Using the allocation of emission permits for Strategic Trade purposes

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Abstract: When the market of tradable emissions permits is perfectly competitive, free allocation of permits through some discretionary rules corresponds to lump sum transfers and cannot have strategic effects. This conclusion is reversed when transactions costs are introduced in the TEP market. Transactions costs proportional to the value of permits exchanged create a gap between selling and the buying price, thus resulting in lower opportunity costs for the holder of excess permits. This can be effectively exploited by a government in order to encourage its firm to gain larger share in an international market. When costs per transaction are fixed, the above effects disappear for those firms participating in the market. For small firms, however, participation may be prohibitively expensive, turning the opportunity cost of any permits hold, equal to zero. This suggests that free permits may create strategic effects within the hands of small firms but not when granted to larger firms.

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1. Introduction

Over the last two decades emissions trading has gained political acceptance and a number of tradable permits systems have been introduced first in the USA, and latter in the EU, while other countries such as Australia and New Zealand are considering the use of such systems. In the USA there are applications both at the federal level (important example is the SO_2 trading system under the framework of the Acid Rain Program of the 1990 Clean Air Act) and the state level (examples include the Emissions Reduction Market System in the State of Illinois, and the Southern California's Regional Clean Air Incentive Market (RECLAIM)). More recently, the European Union has also introduced the Emission Trading Scheme (EU ETS) for reaching its CO2 emission targets under the Kyoto protocol. The increasing interest on tradable permits systems (TPS) is based mainly on the expected efficiency gains, derived from allocating abatement efforts to the lowest cost facilities. The theoretical results have been confirmed, to a certain extent, by a number of studies evaluating existing TPSs, which report significant welfare gains when compared to traditional command and control approaches.[1] However, questions are raised as to whether a) TPSs have actually explored the maximum efficiency gains from using the permits markets, and b) firms and governments use TPSs in the pursuit of different objectives.

This paper examines the latter issue by asking whether a government can use the TPS as Strategic Trade Policy instrument in order to increase the domestic firms' market share in an international market. We provide a mechanism thereby this is possible, and show that a government may prefer the use of discretionary methods to auctioning for distributing permits among domestic firms or sectors. While at first glance grandfathering of permits is immediately suspected as indirect subsidization, in the presence of a competitive market for permits it is difficult to theoretically relate permits to a firm's output decisions. This is so since, even granted for free, permits have an opportunity cost as long as they can be resold. Hence, a firm will use the same amount of permits whether it buys it at an auction or receives it for free through grandfathering. In a competitive permits market, this amount corresponds to a level of emissions for which firm's marginal cost of abatement equals the permits price. Seen in this way, granting permits to a firm corresponds to a lump sum transfer that, while

[1] See for example Stavins (1998) and Carlson et al. (2000).

it may affect entry or exit decisions, it leaves output decisions of existing firms unaffected.

As shown in this work, the above argument fails to hold when transaction costs occurred in permits trading are taken into account. Assuming that transaction costs are proportional to the number of permits traded, a spread between the purchase price and the net amount the seller receives may create an incentive to hold permits that would have been sold, had the market been frictionless. Seen in another way, a firm may decide to use some permits that it would never buy at market price, if those permits are given for free. Due to transactions costs, a firm possessing permits has lower marginal cost than a competitor who needs to buy them. By giving sufficiently large amounts of permits, a government may, thus, create strategic effects in favor of its firms and at the expense of its foreign rivals in international markets. However, as with most strategic trade instruments that aim to increase the aggressiveness of domestic firms, if both countries adopt discretionary permits distribution rules they end up being worse off. This underlines the importance of including in TPSs clauses imposing the same method for the initial permits distribution to all participating countries. This is the case for the first two trading periods of the EU ETS, but it might not hold true for the trading period after 2012. According to the Auctioning Regulation proposed to the member countries by the Commission on April 6, 2010,[2]most of the permits will be auctioned, while a number of them, in specific sectors and member states, will be grandfathered. Furthermore, if more regional or national TPSs for controlling greenhouse gasses evolve and are connected among them, their initial permits allocation rules might differ.

Even when transactions costs do not depend on the volume of transaction, the above described mechanism may still be at work. This can be the case if some firms are locked out of the market, due to their small size: for those firms using permits has no opportunity cost. For large firms, on the other hand, the opportunity cost of using a permit is equal to its market value. As a consequence, giving small amounts of permits to many (small) firms may result in output increases while giving large amounts to some (large) firms works as a lump sum transfer.

