU ETS is sacrificing the efficiency objective in order to minimize the thorny issue of allowance distribution among polluters. Three policy objectives are identified: (i) efficiency, (ii) minimization of transfer payments from polluters to governments, and (iii) equitable distribution of allowances among polluters. We conclude that we are in a dilemma of choosing only two among those three objectives, and the EU ETS is choosing the latter two objectives.

Keywords: EU ETS, allocation of allowances, efficiency, transfer payment, equitable distribution

1 Introduction

Emissions trading and environmental tax are two options that lead to the state of efficient emissions reduction, where a reduction target is achieved at the minimum cost. Emissions trading has, however, an advantage over environmental tax since it can attain better control over polluters' burden of payment through initial allocation of allowances. Under emissions trading, it is possible to reduce transfer payments from polluters' to governments to zero, if, for instance, governments allow the grandfathering of necessary allowances. Under environmental tax, on the other hand, polluters must bear the burden of tax payment to governments equivalent to the amount of tax rate times the amount of pollutants emitted.

This advantage, however, causes another question of how to allocatte allowances among polluters. This is the issue of the distribution of wealth among polluters. Since there is no general principle to allocate allowances equitably, initial allocation is the thorniest problem for emissions trading.

This paper deals with the initial allocations in the EU ETS (EU Emissions Trading Scheme). How allowances are allocated in the EU ETS attracts attention because the scheme is the first emissions trading scheme that is braodly applied to numerous industrial sectors and that covers the most common pollutant, CO_2. First, we examine various allocation approaches. Second, we identify the effects of allocation methods on the efficiencies of emissions trading systems. Lastly, the allocation methods in the EU ETS are examined in the light of the conditions for efficient reduction of pollutant emissions. We find that EU ETS has sacrificed efficiency in order to minimize the thorny issue of allowance distribution among polluters. We conclude that there is a dilemma of choosing only two among three objectives:

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(i) efficiency, (ii)minimization of transfer payments from polluters to governments, and (iii) equitable distribution of allowances among polluters.

2 Approaches to Allocate Allowances

An amount of allowances of pollutant emission under emissions trading is a property that can be bought and sold. Allocation of the allowances is a process where the government distributes the property among the firms emitting the pollutant. It is a difficult task for the government because there is no general principle for a fair allocation of property rights among economic agents.

An approach that can mitigate this difficulty is to allocate by auction, as was proposed by Dales (1968). This method, however, means that the government gives up one of the advantages of emissions trading, i.e. reducing the transfer payments from polluters to governments, since under the auction approach all the allowances are once possessed by the government and then have to be bought by the polluters.

Since it may be thought that the more amount of pollutant a firm is emitting, the more amount of allowance it needs, allocation according to historical (past and present) amounts of emission may be regarded as fair. This approach may, however, compromise the main goal of emissions trading, namely emissions reduction, because the fact that one can receive more allowances when one has been emitting more amount of pollutant may discourage emission reduction. This approach also raises question about its fairness. The present or past amount of emission does not necessarily represent future amounts. Is it fair that a firm receives a small amount of allowance just because it emitts only a small amount of pollutant at present, despite the expected growth of emissions in the future?

Another allocation approach is to use bench marks. Bench mark is a standard value of pollutant emission per unit of economic activity. Under this allocation method, the amount of allowance is distributed according to the sum of the bench mark value times the amount of the activity such as the production amount. In the case of power generation, for example, under a bench mark of 750 kg-CO_2/kWh, a power plant generating 1 billion kWh per year would receive the allowances of 750 million tonne of CO_2.

This method would not discourage efforts to reduce unit value of emission, because one can receive a calculated amount of allowances irrespective of the actual amount of emission, and because one can receive the surplus amount of allowances equivalent to the unit value of emission reduced times the amount of activity when the latter amount does not exceed the value adopted as the base for the calculation of the allowance allocation. This method, however, also has a problem. Under the bench mark approach, the more the amount of activity is, the more the amount of allowances is distributed.

