Discussion Papers No. 568, December 2008
Statistics Norway, Research Department

Cathrine Hagem

Incentives for merger in a noncompetitive permit market

Abstract:
A group of small competitive permits traders facing an imperfectly competitive permit market may consider cooperation (merger) to act strategically in the permit market. It is a well-known result in the literature that the horizontal merger of Cournot players may be unprofitable because of the response of nonmerging agents (a negative strategic effect). We show that the strategic effect of a merger among competitive agents substantially differs from the strategic effect of a merger among Cournot players. Furthermore, we show how the profitability of a merger depends on whether the merged agents are on the same side of the market as the preexisting dominant agent(s). These results show how the expected competitive environment in the permit market may determine how potentially large traders such as the US, and group of small, competitive traders, such as the EU countries, organize their permit trade in any follow-up agreement to the Kyoto protocol.

Keywords: Emission permits, strategic permit trading, mergers, climate agreement, market power.

JEL classification: D43, Q54

Acknowledgement: The author would like to thank Mads Greaker and Knut Einar Rosendahl for their helpful comments and valuable suggestions. The financial support of the Norwegian Research Council is gratefully acknowledged.

Address: Cathrine Hagem, Statistics Norway, Research Department.
E-mail: cathrine.hagem@ssb.no

Discussion Papers comprise research papers intended for international journals or books. A preprint of a Discussion Paper may be longer and more elaborate than a standard journal article, as it may include intermediate calculations and background material etc.

Abstracts with downloadable Discussion Papers
in PDF are available on the Internet:
http://www.ssb.no
http://ideas.repec.org/s/ssb/dispap.html

For printed Discussion Papers contact:

Statistics Norway
Sales- and subscription service
NO-2225 Kongsvinger

Telephone: +47 62 88 55 00
Telefax: +47 62 88 55 95
E-mail: Salg-abonnement@ssb.no

1. Introduction

In the Kyoto Protocol, the only policy instrument for distributing costs between participants is the initial allocation of tradable permits across countries. Burden-sharing considerations in the distribution of permits may provide some agents with an opportunity to exercise market power in the emissions permits market.[1] For example, a number of studies have concluded that Russia, other former Soviet republics and Eastern European countries will become large sellers of permits in the first Kyoto period (see [2] and [3]). [4] and [5], among others, conclude that the former Soviet Union can significantly increase any benefit from the Kyoto agreement by exploiting market power in the permit market. This implies that marginal abatement costs are not equalized across participating countries. Negotiations for the post-Kyoto commitment period (2013 and beyond) have already started, but no consensus has yet emerged. Because of the poor reduction in global emissions achieved by the Kyoto Protocol, it appears reasonable to assume that if the agreement is prolonged, it will be more stringent and will probably involve more countries with binding emissions targets than in the first commitment period.[2] Moreover, as long as the initial distribution of permits is the only instrument for burden sharing, it is reasonable to expect that some countries will also gain market power in the post-Kyoto period.[3] Whether the exercise of market power is on the demand, supply or both sides of the market will then depend on the initial distribution of permits across countries and the abatement costs of participants.

The starting point of our analysis is that a group of countries participates in a climate agreement that constrains total emissions through a tradable permits system. We assume that the initial allocation of permits leaves at least one country with market power. A group of small traders, who realizes they face an imperfectly competitive permit market, may consider cooperation to act strategically in the permit market. If they merge, they then become a buyer or a seller cartel depending on whether their joint premerger net purchases were positive or negative. We assume that if a merger occurs it is with a

---

[1] Hahn [1] shows that opportunities for an agent to exercise market power could be undermined (i.e., the cost-effective outcome is achieved) by the appropriate distribution of permits between agents. However, burden-sharing considerations may prevent a distribution of permits that undermines market power.

[2] The 39 signatories of the Kyoto Protocol listed Annex B and representing about two-thirds of global emissions in 1990, promised to reduce their greenhouse gas emissions by 5.2 percent compared to their 1990 level by 2008-12 (Kyoto period). The United States later withdrew, and the global emission reduction achieved by the protocol is expected to be insignificant. See [6] and [7].