[2] The proposed regulation can be found at the following address: http://ec.europa.eu/environment/climat/emission/pdf/proposed_auctioning_reg.pdf

In order to explain the difference between estimated and actual cost savings from implementing TPSs, the literature has identified a number of market distortions. A large body of the literature explores the effect of imperfections at the permits market,[3] while there is considerable discussion regarding the role of transaction costs and imperfect monitoring and enforcement. Stavins (1995) was the first to set up a theoretical model that incorporated transaction costs in the permits market, while Montero (1996) considered uncertainty as well. The present paper is concerned with the effect that transaction costs could have on the output market. In particular we examine whether the existence of transaction costs in a competitive permits market can create an environment in which the allocation of emission permits can be used as an instrument of strategic trade policy.

The importance of transaction costs in emission permits markets was noticed in a number of theoretical works quite early,[4] and their concerns were supported by empirical analysis. Rose (1994) suggests the existence of transaction costs in the SO_2 permits program, Kerr and Maré (1998) estimate efficiency losses from the presence of transaction costs in lead permits program and Gangadharan, L. (2000) shows that transaction costs were significant in the RECLAIM program, influencing the choice of participation in the market. More recently, Jaraite et al. (2009) measure the Irish firms' transaction costs from the European CO_2 permits program (EU ETS). They find that there are significant transaction costs especially for smaller firms and at the early stages of the program.

Transaction costs consist of administrative and trading costs which create a margin between the buying and selling price of permits. Taking the EU ETS as an example, they are incurred first at the stage in which firms are preparing their administrative systems to comply with the requirements of the regulation, second at the stage of trading and they include search, information, bargaining and decision making, and finally at the reporting stage and they include application and permits, registry

[3] See for example, Hahn (1984), Misiolek and Elder (1989) and Sartzetakis (1997).
[4] See for example Baumol and Oates (1988) and Hahn and Hester (1989).

accounts, monitoring, reporting and verification costs.[5] The first category includes mainly fixed and sunk costs, the third category are periodic – incurred in every reporting period-- and the second category are costs that depend on the number of transactions and the volume of permits traded. In this paper we are concerned with the second category costs, thereafter referred to as transaction costs, which are considered as costs per permit traded. Transaction costs defer according to whether firms trade directly at exchanges (in the case of EU ETS there is a number of exchanges, such as ECX, NordPool and EEX) or use brokers operating in the emissions market for over the counter exchanges. In both cases transaction costs can be split into direct transaction costs – which include exchange membership, brokers' fees, and financial services – and indirect transaction costs – which include personnel to manage transactions and risk management, data/advisory services and financial reporting.

As mentioned above, Stavins (1995) incorporated transaction costs into the basic permits model to establish that cost efficiency conditions are violated and thus, potential welfare from the permits market is not achieved. Furthermore, he showed that, in the presence of transaction costs, the initial distribution of permits affects the output of trading. Extending Stavin's work, Montero (1996) incorporated uncertainty in the model and showed their effect on market performance and control costs. Both these papers are concerned with the effect that transaction costs have on the efficiency of permits market. The present paper builds on these works and is concerned with the effect that transaction costs could have on the output market. Since transaction costs affect marginal cost of compliance with the regulation, they also affect firms' output decisions. And since the initial permits allocation affects firms' decision in the emission permits market, and thus output decisions, it might be used strategically. The initial distribution of permits can be used to influence market shares and aggregate output within a country, or it could be used as a strategic trade instrument. This paper focuses on the second case.

Strategic trade theory demonstrates that, in imperfectly competitive international markets, governments can improve their county's welfare, relative to free trade, by

[5] These are costs incurred by firms in preparing their annual emissions report. The regulatory authority incurs also monitoring verification and enforcement costs, which might also be significant but are not borne by firms and thus, we do not take them into account.

intervening in these markets. A significant literature developed around this idea based on the initial contributions by Brander and Spencer (1984(a), (b)) who examined the case of import tariffs and Spencer and Brander (1983). Dixit (1984), Eaton and Grossman (1986) and Brander and Spencer (1985) examined the case of export subsidies. Based on these results, Conrad (1993), Barret (1994), and Kennedy (1994) among others, have suggested that environmental policy can be used to indirectly subsidize exports by under-internalizing the environmental damage caused from pollution. Sartzetakis and Constantatos, (1995) have shown that the choice of environmental policy instrument could also influence the trade outcome. More recently Pratlong (2005) examines the strategic use of the initial distribution of permits by the government in an attempt to boost its firms' position in the international market. His analysis differs substantially from this paper in that he assumes that permits are not traded internationally. That is, domestic and foreign firms face different permit prices, and governments can manipulate the permit price their firms face by choosing strategically the total amount of permits.