This fact raises the same question about the fairness of allocation as was raised in the historical emission approach. Is it fair to distribute more amount of property to a particular company on the ground that it has been producing more amount of products? Present production quantity does not represent future production quantity. Is it justifiable for a company to reduce production quantity after receiving an amount of allowances corresponding to the previous production quantity, then to sell the resulting surplus allowances just to earn money, and is it justifiable for another company having received less amount of allowances to have to buy additional allowances to expand its production?

Since it is hardly acceptable to distribute property rights entirely arbitrarily irrespective of the actual activities of economic agents, we cannot avoid taking historical emissions or historical activities into accout in allocating allowances. However, the problem of fairness is inherent in both approaches. That is the problem of the distribution among polluters.

3 Models of Pricing

In addition to the problem of the distribution among polluters, there is the problem of efficiency with the allocation methods. Before addressing this problem, let us formulate some models for firms' pricing behaviour to deal with it.

It is a well known fact that the equalization of the marginal costs to reduce emissions is a necessary condition to minimize the total cost for emissions reduction to meet a reduction target. This condition must be met over all the options of emission reduction, whether to reduce emissions per unit of production through energy savings or through changing the types of energy, or to reduce production quantity itself, or to change the types of products.

Suppose that a firm i is producing a certain product under the production cost $C_i(q_i, u_i)$, where q_i represents the quantity of the product and u_i the amount of a pollutant emitted per unit of the product. When an emissions trading scheme is introduced for the pollutant and the price of the allowance becomes τ, the condition for the minimization of the total costs for emissions reduction is

$$\tau = -\frac{\partial C_i/\partial u_i}{q_i} \tag{1}$$

$$p = \frac{\partial C_i}{\partial q_i} + \tau u_i, \tag{2}$$

where p is the market price of the product. The equation (1) means that the allowance price should be equal to the marginal abatement cost through the reduction of the amount of emission per unit of production, while the equation (2) means that the product price should be equal to the marginal production cost taking the allowance cost into account. From the equation (2) we obtain the relation,

$$\tau = \frac{p - \partial C_i/\partial q_i}{u_i}, \tag{3}$$

which means that the allowance price should also be equal to the marginal emission reduction cost through decreasing the production itself.

When an amount of allowances g_i is allocated to the firm i, the total cost for the firm is $C_i(q_i, u_i) + \tau(u_i q_i - g_i)$, and the profit will be $\pi_i = pq_i - [C_i(q_i, u_i) + \tau(u_i q_i - g_i)]$. Under the perfect competition maximizing the profit would lead to the above condition (1) and (2), so far as the allocated amount g_i is not affected by q_i or u_i.

In a real world, however, perfect competition never occurs. Imperfection of markets are prevalent and there is no consensus about how market determines prices or how individual firm selects prices under imperfect market situation. However, the Chamberlin type monopolistic competition model and, as its expansion, the Cournot type oligopolistic competition model have become popularly used since Krugman used them to explain international trade and industrial location (Krugman 1979, 1980; Helpman and Krugman 1989). Although the Cournot model has never been supported by empirical evidences, it is often used owing to its manageability and convenience in expressing the degree of competitiveness. In fact, it includes the perfect competition case as one extreme involving infinite number of firms and the monopolistic competition case as the other extreme with only one firm.

Kate and Niels (2005) formulated a Cournot type model that can be used to predict how much price increases when the marginal production cost rises. Their model was applied to predict how the introduction of emissions trading affects product prices (Smale et al., 2006). Suppose the production cost of a firm i is specified as $C_i(q_i, u_i) = f_i + c_i(u_i)q_i$ (f_i is the fixed cost and $c_i(u_i)$ is the constant marginal cost that is a function of u_i), the number of the firms is n, and the demand price is specified as $p = a - bQ$ ($Q = \sum_{j=1}^{n} q_j$), then the equilibrium price will be

$$p = \frac{a + \sum_{i=1}^{n} c_i(u_i)}{n+1}$$

prior to the introduction of emissions trading. This shows that the price is determined by the maximum willingness to pay a, the marginal cost $c_i(u_i)$ and the number of the firms n, not dependent on the fixed cost or the slope of the demand curve. When all the firms are identical, the subscript i can be omitted and

$$p = \frac{a + nc(u)}{n+1},$$

which means the price is an average of a and $c(u)$ with the weights of 1 and n. Hence, when n becomes large, p approaches a perfectly competitive price.