[3] For instance, Russia obtained quite lax emission reduction requirements under the Kyoto Protocol, i.e., large allotments of free permits. This was probably necessary to achieve its participation in the protocol. In the future, the allocation of large allotments of free permits could also be an instrument for achieving participation from other countries in a Kyoto-like agreement. Further, [8] discusses the importance of fairness in international climate policy and argue that the differentiation of targets in the Kyoto Protocol evidences a need for fairness and justice in global climate policy. In the Kyoto Protocol, these fairness considerations are dealt with through the initial permit allocation between agents.

well-defined group of countries that coordinate their permit trade to maximize joint welfare. The internal and external stability of the cartel (or the climate agreement itself) is not the focus of this paper.[4]

Obvious candidates for cooperation in the permit market are European Union (EU) countries. These presently cooperate on a common climate policy, in addition to their commitments under the Kyoto Protocol, and have an internal emission trading scheme (the EU ETS). For instance, by determining the degree the emission target will be met by domestic measures relative to permit purchases (the supplementary principle), the EU can act as a strategic buyer in the international permit market. This is analyzed in [10]. A comparison of competitive behavior and cartel behavior is also relevant for the implementation of the Kyoto regime in large countries. A country with a potentially large trade in permits—the US if it joins the treaty for instance—can let all domestic emitters trade directly on the international permit market or the government can decide to be the sole trader and exploit its joint market power in the permit market. In the latter case, domestic emissions can be restricted through taxes, a domestic permit system, or direct regulation. This paper illustrates how the cost of these different approaches depends on the competitive environment of the permit market.[5]

The profitability of merger has been widely analyzed in the literature, both theoretically (see [13], [14], [15] and [16]) and empirically (see, among others, [17]). In the seminal paper by Salant, Switzer and Reynolds [13] they show that horizontal mergers may reduce the joint profit of firms that collude (insiders). Merger makes colluding firms internalize the losses they impart to each other. This implies that for any given output of the noncolluding firms (outsiders), the colluding firms contract their aggregate output compared to the premerger output. This will increase their joint profit *ceteris paribus*. However, the lower output of the insiders makes it profitable for outsiders to increase their production. As the output of the outsiders expands, the insiders' profit declines. The increase in production from the outsiders following merger may reduce the profits of insiders more than the increase in profits that would have occurred had outsiders' production remained constant. If this is the case, merger is unprofitable for the colluding firms. Using a Cournot model with n identical firms with constant marginal costs and linear demand, Salant, Switzer and Reynolds [13] show that it is sufficient for a merger to be unprofitable if less than 80 percent of the firms collude.

[4] See, for instance, [9] for a discussion of the internal end external stability of a cartel in an international climate regime.

[5] Obviously, the total cost of a climate agreement is lowest if no country behaves strategically in the permit market. However, the impact on the cost effectiveness of market power is not a concern of this paper. See, e.g., [1], [11] and [12], for discussion of policies to reduce the adverse effects of market power on cost effectiveness in a permit trading regime.

Perry and Porter [14] argue that Salant, Switzer and Reynolds [13] understate the incentives for merger. They show that incentives for merger can be significantly larger when mergers influence firm production cost. Merger then increases the output insiders can produce at a given average cost. In our model, we ignore any economies of scale, so cartelization does not affect the joint marginal production or fixed cost. Cartelization therefore unambiguously leads to a contraction of the permit supply in a seller cartel (and a contraction of demand in a buyer cartel). The profit increase following from the contraction is also (at least partly) offset by the optimal response of outsiders. However, our conclusions about the profitability of merger differ from those in Salant, Switzer and Reynolds because we consider merger among a group of agents with competitive premerger behavior, whereas they only considered merger among a group of Cournot players.

Hence, a merger in our model changes the slope of the residual inverse demand function faced by the outsiders, whereas a merger among a group of Cournot players does not affect the demand function. The outsiders' response to the change in the slope of the inverse demand function benefits the cartel if they are on the same side of the market, and harms them if they are on the other side of the market. Hence, we show that the profitability of a merger depends on whether the merged agents are on the same side of the market as the outsiders, whom we refer to as the preexisting dominant agent(s). This explains why it might be unprofitable for a group of buyers to establish a cartel in a market characterized by dominant sellers, whereas it can be profitable for a group of sellers to establish a seller cartel in the same market. This is of relevance when considering different opportunities for cooperation and strategic emission trading under a post-Kyoto protocol.

2. The model

Let $N = \{1, 2, \ldots, n\}$ denote the set of all countries participating in the climate agreement.[6] Let $\bar{\varepsilon}$ denote the constraint on total emissions and let e_i denote emissions from an individual country i. The total emissions constraint for the agreement members is then:

(1) $$\sum_{i \in N} e_i \leq \bar{\varepsilon} .$$

We assume throughout the paper that (1) is satisfied with equality. A system of tradable emissions permits is implemented among the members of the agreement and permits are grandfathered, i.e.,

---

[6] We assume that the government in each country is the decision taker. However, the conclusions of the paper are unaffected whether governments or firms are the decision taker. A permit cartel is then established through either a merger between several countries or a merger between several firms (emitters).

given for free to the participants. Let $(\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_N)$ denote the distribution of the initial endowment of permits that should satisfy the total emissions constraint:

(2) $$\sum_{i \in N} \varepsilon_i = \overline{\varepsilon} .$$

We assume that all members of the agreement choose their emissions level in order to maximize their welfare (*W*):

(3) $$W_i = B_i(e_i) + p \cdot [\varepsilon_i - e_i] .$$

where *p* is the price of permits and $B_i(e_i)$ denotes the incomes (benefits) of the emissions function in country *i*. We assume that incomes are strictly increasing and concave in emissions, such that $B' > 0, B'' < 0$. This signifies that incomes fall with emissions reductions, and the larger the reduction in emissions, the higher the loss in income of additional emissions reductions.