2. The model

Assume there are two countries *A* and *B* which are the sole producers at the world market of a product *X*. Denote by q_i the output level of country i=*A, B*. We further assumed that commodity *X* is not consumed in these two countries and all production is exported in a third country *W*, in which the inverse demand is assumed linear of the form:

$$P = a - Q \tag{0.1}$$

where *P* and *Q* represent the price and total quantity of the product respectively. We assume that in each producer country, the good is produced by a single firm with constant marginal cost, which without loss of generality is set equal to zero. Firms are denoted by their respective country-index. In country *W*'s market, the two firms compete in quantities (Cournot competition). The production of *X* generates emissions of a global pollutant, common to many other industries in many countries.

We assume that each unit of output generates a fixed number of emissions and by normalizing units we assume that for each firm located in country $i = A, B,$ emissions are given by $\xi_i = q_i$. Firms can reduce their pollution by choosing the level of their abatement effort r_i. The cost of abatement is assumed quadratic in the level of abatement effort,

$$C_i(r) = r_i^2/2, \quad i = A, B \tag{0.2}$$

Countries *A* and *B* participate in an international agreement to control emissions of this pollutant. The targets specified in the international environmental agreement are achieved through an international TPS requiring that any amount of pollution in excess of total permits held by a firm must be abated. For simplicity we assume that each permit corresponds to a unit of pollutant emission and therefore, to a unit of output produced, since $\xi_i = q_i$. Each government possesses a total quantity of permits to be distributed to its domestic firms in *all* the industries emitting the same pollutant. While the total amount of permits at the disposition of any government is determined by the international agreement, a country's government can determine the way permits are distributed (auction, grandfathering or other schemes), as well as the amount of permits granted (if any) by sector and by firm. All firms from all the industries emitting the pollutant (not just industry *X*) can buy or sell permits in the international market which is perfectly competitive. Since we have assumed that product *X* is not consumed in country *A*, the only objective that country *A*'s government may have in that market is the maximization of profits generated by its firm(s)'s exports; the objective of country *B*'s government will be specified on a case-by-case basis.

Each firm's net demand for permits is $\xi_i - r_i - e_i$, where e_i denotes the amount of permits the firm receives free of charge from the government. Therefore, firms' cost of complying with the regulation, including transaction costs, is

$$C_i(r_i) + z(\xi_i - r_i - e_i) + T(\xi_i - r_i - e_i),$$

where z denotes the emission permits price and T the total transaction costs, which depend on the amount of permits traded. To simplify the exposition we assume constant marginal cost of transaction equal to t, together with a fixed cost $F \geq 0$ necessary in order to enter the market.

3. Emission permits and international trade

3.1 The no-transactions cost case

Before considering the effect of transaction costs, we examine the benchmark case without transaction costs. Let us assume that access in the international permits market is not only free, but also costless. A firm will abate until its marginal abatement cost becomes equal to z. Under our assumptions of linear demand with slope equal to one, zero production costs and constant marginal abatement cost equal to one, this happens at the output level $\underline{q} \equiv z$ as shown in Figure 1 below.

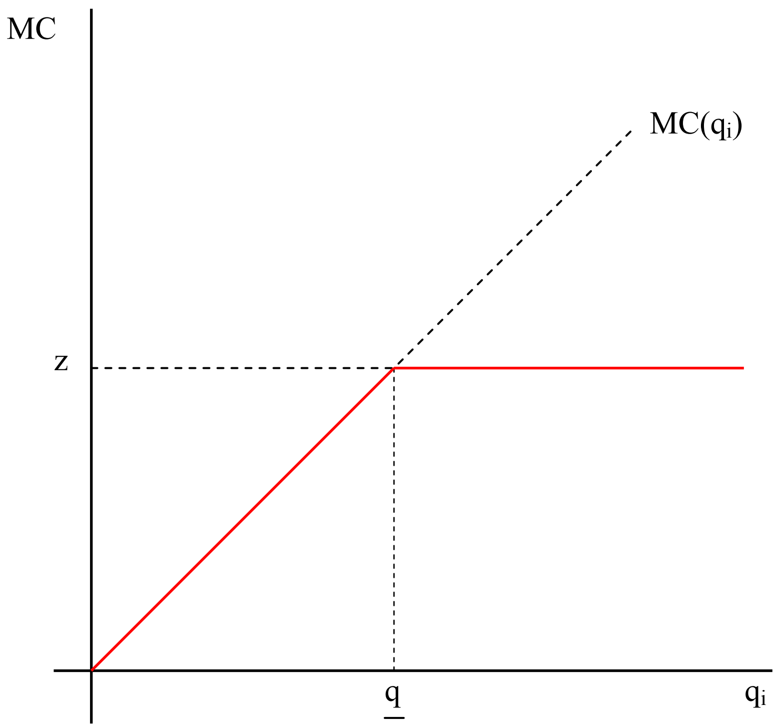

Figure 1. Firm *i*'s marginal cost of compliance with the regulation

Thus, firm *i*'s cost function becomes:

$$C_i(q_i) = \begin{cases} \frac{q_i^2}{2}, & \forall q \le \underline{q}, \\ z(q_i - \underline{q}) + \frac{\underline{q}^2}{2} - ze_i, & \forall q \ge \underline{q}, \end{cases} \quad i = A, B, \tag{0.3}$$

where e_i denotes the amount of permits granted to that firm. The reaction function of firm *i* becomes:

$$q_i = \begin{cases} \frac{a - q_j}{3}, & \forall q_j \in [0, \underline{q}] \\ \frac{a - z - q_j}{2}, & \forall q_j \ge \underline{q} \end{cases} \quad i = A, B. \tag{0.4}$$