When emissions trading is introduced and g of allowances are endowed to the identical firm, then its cost becomes $f + c(u)q + \tau(uq - g)$ and the Cournot equilibrium will meet

$$\tau = -c'(u)$$

$$p = \frac{a + n[c(u) + \tau u]}{n+1}.$$

The latter equation can be transformed into

$$\tau = \frac{(n+1)p - a}{nu} - \frac{c(u)}{u},$$

which approaches the equation (3) when n becomes large. Therefore, under the Cournot type oligopolistic competition model, the effects of the introduction of emissions trading are not so different from those under the perfect competiton model. In fact, even when $n = 5$, 80% of the increase in marginal cost due to the allowance cost will be transferred to the product price under the Cournot equilibrium. The price does not depend on fixed cost or the amount of allowances allocated.

In both the perfect competition model and the Cournot oligopolistic model, the marginal cost determines the product price, so they can be categorized as marginal cost pricing models or marginalist pricing models. The marginalist price theory has been criticized since 1930s on empirical grounds (Means 1939, Hall and Hitch 1939, Andrews 1955, Lee 1998). The non-marginalist price theories emphasize that firms are not concerned with marginal costs, that firms do not know their own demand curves owing to the uncertainty about consumers' behaviour and the complexity of competitors' behaviour, that firms produce multiple products with heavy fixed and overhead costs, and that firms do not pursue profit maximization but try to earn stable profits that guarantee sustainable growth. Under these circumstances, firms are assumed to price their products in a way to recover direct and indirect costs and earn profits of a predetermined rate while maintaining such price over a certain period. This kind of pricing is called full-cost pricing[1].

Under the full-cost pricing the price of a product depends on average cost rather than marginal cost. The effect of this with respect to emissions trading is that the amount of grandfathered allowances affects the product price and emission reduction. When the price is determined so as to ensure a profit at a rate r with the standard production quantity q_0, then the full-cost price will be

$$p = (1+r)\left[\frac{f}{q_0} + c(u)\right].$$

With the introduction of emissions trading the marginal cost will rise by τu, but the average cost will not necessarily rise by this amount if certain amount of allowances are grandfathered. When g of allowances are grandfathered, the average cost at the production level q_0 will become

$$\frac{f}{q_0} + c(u) + \tau u - \tau\frac{g}{q_0}.$$

When $g = uq_0$, i.e., the firm receives the allowances equal to the emission amount at the standard production level, the average cost will be the same as before the introduction of the emissions trading. This means that if the product price is determined through full-cost pricing, the increase in the marginal production cost due to the allowance price may not be transfered to the product price and the marginal cost of emission reduction due to production decrease will not necessarily be equal to the allowance price.

Smale at al. (2006) and Oxera (2004) estimated the impacts of the introduction of emissions trading on marginal costs, product prices and company profits in several industries using the Cournot type oligopolistic competition model. According to their results, under a scenario where the allowance price is 5 euro/t-CO_2 and 98.8% of historical emissions are grandfathered, the marginal cost of power industry will rise by 12% and the power price will increase by 8%, and 90% of the marginal cost increase will be transferred to power price increase. Using the same data but assuming a full-cost pricing, the power price will increase by only 0.1% although the marginal cost will increase by 12%[2].

4 Allocation Approaches and Efficiency

Two approaches to allocation were identified above: the allocation according to historical emissions and the allocation using bench marks. First, let us examine the effect of the former approach. Suppose a

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[1] Lee (1998) distinguishes normal cost pricing, mark-up pricing and target rate of return pricing, but they are similar and possess common properties.

[2] It is assumed that the electricity demand is 251TWh/y at the price of £23.1/MWh, that the price elasticity of demand at that point is 0.25, that nine identical companies supply electricity, that the constant marginal cost is £16.5/MWh, and that 0.6t/MWh of CO_2 is emitted.

proportion $\alpha(0 < \alpha < 1)$ of the historical emission uq is grandfathered, the production cost will be

$$f + c(u)q + \tau(1-\alpha)uq.$$

Profit maximization under perfect competition would lead to an abatement and production activity that will meets

$$\begin{aligned} &\tau(1-\alpha) = -c'(u) \\ &p = c(u) + \tau(1-\alpha)u \end{aligned}$$

which means that the level of the abatement activity in equilibrium is smaller than the efficient level and that the production level is larger than the efficient one.