3. One dominant country—all other countries are price takers

We consider the situation where there is one large country, denoted D, which, as a result of the initial allocation of permits, becomes a sufficiently large trader to be in a position to exercise market power in the permit market.[7] All other countries are individually small as traders so they are price takers. We divide these countries into two groups (1 and 2), as the purpose of this paper is to evaluate whether one of these groups of competitive countries might benefit from merging into a cartel and behave strategically in the permit market. In the case of no-merger, each country *j* within these groups takes the price of permits as given and chooses its emissions level in order to maximize the individual welfare given by **Feil! Fant ikke referansekilden.**:

(4) $$\max_{e_j} W_j = B_j(e_j) + p \cdot [\varepsilon_j - e_j] \quad \forall j \in 1,2.$$

Whether a country becomes a buyer ($\varepsilon_j - e_j < 0$) or a seller ($\varepsilon_j - e_j > 0$) depends on the initial endowment, the benefit of emissions and the equilibrium price. The solution to this maximization exercise for every price-taking country gives rise to the following first-order conditions:

(5) $$B_j'(e_j) = p \quad j \in 1,2.$$

[7] The general conclusions of the paper are unaffected if there are several countries with market power.

The first-order condition (5) defines an implicit emissions function:

(6) $$e_j = B_j'^{-1}(p), \quad \frac{de_j}{dp} = \frac{1}{B_j''} < 0, \quad \forall j \in 1,2.$$

Aggregating these emissions functions over all countries within each group yields two downward-sloping, inverse aggregate emissions permits demand functions for groups 1 and 2:

(7) $$p = p(e_s), \quad p' = \frac{1}{\sum_{j \in s} \frac{1}{B_j''}}, \quad s = 1,2,$$

where $\sum_{j \in s} e_j = e_s$.

Further, let $B_s(e_s)$ denote the aggregate benefit of emissions for each group when emissions are distributed cost effectively across all countries within the group, such that the first-order condition (5) implies:

(8) $$B_s'(e_s) = p \quad s = 1,2.$$

The standard approach in the literature when there are several small competitive suppliers in addition to a dominant seller is to model the market as a dominant agent with a competitive fringe, where the dominant agent behaves as a Stackelberg leader with respect to the competitive fringe (a dominant-firm, competitive-fringe model). We use this approach in the following, although we include the possibility that the competitive fringe and the dominant agent can lie on opposite sides of the market. Alternatively, we could have modeled the market as a dominant agent facing a net inverse demand (supply) function from the competitive agents, who aggregate on the other side of the market as the dominant agent. This is the approach followed in several studies of market power in the permit market (see [1] and [12]. The two approaches, however, lead to identical outcomes, as proved in the appendix.

Let the agents in Group 2 constitute what we refer to as the competitive fringe. Inserting from the emission constraint, (1), the inverse demand function for Group 1 can be written as $p(\bar{\varepsilon} - e_D - e_2)$, and the following expression for the first-order condition for the competitive fringe (Group 2) is:

(9) $$p(\bar{\varepsilon} - e_D - e_2) = B_2'(e_2).$$

Equation (9) implicitly defines $e_2(e_D)$, and the inverse residual demand function facing the dominant agent in the premerger situation (p_{PM}) is:

$$(10) \qquad p_{PM} = p_{PM}\left(\overline{\varepsilon} - e_D - e_2\left(e_D\right)\right).$$

The optimization problem of the dominant agent is then:

$$(11) \qquad \max_{e_D} W_D = p_{PM}\left(\overline{\varepsilon} - e_D - e_2\left(e_D\right)\right)\cdot\left(\varepsilon_D - e_D\right) + B_D\left(e_D\right).$$

The first-order condition equates marginal income and marginal cost:

$$(12) \qquad p'_{PM}\cdot\left(1+\frac{\partial e_2}{\partial e_D}\right)\cdot\left(\varepsilon_D - e_D\right) + p_{PM} = B'_D\left(e_D\right).$$

For $\left(\varepsilon_D - e_D\right) > 0$, the left-hand side of (12) equals the marginal loss in revenue of one unit less permit sale (one more unit emissions), whereas for $\left(\varepsilon_D - e_D\right) < 0$, the left-hand side equals the marginal cost of one more unit permit purchase. The right-hand side is the marginal income from emissions.