In the symmetric equilibrium, output per firm is:

$$q^N = \begin{cases} \frac{a}{4}, & z \ge \frac{a}{4} \\ \frac{a - z}{3}, & z \le \frac{a}{4} \end{cases} \tag{0.5}$$

The first part of (0.5) holds when the permits price relative to product demand is sufficiently high, so that no firm wishes to use the permits market. Hereafter we rule out this case by assuming $z \le (a/4)$.

3.2 The presence of transactions cost

3.2.1 Only one country adopts grandfathering

Let transactions in the permits market bear a cost. At this section we assume that the fixed cost of a transaction is zero, while the variable cost is proportional to the quantity of permits exchanged. In order to simplify the analysis we assume that only selling bears that cost at a rate t. This creates a gap between the market price z and the net price received by the seller which is $z_s = z - t$.[6] Assume further that the government in country *B* auctions all its available permits to its domestic firms, while country *A* uses some grandfathering scheme. The equilibrium price of the permits auction in country *B* cannot be higher than *z*; it will be equal to *z* if total demand for permits from all sectors in *B* exceeds the available quantity in that country. For the sake of simplicity we assume the latter to be the case, therefore the price of auctioned

[6] Analytically, nothing changes if we add a transactions cost on TEP purchases. In that case z would be interpreted as full price, including the transactions cost.

permits in country *B* is the same as that of the international markets. In country *A*, on the other hand, permits are given for free and according to the applied distribution rule, the producer of *X* receives an amount e_A. For the *A* based producer, the opportunity cost of its permits is equal to z_s and its marginal cost function becomes:

$$C'_A = \begin{cases} q_A, & 0 \le q_A \le z_s \\ z_s, & z_s \le q_A \le z_s + e_A \\ (q_A - e_A), & z_s + e_A \le q_A \le z + e_A \\ z, & q_A \ge z + e_A \end{cases} \tag{0.6}$$

which is illustrated in Figure 2.

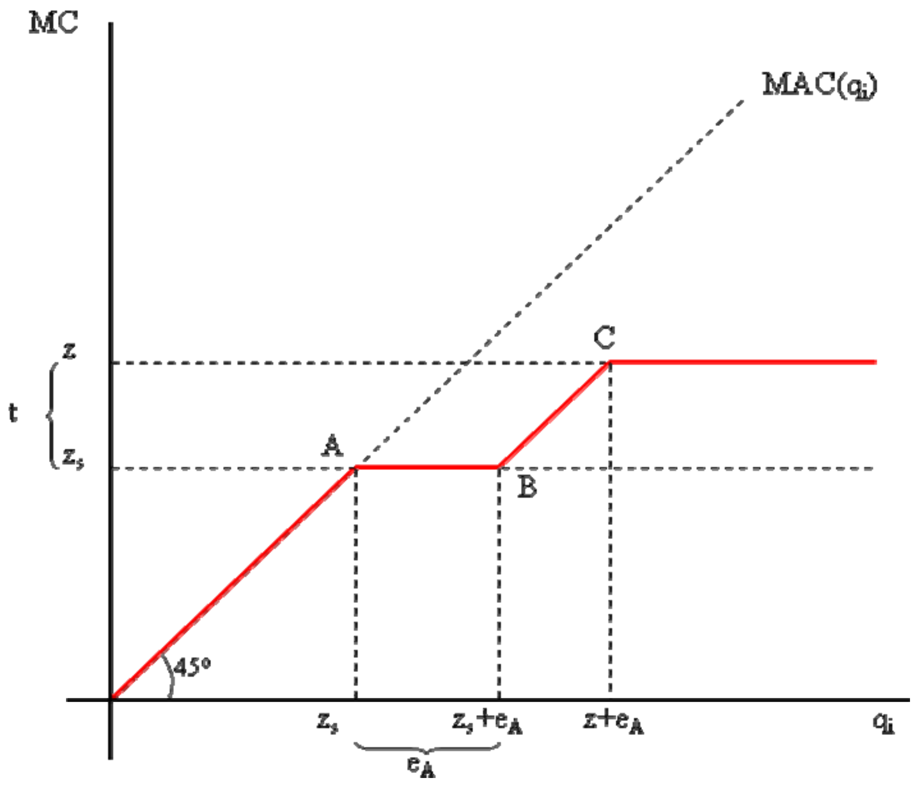

Figure 2. Firm *A*'s (facing transaction costs) marginal cost of compliance

When the amount of permits granted to firm *A* is not too high, *i.e.*, $e_A \le (1/2)(a - 3z)$, the reaction of firm *A* has four parts:

