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New Entrant and Closure Provisions: How do they Distort?*

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Provisions to endow new entrants with free allowances and to require closed facilities to forfeit allowance endowments are ubiquitous in the EU Emissions Trading Scheme, but a new design feature in cap-and-trade systems. This essay seeks to explore, within a comparative statics framework, the effect of these provisions on agent behavior in output and emissions markets assuming profit maximization. The main conclusion is that the principal effect is on capacity. The effect of the resulting over-capacity on output markets is to reduce output price and to increase output. The effect on emissions markets is more ambiguous in that it depends on the emission characteristics of the new capacity, existing capacity, and the capacity not retired, and the distribution of the excess capacity among these categories.

1. INTRODUCTION

As a person whose life began in England and ended in North America and who maintained academic affiliations in the United Kingdom, Canada and the U.S., Campbell Watkins had a fine appreciation for the subtle differences that mark the two sides of the North Atlantic. He embodied the cross-fertilization that trans-Atlantic exchanges imply and I have no doubt that that was one of the reasons the IAEE received so much of his attention and benefited so grandly from it. This essay concerns one of those trans-Atlantic exchanges and one of which Campbell would have enjoyed the irony: An American innovation that goes to Europe and becomes bigger than anything yet seen in North America. The transplant is the cap-and-trade form of emissions trading and the European application is the European Union CO_2 Emissions Trading Scheme (EU ETS). More specifi-

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cally, this paper focuses on a particular feature of the allocation process in the European variant, the endowment of new entrants with allowances and the forfeiture of allowances when facilities are closed.

The European Union Emissions Trading Scheme (EU ETS) is the world's first cap-and-trade program for CO_2. It has been implemented by the twenty-seven Member States of the European Union (EU) as one of the measures to fulfill their obligations under the Kyoto Protocol. It applies to stationary sources larger than 20 MW^{th}, generally fossil-fuel-fired electricity generators and CO_2 emitting industrial facilities and it covers approximately 52% of the CO_2 emissions of the entire EU. The first stages of implementation occur in two distinct periods: a first "trial" period encompassing calendar years 2005-07 and a second period corresponding to the first commitment period under the Kyoto Protocol, 2008-2012.

Although modeled after the U.S. SO_2 cap-and-trade system, the EU ETS is much larger in all dimensions. It includes about four times as many installations, approximately 11,400 installations as compared to about 3,000 in the US SO_2 program. The volume of annual emissions covered is a thousand times greater: approximately 2.2 billion metric tons of CO_2 compared to about 18 million short tons of SO_2 (before the 50% reduction imposed by the initial SO_2 cap). Finally, although prices per allowance and per ton of emissions have been much higher in the SO_2 program than in the EU ETS (from $70 to $1600 compared to 8 to 30 euros), the value of the allowance assets distributed in the EU ETS is about ten times that of the US SO_2 program, about $50 billion compared with $5 billion at current prices of 18 euros/metric ton and $600/short ton, respectively.

Cap-and-trade programs create allowances, which are explicit limited rights to emit the specified substance, and all programs face the initial problem of allocation: deciding how to distribute these limited and prospectively valuable rights. In the U.S. program, allocation was decided centrally by the U.S. Congress as an integral part of Title IV of the 1990 Clean Air Act Amendments. In the EU ETS, allocation is delegated to the 27 member states, each of which is responsible for developing its own National Allocation Plan (NAP) subject to review by the European Commission. Despite this fundamental difference in allocation approach, both programs are alike is distributing nearly all of the allowances for free to the incumbents on whom the liability to surrender allowances equal to emissions is imposed.

One of the notable differences between the EU ETS allocation of CO_2 allowances and the U.S. allocations of either SO_2 or NO_x allowances concerns the treatment of new and closed facilities. Generally, new entrants in the U.S. do not receive allowances and therefore must purchase whatever they would need from the market.[1] Moreover, closed facilities are allowed to retain the initial endowments. In the EU, all 27 Member States have set aside a certain percentage of the total number of allowances for new entrants and most Member States require

1. Some exceptions occur in the NOx Budget Program, where allocation decisions have also been decentralized to the states.

the owners of closed facilities to forfeit future allowance endowments at closure. Some Member States have also developed transfer rules whereby the allowances from a closed facility can be transferred to a new facility under certain well-specified conditions.[2] A further important condition of the new entrant endowments, like those to incumbents, is that once determined they are fixed in keeping with the criteria of no ex post adjustment of allowance endowments.