We let $e_1^{PM}, e_2^{PM}, e_D^{PM}, p_{PM}^{PM}$ denote the solutions to (1), (8) and (12), and $W_1^{PM}, W_2^{PM}, W_D^{PM}$ represent the corresponding levels of welfare in the premerger outcome.

4. Part of the fringe merge into a cartel

In this section, we analyze the situation where one group of competitive agents (Group 2) considers merging into a cartel. The potentially merging agents can be either a group of net competitive sellers or buyers. We consider the cartelization as a two-stage game. In the first stage, the agents decide whether to merge. In the second stage, and if they have merged, they decide their aggregate demand/supply given Cournot competition in the output market. We assume that when the agents make their merger decision in period 1 they can correctly anticipate the Cournot–Nash equilibrium of the output market that emerges in the second stage. Hence, merger only occurs if it turns out to be profitable in stage 2.

The inverse demand function given by (7) (for s = 1), and the total emission constraint (1) lead to the following inverse demand function (p_M) faced by both Cournot players in case of merger:

$$(13) \qquad p_M = p_M\left(\overline{\varepsilon} - e_D - e_2\right).$$

The cartel's (Group 2) optimization problem is:

(14) $$\max_{e_2} W_2 = B_2\left(e_2\right) + p_M\left(\bar{\varepsilon} - e_D - e_2\right)\cdot\left(\varepsilon_2 - e_2\right).$$

The dominant agent's optimization problem is:

(15) $$\max_{e_D} W_D = B_D\left(e_D\right) + p_M\left(\bar{\varepsilon} - e_D - e_2\right)\cdot\left(\varepsilon_D - e_D\right)$$

This leads to the following first-order conditions for the cartel and the dominant agent, respectively:

(16) $$p_M' \cdot\left(\varepsilon_2 - e_2\right) + p_M = B_2'\left(e_2\right).$$

(17) $$p_M' \cdot\left(\varepsilon_D - e_D\right) + p_M = B_D'\left(e_D\right).$$

We assume that the second-order conditions for a maximum are satisfied, i.e.:

(18) $$B_g''\left(e_g\right) + p_M'' \cdot\left(\varepsilon_g - e_g\right) + 2p_M' < 0 \quad g = 2, D.$$

Let $e_1^M, e_2^M, e_D^M, p_M^M$ denote the solution to (1), (8) (for s = 1), (16) and (17), and let W_1^M, W_2^M, W_D^M denote the corresponding welfare levels.

From (16) and (17) we find the reaction functions (optimal response functions) $e_2\left(e_D\right)$ and $e_D\left(e_2\right)$. We find the slopes of the reaction functions by totally differentiating (16) and (17). To ensure the existence of a unique stable equilibrium, we assume that the reaction functions are downward sloping, with an absolute value less than 1:

(19) $$-1 < \frac{de_2}{de_D} = -\frac{p' + p''\cdot\left(\varepsilon_2 - e_2\right)}{B_2'' + 2p' + p''\cdot\left(\varepsilon_2 - e_2\right)} < 0.$$

(20) $$-1 < \frac{de_D}{de_2} = -\frac{p' + p''\cdot\left(\varepsilon_D - e_D\right)}{B_D'' + 2p' + p''\cdot\left(\varepsilon_D - e_D\right)} < 0.$$

(In (19) and (20) we omit the subscript M on p). Given (18), and the assumed concavity of the benefit functions $\left(B'' < 0\right)$, (19) and (20) are satisfied for $p' + p''\cdot\left(\varepsilon_g - e_g\right) < 0 \quad g = 2, D$.

An agent's action is said to have a positive strategic effect if the other agents' responses to the action increase the profit of the agent taking the action. If, on the other hand, the other agents' responses decrease the agent's profit, the action is said to have a negative strategic effect (e.g., [18], Chapter 8). By comparing the equilibrium with and without merger, we derive the following proposition.

Proposition 1

Consider a competitive environment with a dominant agent and a competitive fringe. If a subgroup of fringe agents merge and face Cournot competition in the output market, the strategic effect of the merger is unambiguously negative (ambiguous) if the merged agents are on different (the same) sides of the market as the preexisting dominant agent.

Proof:

The strategic effect of merger is negative if the dominant agent's response to the merger hurts the merging agent. We see from (14) that:

(21) $$\frac{\partial W_2}{\partial e_D} = -p'_M \cdot \left(\varepsilon_2 - e_2\right) > (<) 0 \text{ for } \left(\varepsilon_2 - e_2\right) > (<) 0.$$

The merger has two effects on the dominant agent's optimal choice of e_D.

(i) By comparing the first-order condition with no cartel (12) with the first-order condition with a cartel (17), we see that for $e_2 = e_2^{PM}$, the dominant agent's optimal e_D increases (decreases) compared to the premerger situation for $\varepsilon_D - e_D > 0 \left(\left(\varepsilon_D - e_D\right) < 0\right)$. (The dominant agent's sale/purchase is lower than without the cartel as $1 > \left(1 + \frac{\partial e_2}{\partial e_D}\right)$, see **(31)**, $B''_D < 0$ and $p_M\left(\bar{\varepsilon} - e_D^{PM} - e_2^{PM}\right) = p_c\left(\bar{\varepsilon} - e_D^{PM} - e_2^{PM}\right)$.