Under the Cournot model for imperfect competition, profit maximization would lead to an equilibrium which meets

$$\begin{aligned} &\tau(1-\alpha) = -c'(u) \\ &p = \frac{a + n[c(u) + \tau(1-\alpha)u]}{n+1}. \end{aligned}$$

In this case again the equilibrium abatement activity is smaller than the efficient level and the production is larger than the efficient one. When $\alpha = 1$, the emissions trading has no effect on emissions reduction.

Under the full-cost pricing, when a proportion α of the historical emission is grandfathered, the average cost at the standard production q_0 will become

$$\frac{f}{q_0} + c + \tau u\left(1 - \frac{\alpha q}{q_0}\right)$$

Since in the full-cost pricing the firm does not maximize profit, it is not known whether $(1-\alpha)\tau = -c'(u)$ or not, but the marginal cost increase will not sufficiently be transfered to the product price.

Under the bench mark approach, the amount of the grandfathered allowances would be described as βq, and the total cost would be

$$f + c(u)q + \tau(u-\beta)q.$$

Profit maximization under perfect competition would lead to an abatement and production activity that will meet

$$\begin{aligned} &\tau = -c'(u) \\ &p = c(u) + \tau(u-\beta). \end{aligned}$$

The abatement to reduce the emission per unit production will be done under the same condition as (1), but the emission reduction through the production decrease will not reach the sufficient level.

The result will be the same under the Cournot model. In fact, profit maximization will lead to

$$\begin{aligned} &\tau = -c'(u) \\ &p = \frac{a + n[c(u) + \tau(u-\beta)]}{n+1}. \end{aligned}$$

The emission reduction through the production reduction will not reach the sufficient level[3]

Under the full-cost pricing, the average cost will be

$$\frac{f}{q_0} + c + \tau u\left(1 - \frac{\beta q}{u q_0}\right).$$

Here again the marginal cost increase will not sufficiently be transfered to the product price.

To sum up, both the historical emission approach and the bench mark approach have harmful effects on the efficiency goal of emissions trading. Both of them hinder the marginal costs through production

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[3] This result was obtained by Demailly and Quirion (2006).

decrease or the change of products from being equal to the allowance price, and the former approach also hinders the marginal abatement costs through the reduction of the value of emission per unit of production from being equal to the allowance price. When the full-cost pricing is adopted, the marginal reduction costs through the change of production magnitudes will not be equal to allowance price irrespective of allocation approaches.

Evidently it is necessary to make the grandfathered amount g not related to uq or q. Except for the case of completely arbitrary allocation, there are two ways to achieve this. One is to make $g = 0$. This is the auction approach or no allocation approach, but this approach is imcompatible with one of the objectives of emissions trading, i.e. to control the distribution between the government and the polluters. Another way to make g not related to uq or q is to make g dependent only on the past emissions or productions, and cut the link between the present and future emissions or productions and the allocation. This method requires that readjustment or reallocation never takes place after the allocation is fixed.

5 Allocations in the EU ETS

Introduced by the EC Directive 2003/87/EC, EU ETS has been implemented since 2005. Phase I is from 2005 to 2007, and phase II is from 2008 to 2012. Allocation of allowances is determined by the National Allocation Plans (NAPs), which member states submit to the European Commission for their approval. NAPs for the second phase (NAP2) for 23 countries have already been decided by July 2007.

The total amount of allowances allocated in NAPs for the first phase (NAP1) was 2190.9 Mt-CO_2 for 25 member states. The total amount of verified emissions in 2005 was 2005.5 Mt. The amount of phase II allowances decided for 23 countries is 1903.4 Mt, whereas the verified emissions for the same countries in 2005 were 1948.8 Mt.

Each member country allocates their allowances under NAPs to individual installations. Therefore, allocation method is different from state to state. However, there are some common characteristics.