$$q_A = \begin{cases} \dfrac{a-q_B}{3}, & q_B \ge a-3z_s \\ \dfrac{a-z_s-q_B}{2}, & a-3z_s-2e_A \le q_B \le a-3z_s \\ \dfrac{a+e_1-q_B}{3}, & a-3z-2e_A \le q_B \le a-3z_s-2e_A \\ \dfrac{a-z-q_B}{2}, & q_B \le a-3z-2e_A \end{cases} \tag{0.7}$$

When $(1/2)(a-3z) \le e_A \le (1/2)(a-3z_s)$ firm *A*'s reaction function becomes

$$q_A = \begin{cases} \dfrac{a-q_B}{3}, & q_B \ge a-3z_s \\ \dfrac{a-z_s-q_B}{2}, & a-3z_s-2e_A < q_B \le a-3z_s \\ \dfrac{a+e_A-q_B}{3}, & 0 \le q_B \le a-3z_s-2e_A \end{cases} \tag{0.8}$$

while for $e_A \ge (1/2)(a-3z_b)$ firm *A*'s reaction function is

$$q_A = \begin{cases} \dfrac{a-q_B}{3}, & q_B \ge a-3z_s \\ \dfrac{a-z_s-q_B}{2}, & 0 \le q_B \le a-3z_s \end{cases} \tag{0.9}$$

The reaction function of firm *B* is:

$$q_B = \begin{cases} \dfrac{a-q_A}{3}, & q_A \ge a-3z \\ \dfrac{a-z-q_A}{2}, & 0 \le q_A \le a-3z \end{cases} \tag{0.10}$$

the first (second) segment corresponding to levels of output at which firm *B* uses (does not use) the permits market. Equilibrium is obtained at the intersection of (0.10) with one of (0.7)-(0.9), according to parameter values. The two firms' reaction functions are represented by the solid segments on Figure 3 below.

Firm *A*'s reaction function R_A has been drawn in four parts according to (0.7), each solid segment from upper-left to lower-right corresponding to one sub-case in (0.7). Firm *B*'s reaction function in (0.10) correspond to the lower-right and upper-left segments of R_B. Observe that the slope of all the segments in (0.7)-(0.9) is either 3 or 2, while that of the two segments in (0.10), $1/3$ or $1/2$. This implies that any segment in the reaction function of firm *A* is steeper than any segment on the reaction function of *B* which, in turn, implies that there are no multiple intersections, and therefore there exist no multiple equilibria. A typical equilibrium is represented by point *E* on Figure 3 as the intersection of the two reaction functions. Due to multiple kinks in the reaction functions we must proceed examining various sub-cases, a cumbersome exercise the details of which are omitted.