(ii) We can see by comparing (9) with (16), that for $e_D = e_D^{PM}$, the cartel's optimal e_2 increases (decreases) compared to the premerger situation for $\varepsilon_2 - e_2 > 0\left(\left(\varepsilon_2 - e_2\right) < 0\right)$ as $p'_M \cdot \left(\varepsilon_2 - e_2\right)$ is negative (positive) for $\left(\varepsilon_2 - e_2\right) > 0\left(\left(\varepsilon_2 - e_2\right) < 0\right)$ and $p_M\left(\bar{\varepsilon} - e_D^{PM} - e_2^{PM}\right) = p_{PM}\left(\bar{\varepsilon} - e_D^{PM} - e_2^{PM}\right)$. The dominant agent's response to an increase in emissions from the cartel is found from the response function (20).

The first effect (i) is positive (negative) if the cartel is on the same (opposite) side of the market as the dominant agent. The second effect (ii) is always negative. If the cartel is on the same side of the market as the dominant agent, the strategic effect is positive (negative) if the first (second) effect outweighs the latter (former) effect. If the cartel is on the other side of the market as the dominant agent, both effects harm the cartel.

In the following, we provide an example where the strategic effect of merger is positive. Let the income of emissions function be:

(22) $$B_k\left(e_k\right) = 5 \cdot e_k - \frac{1}{4} e_k^{\,2} \quad k = 1, 2, D.$$

Let the initial endowment of the commodity be $\varepsilon_1 = 0, \varepsilon_2 = 3$ and $\varepsilon_D = 5$.

If we compare the equilibrium outcomes from the premerger situation, found from (1), (8) and (12), with the equilibrium outcomes with merger, found from (1), (8) (for *s* = 1), (16) and (17), we can see that $e_1^{PM} - e_1^M = -\frac{3}{8}, e_2^{PM} - e_2^M = \frac{1}{8}, e_D^{PM} - e_D^M = \frac{2}{8}$. In this example, both Group 2 and the dominant firm are sellers of permits. The strategic effect of merger is positive as $e_D^{PM} - e_D^M > 0$. □

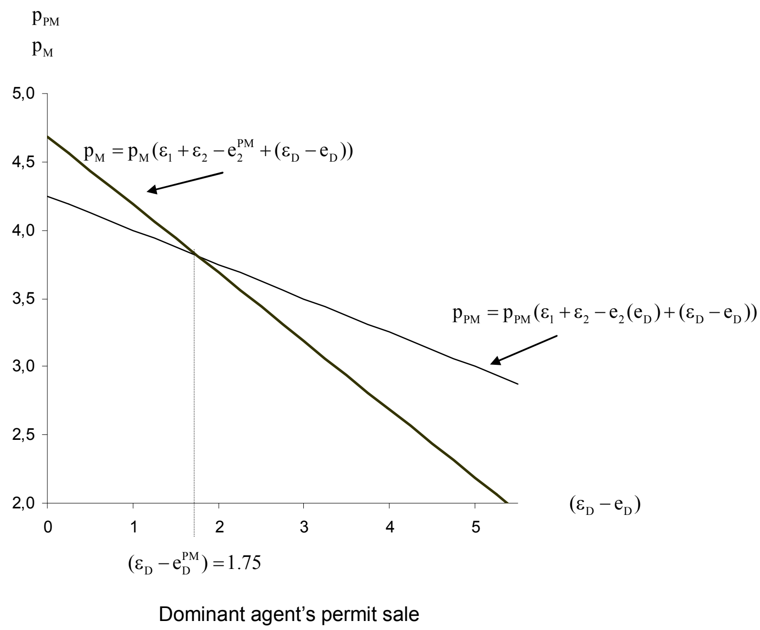
In Salant, Switzer and Reynolds ([13]) the strategic effect of merger only followed from the contraction in output of the merged agents (as described in (ii) in the proof of Proposition 1), as the starting point of their analysis was that the countries that merged were Cournot players before the merger. Hence, in their model the strategic effect of the merger was unambiguously negative. By assuming the merger of premerger competitive agents in our model, we have shown that there is another strategic effect resulting from the subsequent shift in the price responsiveness of the residual demand function faced by the dominant agent. The inverse demand function becomes steeper (for given premerger emissions).[8] Figure 1 depicts the inverse residual functions faced by a dominant seller following from the numerical example given in the proof of Proposition 1. In the premerger situation, the inverse demand function is p_{PM} (see (10) and (2)). The equilibrium permit sale from the dominant agent $\left(\varepsilon_D - e_D^{PM}\right)$ equals 1.75. In the postmerger price function p_M (see (13) and (2)), emissions from the cartel are held constant at the premerger equilibrium level e_2^{PM}. As shown, a merger makes the