First, the historical emission approach is the most prevalent among EU member countries. In the NAP1 of the UK, individual installations received the amount of allowances equal to their actual share of emissions (1998 to 2003 in most cases) in the industrial sector they belong to times the total allowances allocated to that sector. The total allowances allocated to a sector, except for the power sector, were determined as forecasted emissions in 2006 taking into account the Climate Change Agreement, the production growth and the necessity of New Entrant Reserve (NER). The method is almost the same in the UK NAP2.

In Germany individual installations received allowances equal to their historical emissions (2000 to 2002) times the Compliance Factor (CF) of 0.9755 in NAP1. In German NAP2 the CF is revised to be 0.9875, but the method is the same as in NAP1. A CF of 0.85 for the power sector was initially proposed, but later a bench mark method was adopted to this sector.

In the NAP1 of the Netherlands individual installations received the allowances equal to their historical emissions (2001 to 2002) times the Growth Factor (GF) times the Efficiency Factor (EF) times the CF (0.97). The bench mark method is partly employed in the EF in that EF>1 when the actual unit value of emission is smaller than the bench mark value and EF<1 when the actual unit value is larger than the bench mark value. In the NAP2 CF is reduced to 0.9 (0.75 for the power sector)and GF is raised to 1.07, but the method is the same as in NAP1.

As seen here, existing installations receive allowances basically according to their historical emissions, although the idea of bench mark is partly utilized. Since the past emissions (up to 2003) are taken as the base for allocation for NAP1, if the determined allocation of allowances is fixed and no further reallocation is performed, this allocation would not have any harmful effects on efficiency. However, that is not the case.

The EU ETS consists of two phases, and the allocations for phase II are carried out in the period of phase I. Therefore, there are reallocations. If the emissions in the period of phase I are never used as a basis for the allocations for the second phase[4], the problem may not be significantf, but actually the emissions in 2005 are used as a basis in Germany and the Netherlands. In the UK, the emissions in 2005 was not used as a basis of allocation, but the base years were changed from 1998-2003 to 2000-2003. This

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[4] This is required by the European Commission (Commission of the European Communities 2005, p.8).

shift will lead to the prospect of the third phase allocation being based on later emissions, affecting the activities in the earlier phases.

Even more important is the reallocation within one phase. NER is set aside to allocate additional allowances to new entrants. New entrants are provided with certain amount of allowances for free as calculated by using bench marks in many countries. Here the words 'new entrant' does not necessarily mean 'new company'. New installations built by existing companies are regarded as new entrants. Furthermore, the expanded units of the existing installations are also regarded as new entrants. This means that existing firms can expand their production and increase emissions without a need to purchase additional allowances. As a result, there are emission increases without taking the allowance costs into account. As shown in the previous section, this will make the marginal costs of emission reductions through the reduction of production not equal to the allowance price.

When an installation possessing allowances is closed, such allowances will be withdrawn from the installation without compensation. An exception is the transfer provision observed in the German NAPs, under which allowances can be transfered from the closing installations to the replacing installations under a certain rule. In general, however, it is regarded as undesirable that installations that no longer need the allowances continue to possess them or sell them in the market.

The European Commission declared that ex-post adjustments of allocation 'contradicts the essential concept of a "cap-and-trade" system as conceived by the Directive', and determined that the intention of Italy to adjust the allocation of allowances in the event of a physical extention of the network of a CHP installation causing an increase of emissions of more than 10%, of a "restart of operation from closure/suspension 2nd period", of a "partial interruption of services", of a "partial temporary suspension of services" and, to the extent that the operator may maintain part of the allocated allowances, of a "closure due to processes of production rationalisation" contravenes criterion 10 in Annex III of the Directive (Commission of the European Communities 2007b, p.12). The Commission stated that new entrance and closure are the only two cases where adjustments can be made legitimately and without no detrimental effect on the functioning of the EU ETS (*ibid.*, p.13). However, the ex-post adjustments with these two events are as detrimental for the efficiency objective of the scheme as those intended by Italy.