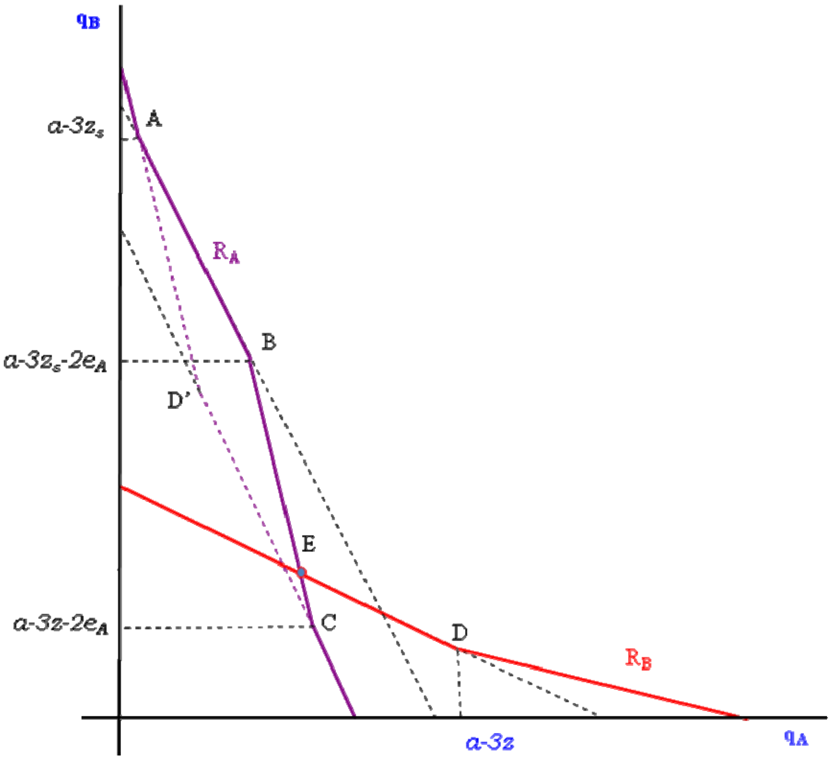

Figure 3. Firms reaction curves when only firm *A* faces transaction costs

The Cournot equilibrium quantities of this game crucially depend of two parameters: the transactions cost per unit of permits, t, and the number of permits granted to firm *A*, e_A. We distinguish between two cases, according to whether transactions cost is high or low, *i.e.*, $t > (<) S \equiv a - 4z$. Cournot equilibrium $\left(q_A^C, q_B^C\right)$ is then:

- $\forall t > 0$,
  - **Region I:** when $e_A < \frac{1}{3}S$,

$$q_A^C = q_B^C = \frac{1}{3}(a - z) \tag{0.11}$$

- $\forall t \geq S$:
  - **Region IIa-i:** when $\frac{1}{3}S < e_A < \frac{1}{3}(S + 4t)$,

$$\begin{cases} q_A^C = \frac{1}{5}(a + z + 2e_A) \\ q_B^C = \frac{1}{5}(2a - 3z - e_A) \end{cases} \tag{0.12}$$

- **Region IIa-ii:** when $\frac{1}{3}(S+4t) < e_A < \frac{2}{5}(S+5t)$

$$\begin{cases} q_A^C = \frac{1}{8}(2a + 3e_A) \\ q_B^C = \frac{1}{8}(2a - e_A) \end{cases} \tag{0.13}$$

- **Region IIIa:** when $\frac{2}{5}(S+4t) < e_A$

$$\begin{cases} q_A^C = \frac{1}{5}(2a - 3z + 3t) \\ q_B^C = \frac{1}{5}(a + z - t) \end{cases} \tag{0.14}$$

- $\forall t \le S$:
  - **Region IIb:** when $\frac{1}{3}S < e_A < \frac{1}{3}(S+5t)$

$$\begin{cases} q_A^C = \frac{1}{5}(a + z + 2e_A) \\ q_B^C = \frac{1}{5}(2a - 3z - e_A) \end{cases} \tag{0.15}$$

  - **Region IIIb:** when $e_A > \frac{1}{3}(S+5t)$

$$\begin{cases} q_A^C = \frac{1}{3}(a - z + 2t) \\ q_B^C = \frac{1}{3}(a - z - t) \end{cases} \tag{0.16}$$

The above constitutes the full solution of the Cournot game provided that $a > 4z$.[7] In order to see the role of permits as a strategic trade instrument, let us consider the $t \le S$ case. Condition (0.11) defines a minimum amount of permits, equal to $S/3$, below which permits granted to firm A have no strategic value. However, the equilibrium solution in Region IIb (equations (0.15)) shows that within the specified

[7] Recall that if this condition is not respected no firm uses permits and the equilibrium is a typical symmetric Cournot one with linear increasing marginal costs.

limits, increases in permits-granted increase monotonically the output of the domestic firm and reduce monotonically the output of the rival firm. Finally, in Region IIIb equilibrium output (Eq. (0.16)) of neither firm is affected by increasing the number of permits granted to firm *A*. The equilibrium represented by (0.16), however, is asymmetric, with the domestic firm *A* producing more output than its rival. The difference in output ($3t$) is proportional to the level of transactions cost. When $t \geq S$ the analysis remains essentially the same, except that Region II is now breaking in two parts, IIa-i and IIa-ii. While the functional form of equilibrium outcomes changes from one sub-region to the other, the qualitative result, namely that an increase in permits increases domestic firm's output while reducing that of the foreign firm, remains. The marginal impact of this effect is reduced in Region IIa-ii relative to Region IIa-i. In terms of Figure 3 this implies that when $t \geq S$ the equilibrium may fall on R_A's the BC segment.