---

[8] From (10) we find that $\frac{dp_{PM}}{de_D} = -\frac{dp_{PM}}{de_1}\left(1 + \frac{de_2}{de_D}\right) = -\frac{B_1'' \cdot B_2''}{B_1'' + B_2''}$ (see the appendix). From (13) we find that $\frac{dp_M}{de_D} = -\frac{dp_M}{de_1} = -B_1''$. For $e_2^M = e_2^{PM}$, $e_D^M = e_D^{PM}$, $\left|\frac{dp_{PM}}{de_D}\right| < \left|\frac{dp_M}{de_D}\right|$.

dominant firm face a steeper inverse demand function. This makes the dominant seller contract supply (demand in the case of a net dominant buyer). This effect leads *ceteris paribus* to an increase in the equilibrium price if the dominant agent is a net seller and a decrease in the price if the dominant agent is a net buyer. Hence, it reduces the merged agents' aggregate profit if they are on opposite sides of the market as the dominant agent, whereas their profit increases if they are on the same side of the market.

Figure 1. Premerger and postmerger residual inverse demand functions faced by the dominant firm, following the numerical example in the proof of Proposition 1



The merger is always profitable if the strategic effect is positive. If the strategic effect is negative, the merger is profitable if the increase in profit following from the contraction in demand/sale (owing to the internalization of the losses they impart to each other) more than offsets the decrease in profit following from the negative strategic effect of the merger.

To highlight the differences in a merger between premerger price takers and premerger Cournot players, we consider the situation where the merged agents become a Stackelberg leader in the output market. We show that a merger between premerger competitive agents may be unprofitable, even where the merger leaves the cartel in a position to be a Stackelberg leader. This result is the opposite of the effects of a merger between premerger Cournot players, which is always profitable if the merger also makes them a Stackelberg leader.

5. Part of the fringe merge into a cartel with Stackelberg leadership

In contrast to the Cournot game where outputs among the Cournot players are chosen simultaneously, in a Stackelberg game model one of the agents (the leader) can choose/credibly commit to an output before the output decisions of the other players (the followers). The followers then choose their output given the leader's output decision. In our setting, the dominant agent becomes a Stackelberg follower. The merging countries take into account the dominant agent's (Stackelberg follower) optimal response given by (17) when they determine their permit trade (joint emission). The EU's establishment of an internal emission trading scheme (the EU ETS) that restricts purchase of emissions reductions by eligible installations from non-EU countries can be seen as a situation where EU countries take Stackelberg leadership in the permit market.[9]

The inverse demand function given by (7) (for s = 1), and the total emission constraint (1) lead to the following inverse demand function (p_S) faced by the cartel if it is a Stackelberg leader:

(23) $$p_S = p_S\left(\bar{\varepsilon} - e_D\left(e_2\right) - e_2\right),$$

where $e_D\left(e_2\right)$ is given by (17).

The cartel's optimizing problem is:

(24) $$\max_{e_2} W_2 = B_2\left(e_2\right) + p_S\left(\bar{\varepsilon} - e_D\left(e_2\right) - e_2\right)\cdot\left(\varepsilon_2 - e_2\right).$$

This leads to the following first-order condition:

(25) $$p_S' \cdot \left(\frac{\partial e_D}{\partial e_2} + 1\right)\cdot\left(\varepsilon_2 - e_2\right) + p_S = B_2'\left(e_2\right).$$

[9] According to the Kyoto Protocol, industrialized countries with quantified emissions targets are allowed to meet part of their reduction commitment through investment in emission-reducing projects in developing countries (the Clean Development Mechanism, CDM), or in other industrialized countries (Joint Implementation, JI). However, the EU Commission did not accept national allocation plans for the EU ETS for 2008-12, if there were no restrictions on the amount of emission credits they could buy from non-EU countries, through either CDM or JI. See [19].

Let $e_1^S, e_2^S, e_D^S, p_S^S$ denote the solutions to (8) (for s = 1), (17), (23) and (25). Let W_1^S, W_2^S, W_D^S denote the corresponding welfare levels.

Although the merged agents have chosen the optimal amount of permit purchase (given the anticipated response from the dominant agent), the negative strategic effect from a shift in the slope of the demand function (as explained by (i) in the proof of Proposition 1) can still make merger unprofitable if the merged agents are on the opposite side of the market to the dominant agent. Hence, we get the following proposition.

Proposition 2

Consider a competitive environment with a dominant agent and a competitive fringe. If a subgroup of fringe agents merges and becomes a Stackelberg leader in the output game, merger is always profitable for the merging agents if they are on the same side of the market as the dominant agent, but can be unprofitable if they are on the other side of the market.