The European Commission also determined that the relocation scheme intended by the Netherlands contravenes the criterion 10 in Annex III of the Directive (Commission of the European Communities 2007a, p.14). Under the relocation scheme, the Netherlands intended, the allowances possessed by a closing installation can be transfered to another installation within the same group of companies that will take over the production of the closing installation. This scheme actually has no detrimental effect on the efficiency objective of the EU ETS because there is no difference between this transfer of allowances and the transfer through ordinary trade of allowances. It has no theoretical ground not to accept that the sellers are the closing installations. Actually German proposed a similar transfer scheme and the Commission has not rejected it.

With regard to the German NAP2, the Commission has opposed Germany's application of less stringent CF (= 1) to the installations such as new entrants in the first phase, installations having started operation in the year 2003 and 2004, new installations having replaced other installations on the transfer provision during the first phase, and installations having started operations or being modernized in the year 1994-2002. The Commission insists that installations should not be treated discriminatively just because of the period during which they started operation, that new entrants in a period is not new in the next period and that the discriminative treatment of existing installations in one period distorts competition (Commission of the European Communities 2006, p.13).

The new entrants in the first phase have received allowances through the bench mark approach. Since the bench marks are defined by the best available technology (BAT), they have gotten a more stringent cap and would emit less amount of CO_2. To apply the ordinary CF (= 0.9875) for the second phase means that they have further more stringent cap in the following period. In order for the investment in new installations to be made appropriately, i.e. taking production costs, abatement costs and allowance costs into account, the property aquired in the previous period must not be depreciated for noneconomic reasons. That is why Germany intended to apply favourable CF to the installations that newly came into operation.

Eventually a bench mark approach will be used for all the installations that have come into operation in 2003 to 2007 (Zuteilungsgesetz 2012). This is more appropriate method to achieve what Germany intended.

6 Conclusion

The allocation approaches adopted in the EU ETS have been characterized as (i) depending on historical emissions or historical productions and (ii) including recurrent reallocations over the phases as well as within one phase. These characters contradict the objective of efficiency. Efficiency is an important objective of emissions trading, but this objective has been sacrificed for other objectives.

We have identified two other objectives above: (i) minimization of transfer payments from polluters to governments and (ii) equitable distribution of allowances among polluters. Since the former objective concerns the distribution of wealth between polluters and governments, both objectives can be refered to as 'distributional objectives'. In the EU ETS, both of them are pursued. Pursuance of the former objective is common in emissions trading because it is the point that makes emissions trading more preferable than environmental tax. Characteristics of the EU ETS is its intention to reduce the problem of distribution among polluters to a minimum level by reallocating recurrently and adjust the amount of allowances or asset to the level necessary for each installation.

The EU ETS prioritizes the two distributional objectives over the efficiency objective. This feature is especially apparent in the case of German NAPs , which declare that if the allowances needed to allocate to new entrants exceeds the NER, an appointed agency will purchase additional allowances and make these available for new installations.

Auction enables the efficiency objective and the objective of equitable distribution among polluters to be achieved but forfeits the objective of distribution between polluters and governments. Grandfathering without reallocation enables the efficiency and the distributive adjustment between polluters and the government to be achieved at the cost of giving up the distributive adjustment among polluters. Grandfathering with recurrent reallocation enables the two kinds of distributive adjustment to be achieved at the cost of giving up the efficiency. Therefore, we can achieve only two of the three objectives. The EU ETS has chosen the two distribution objectives.

Is this choice wrong because it undermines the important objective of emissions trading? Not necessarily so. As mentioned above, the efficiency objective is vulnerable to imperfection of competition and to firms' pricing behaviour. Even if initial allocation is carried out ideally and there is no reallocation thereafter, the efficiency goal may not be achieved when prices are dependent on average costs rather than marginal costs. Taking this fact into account, it would be wise to choose another important objective of the distribution among polluters and to give up efficiency.

In many instances of environmental tax systems, the objective of efficiency is also sacrificed for pursuing another objective. Since the thorniest problem with environmental tax is the heavy burden of transfer payment on the side of polluters, various measures to reduce this problem have commonly been adopted, such as tax rate reduction for particular industrial sectors, two-stage tax rates according to the emission level and, combination of tax and emission standards. These measures undermines the efficiency objective of the environmental tax. This fact reveals the preference of the distributional objectives to the efficiency objective. Similarly, in the EU ETS the two kinds of distributional objectives are preferred to efficiency.

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