3.2.2 Both countries adopt grandfathering

Let us now assume that neither country auctions its permits, but rather both countries adopt some discretionary rule for distributing their available permits. Let e_B represent the amount of permits country *B* grants for free to its *X* producer. Each government aims to maximize the share of its firm in the international market. We have now a two stage game where, at the first stage both governments must simultaneously decide how many permits to distribute to their respective firm (e_A, e_B), and at the second stage firms simultaneously compete in quantities in country *W*'s market. Rather than solving the entire model anew, we will simply try to characterize the equilibrium. Assume that initially $e_B = 0$ and let, for simplicity, $t \leq S$, so the second stage equilibrium is given by (0.11), (0.15), and (0.16). Simple inspection of these cases shows that firm *A*'s share is maximized in Region III, where it remains constant at its maximum level, independently of the number of permits granted to that firm beyond the $e_A = \frac{1}{3}(S + 5t)$ level. In terms of Figure 3, this corresponds to the lowest point that can be reached on firm *B*'s reaction function. Notice that by granting more permits the government of country *A* can only shift the break in firm *A*'s reaction function; the distance between the parallel segments is exogenous, since it only depends on *t*. Hence, any e_B determines a particular position for the reaction function of firm *B*, and country A's government will set e_A in such a way, that firm A's reaction function intersects that of firm B at the lowest possible point. This determines the reaction function $e_A = e^A(e_B)$ of government A. A similar reaction function $e_B = e^B(e_A)$ exists for government B and is symmetric to that of government A. Thus, the equilibrium must be symmetric with both firms abating the amount of emissions corresponding to $\underline{q}$ and using free permits for the rest. Their marginal cost in the neighborhood of equilibrium being, therefore, $z_s = z - t$, the equilibrium output is:

$$q_A^C = q_B^C = \frac{a - z + t}{3} \tag{0.17}$$

The situation is depicted in Figure 4. Unlike that in Figure 3, firm B's reaction function has a component $A'B'$ lying on the upper doted line, the latter corresponding to optimal responses when firm B's marginal cost is $z - t$. The extent of this segment depends on the number of permits granted to firm B. The B-country's government optimal reaction is to give the number of permits necessary to extend the segment $A'B'$ up to point J. However, country A's government pursues a similar strategy; thus, the equilibrium will be finally at point H. At this equilibrium, both firms are more aggressive since they perceive their marginal cost to be $z - t$.

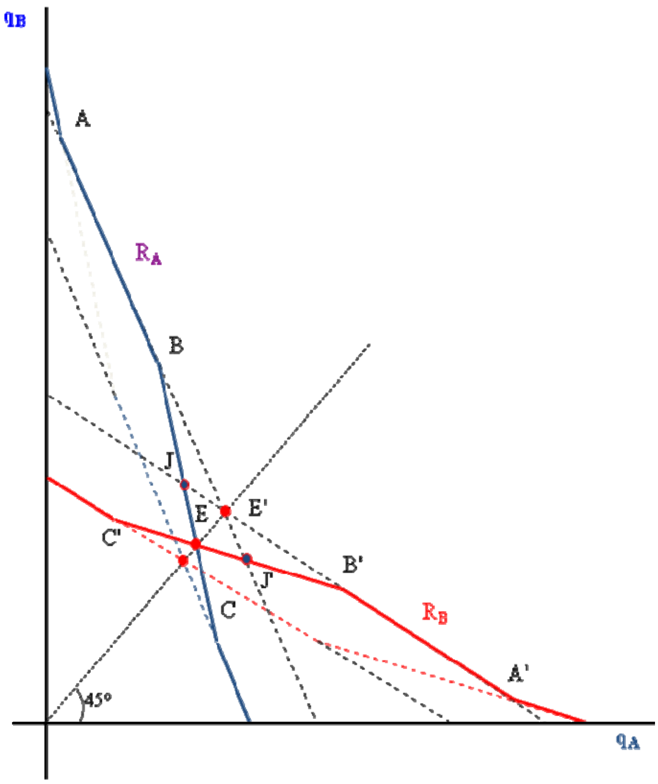

Figure 4. Firms reaction curves when both firms face transaction costs

Comparison of (0.17) with (0.5) reveals immediately that following the mutual adoption of discretionary distribution rules no firm increases its market share. Total output in country *W* increases, and therefore, price and profits fall. Discretionary permits-distribution rules—like most strategic trade policies aiming at making the domestic firm more aggressive—when mutually adopted, yield a result counter to that they were designed to bring. However, absent an international agreement that forbids free permits distribution, both governments are locked into a prisoner's dilemma situation, most likely resorting to such policies.

3.3 The case of fixed transactions costs.

Often transactions costs are of the form $T = F + t\left(\xi_i - r_i - e_i\right)$, *i.e.*, there is a fixed part related to the number of transactions but not on the amount exchanged. Assuming for simplicity that the variable part *t* is very small, in fact zero, the question is again if the distribution of (free) permits may affect output decisions. The present paper does not offer a full analysis of all cases, but a simple example may illustrate the situation.