Proof:

One effect of merger is identical to that described in ii) in the proof of Proposition 1. We can see by comparing (9) with (25) that e_2^S and e_2^{PM} generally differ. However, when the cartel optimizes its welfare function it takes into account the response function of the dominant agent. Therefore, the welfare effect of choosing $e_2^S \neq e_2^{PM}$ cannot be negative given that merger has occurred, as the cartel can always credibly commit to choosing the joint premerger emission level e_2^{PM}.Hence, the welfare effect of merger can only be negative if the cartel is on the opposite side of the market to the dominant agent, and the negative strategic effect described in (i) in the proof of Proposition 1 more than outweighs the nonnegative welfare effect of choosing $e_2^S \neq e_2^{PM}$ .We provide below an example where merger decreases welfare (and will therefore not occur), even though the merged agents become a Stackelberg leader.

Let (22) give the income of emissions function. Let the initial endowment of permits be $\varepsilon_1 = \varepsilon_2 = 0$, and $\varepsilon_D = 8$. If we compare the equilibrium outcomes from the premerger situation, found from (8), (7) and (12), with the equilibrium outcomes with merger and Stackelberg leadership found from (8) (for $s = 1$), (17), (23) and (25), we find that $e_1^S - e_1^{PM} = -\frac{2}{21}, e_2^S - e_2^{PM} = -\frac{18}{21}, e_D^S - e_D^{PM} = \frac{20}{21}$. In this example, the cartel is a net buyer of permits. The strategic effect of merger is negative as $e_D^S - e_D^{PM} > 0$. Furthermore, we find that $W_2^S - W_2^{PM} = -\frac{5}{21} < 0$. □

Obviously, if a group of premerger Cournot players merge, and through the merger gain Stackelberg leadership in the output market, merger will always be profitable. In the case of a merger of Cournot players, there is no strategic effect through the shift in the slope of the residual demand function faced by the dominant firm (as explained above). Moreover, as explained in the proof of Proposition 2, the cartel would never commit to an emission level that reduces its welfare compared to the premerger situation.

6. Concluding remarks

In this paper, we evaluate the profitability of merger in a noncompetitive permit market. The international permit price is of great significance for the cost of countries meeting their commitments under an international climate regime. Manipulation of the permit price through strategic behavior in the permit market does not only affect the cost effectiveness of reaching a global emissions target, but also the distribution of cost across countries. Hence, the competitive environment in the permit market may affect the countries' willingness to accept tough emissions targets. A group of small, competitive traders, such as the EU countries, will most likely become large net buyers of permits in a post-Kyoto agreement, as they have announced their willingness to accept though targets. Strategic behavior in the permit market may therefore severely affect these countries. This is because strategic behavior among permit sellers increases the compliance costs of EU countries as the permit price is above the competitive level. In addition, and as shown in this paper, coordination of permit purchase (merger) to reduce the permit price, may only lead to an even larger cost.

However, if a large strategic buyer characterizes the permit market, it is more likely that the coordination of permit purchases among EU countries may become profitable. If, for instance, the US decides to join a follow-up agreement to the Kyoto Protocol, it becomes a large buyer of permits if the distribution of permits across countries in the post-Kyoto period does not deviate too much from the Kyoto target. Hence, we may find a post-Kyoto permit market characterized by two large buyers, the US and the EU. However, to be in a position to exploit their potential market power it is necessary to have effective restrictions on the (international) permit trade of their domestic emitters. Hence, the expected competitive environment in the permit market determines whether it is most profitable for the US (if they join a follow-up agreement to the Kyoto Protocol), to let the government act strategically on the permit market on behalf of its domestic emitters (and restrict domestic emissions through domestic taxes/permits) or let its domestic emitters trade directly in the international permit market where they behave as price takers.

References

[1] R.W. Hahn, Market Power and Transferable Property Rights. The Quarterly Journal of Economics 99 (1984) 753 - 765.

[2] J. Weyant, and J. Hill, Introduction and overview. in: J. Weyant, (Ed.), The Cost of the Kyoto Protocol: a Multi-Model Evaluation, The Energy Journal, Special Issue, International Association for Energy Economics, 1999, pp. vii–xiv.

[3] J. Weyant, (Ed.), The Cost of the Kyoto Protocol: a Multi-Model Evaluation The Energy Journal, Special Issue, International Association for Energy Economics, 1999.

[4] C. Böhringer, Climate politics from Kyoto to Bonn: from little to nothing? The Energy Journal 23 (2002) 51-73.

[5] C. Hagem, S. Kallbekken, O. Mæstad, and H. Westskog, Market Power with Interdependent Demand: Sale of Emission Permits and Natural Gas from Russia. Environmental and Resource Economics 34 (2006) 211-227.

[6] C. Hagem, and B. Holtsmark, From small to insignificant -Climate impact of the Kyoto Protocol with and without U.S., Policy Note 2001:1, CICERO, 2001.

[7] C. Böhringer, and A. Löschel, Market power and hot air in international emissions trading: the impacts of US withdrawal from the Kyoto Protocol. Applied Economics 35 (2003) 651-664.

[8] L. Ringius, A. Torvanger, and A. Underdal, Burden sharing and fairness principles in international climate policy. International Environmental Agreements: Politics, Law and Economics 2 (2002) 1-22.

[9] M. Finus, E. Ierland, and R. Dellink, Stability of Climate Coalitions in a Cartel Formation Game. Economics of Governance 7 (2006) 271-291.

[10] A.D. Ellerman, and I.S. Wing, Supplementarity: An Invitation to Monopsony? Energy Journal 21 (2000) 29-59.

[11] C. Hagem, and H. Westskog, Intertemporal Emission Trading with a Dominant Agent: How does a Restriction on Borrowing Affect Efficiency? Environmental and Resource Economics 40 (2008) 217-233.

[12] C. Hagem, and H. Westskog, The Design of a Dynamic Tradeable Quota System under Market Imperfections. Journal of Environmental Economics and Management 36 (1998) 89-107.

[13] S.W. Salant, S. Switzer, and R.J. Reynolds, Losses from Horizontal Merger: The Effects of an Exogenous Change in Industry Structure on Cournot-Nash Equilibrium. The Quarterly Journal of Economics 98 (1983) 185-199.

[14] M.K. Perry, and R.H. Porter, Oligopoly and the Incentive for Horizontal Merger. The American Economic Review 75 (1985) 219-227.

[15] R. Fauli-Oller, On merger profitability in a Cournot setting. Economics Letters 54 (1997) 75-79.

[16] S. Huck, and K.A. Konrad, Merger Profitability and Trade Policy. Scandinavian Journal of Economics 106 (2004) 107-122.

[17] D.J. Ravenscraft, and F.M. Scherer, The profitability of mergers. International Journal of Industrial Organization 7 (1989) 101-116.

[18] J. Tirole, The Theory of Industrial Organisation, The MIT Press, Cambridge, Massachusetts 1988.

[19] K. Neuhoff, M. Åhman, R. Betz, J. Cludius, F. Ferrario, K. Holmgren, G. Pal, M. Grubb, F. Matthes, K. Rogge, M. Sato, J. Schleich, J. Sijm, A. Tuerk, C. Kettner, and N. Walker, Implications of announced phase II national allocation plans for the EU ETS. Climate Policy 6 (2006) 411-422.

Appendix

Below we model the market as a dominant agent facing a net demand function from the fringe and show that the equilibrium outcome of this modeling approach is identical to the approach followed in Section 0. Let *P* denote the price of permits.

From, (8), replacing p with *P*, we find that $e_s = B_s'^{-1}(P), s = 1,2$. Inserting (1) gives the following inverse net demand function faced by the dominant firm:

(26) $$P\left(e_1 + e_2\right) = P\left(\bar{\varepsilon} - e_D\right).$$

Following the aggregation of competitive agents individual demand functions given by (5)- (7):

(27) $$\frac{\partial P}{\partial e_D} = -P' = -\frac{1}{\frac{1}{B_1''} + \frac{1}{B_2''}} = -\frac{B_1'' \cdot B_2''}{B_1'' + B_2''}.$$

The dominant supplier's optimization problem is:

(28) $$\max_{e_D} W_D = B_D\left(e_D\right) + P \cdot \left(\varepsilon_D - e_D\right).$$

The first-order condition gives:

(29) $$-P' \cdot \left(\varepsilon_D - e_D\right) + P = B_D'\left(e_D\right).$$

By inserting (27) and (8) (where s = 1), we can write the first-order condition (29) as:

(30) $$\frac{B_1'' \cdot B_2''}{B_1'' + B_2''} \cdot \left(\varepsilon_D - e_D\right) + B_1' = B_D'\left(e_D\right).$$

In the modeling approach followed in Section 0, we defined the price of emission, *p*, as a function of the emissions from Group 1, that is $p(e_1)$. Totally differentiating (9):

(31) $$\frac{\partial e_2}{\partial e_D} = -\frac{p'}{p' + B_2''} < 0.$$

Further, we can see from (8) (for s = 1), that $p' = B_1''$. Hence, we can write the first-order condition (12) as:

$$\frac{B_1'' \cdot B_2''}{B_1'' + B_2''} \cdot \left(\varepsilon_D - e_D\right) + B_1' = B_D'\left(e_D\right). \tag{32}$$

Eq. (29) equals eq. (32) such that we get equal amount of permit trade under both approaches.

□