Consider a second industry *Y* that has the same structure as industry *X*, *i.e.,* one domestic and one foreign firm, both exporting in country *W*. Assume that the two products *X* and *Y* are unrelated, so on the demand side the two industries are completely independent. Assume the demand for *X* is as in the previous section, while the demand for *Y* in country *W* is $P_Y = a_Y - Q_Y$, with $a_Y = ka$, $k > 1$. The production cost function is similar in the two industries (here assumed equal zero) and the production process of the two industries generates the same pollutant. Let $S_Y = a_Y - 4z$, where S is defined in a similar way as before. Assume that the fixed cost for entering the permits market is just prohibitive for a firm in the *X* market. The use of permits that have been acquired for free has no opportunity cost for the producer of *X* in country *A*. This implies that even if the value of *t* imposed by the permits market is zero, the variable transactions cost for that producer is equal to *z* for all permits granted.

For any amount of permits $e_A^X \geq S/3$ given to that firm (and no permits given to its rival in country *B*) equilibrium in market *X* is described by (0.11)-(0.14) or by (0.11), (0.15), and (0.16), according to whether $z \geq S$. A sufficient level of the fixed cost for *any* producer in market *X* to stay out of the permits market is $F = \pi_A^{CX}\left(q_A^{CX}, q_B^{CX}\right)$, where q_A^{CX}, q_B^{CX}, are given in (0.16), and $\pi_{AX}^{C}(\cdot)$ is the corresponding equilibrium profit for firm *A* in industry *X*. While the firms in industry *X* are locked out of the permits market and use all their permits as if they were a subsidy, since their opportunity cost is zero, for firms in industry *W* where profits are much larger, this does not need to be the case. *S*ince profits in *W* can be arbitrarily larger than those of the small firm, we can have situations where the entry fee is not prohibitive and the opportunity cost for using permits is equal to z. Thus, fixed transactions costs create thresholds within which permits have zero opportunity costs and operate as pure subsidies. Due to this lock out effect, permits widely distributed in the hands of small firms may have strategic impact, while large volumes of permits in the hands of large firms have no impact on output.

4. Conclusions

We have investigated the strategic potential of a free permits distribution system. In the presence of a perfectly competitive permits market, grandfathered emission permits are considered as equivalent to monetary transfers, since a firm can always exchange them for money. Thus, contrary to offering direct *per-unit* or *ad valorem* subsidies, the granting of free permits to a firm cannot make that firm's output response more aggressive. As a result, the total value of permits granted to a firm corresponds to a lump-sum gift that cannot affect industry output, excluding perhaps cases where it delays the exit decision of some firms.

Our analysis shows that the above reasoning is limited to the case where permits' transactions bear no additional costs. The introduction of a per-unit transactions cost reduces the net profit from selling available permits, thus reducing the opportunity cost of using them in the production process. This reduces marginal cost, thus inducing the holder of any excessive permits to a more aggressive behavior. While it appears that both permits and subsidies may be used strategically to increase the domestic firm's output, there exist still a difference between the two. Unless there are quotas restricting the number of units to be subsidized, the subsidy applies to all units and the government's decision concerns the subsidization rate. N the case of grandfathered emission permits, on the contrary, the amount of subsidy per unit of output is exogenous, determined by transactions costs. What the government may affect in this case is *the number of subsidized units*. Hence, grandfathered permits are closer to *capacity commitments*, in the sense of the Dixit-Spence model.[8]

The above consideration yields some policy conclusions. First, by choosing a grandfathering scheme of distributing free permits to its firms, a government may benefit its domestic firms versus foreign rivals from countries that distribute their permits through auctions. Second, the common curse to commitment-for-aggressive-behavior strategies applies here as well: if both countries try to use grandfathering in a strategic way they will end up reducing the profits of their firms, in favor of buyers. Since unilateral renouncement of grandfathering makes the auction-using country worse-off, a prisoner's dilemma emerges in the absence of international agreements.

While our formal analysis was mostly based on transactions costs per unit of permits exchanged, our results carry through the case of fixed transactions costs. The latter may create a volume threshold below which it is not worth entering the permits market. This separates firms in two categories, according to the number of permits they wish to sell. While our theory no longer applies to firms aiming to sell a large volume of permits, it does so with a vengeance to those with a small volume: being locked-out of the permits market, they consider the *entire* value of their permits as subsidy to production. Output stimulating objectives suggest in this case that, *ceteris paribus,* a wide distribution of permits is preferable than giving large volumes to a limited number of firms.

While in this paper we have used strategic trade as a government's policy objective, our analysis has implications for any policy that aims to stimulate output. For instance, an unequal distribution of permits to otherwise symmetric firms may bring

[8] See Tirole (1989).

total industry output closer to its Stackelberg level. Since the latter is, *ceteris paribus*, higher than total output in the Cournot equilibrium, output-stimulating objectives may require *unequal* distribution of permits among otherwise symmetric firms. Full investigation of this issue lies high on our research agenda.

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