This paper concerns the effect of these new entrant and closure provisions and specifically the means by which efficient resource allocation is distorted. A considerable literature has already developed about these provisions generally within the context of over-all treatments of the allocation procedures in the EU ETS. Although all of these contributions recognize that the new entrant and closure provisions are distorting, the focus is as often on the diversity of these provisions among member states, and on the additional distortion thereby introduced into EU-wide investment by the carbon market, as it is on the more fundamental nature of the distortion. Moreover, many (Matthes et al. 2005; Engenhofer et al., 2006; Neuhoff et al., 2006) see the main effect on the pricing of carbon and on the incentives thereby provided for investing in higher or lower carbon content technology. Only Åhman et al. (2006) clearly state that the main effect is on output. None attempt a formalization of the effects on agent behavior and how this would influence product and emissions markets. This paper offers that formalization in the interest of clearly stating the channels by which resource allocation is distorted. The main clarification to the current discussion is that the primary effect of these provisions is to create over-capacity and that the effect on emission markets is indirect and more ambiguous. The unambiguous effect of over-capacity is to reduce output prices and to increase output. The effect on emissions will depend on the emissions characteristics of the new and extended capacity and of the production that is displaced by the excess capacity. Although increased demand for allowances and higher allowance prices seems likely, this outcome is by no means certain. It depends on what is displacing what.

The next section of this paper models the effect of these provisions on agent behavior using a standard profit equation from which the usual first-order-conditions can be derived. The third section discusses what would be the effects of these provisions on output and emissions markets. The final section concludes.

2. EFFECTS ON AGENT BEHAVIOR

Competitive market conditions are assumed so that agents are price takers in both output and emissions markets. A further assumption is that agents maximize profit where profit is most generally described as revenue less cost elements

2. The most complete account of the details of the final new entrant, closure and transfer provisions is UBA (2005). Betz et al. (2004) provides the earliest account of these provisions based on the first versions of NAPs. As a result, some of the details in this early account are inaccurate as a result of further changes as NAPs were finalized. Godard (2003) provides another early evaluation of these provisions motivated by discussions during the development of the French NAP.

for variable costs, emissions cost and capital recovery.[3] Short-run and long-run effects are distinguished by whether the capital stock is fixed or not, which among other things determines whether the cost element for capital recovery is included in optimization decisions. A distinction is also made between the prices applicable for short-run maximization and those for long-run decisions. The price used for short-run profit maximization is assumed to be a single price that is known and applicable for the relatively short period over which the relevant output and abatement decisions are made and during which the capital stock is always invariable. The price used for long-run profit maximization is an expectation of the short-run prices over the relevant horizon for the particular decision concerning investment in or removal of capital stock. The mean of this expectation can be thought of as a long-term price, but it exists only in expectation. Realized prices are always the result of short-term maximization. These differences are illustrated in the following three cases.

2.1 Short-run Optimization with Fixed Allowances

In keeping with standard economic theory, firms are assumed to produce so long as the current market prices are sufficient to cover marginal costs. The profit to be earned will be determined by the following short-term profit equation.

$$\pi = pq - C[q,r] - v(rq - a) \tag{1}$$

Where:
π = short-term profit
p = product price
q = quantity produced
C […] = short-run or restricted cost function
r = emission rate per unit of output
v = price of allowances
a = fixed allowance allocation

The environmental constraint is represented by the new argument, r, in the cost function for abatement and by the further cost component corresponding to the net effect of the emissions constraint on the firm's profits taking into account the allowance endowment, a, and the new positive price on emissions, v. Note that the abatement argument of the restricted cost function is the emission rate instead of emissions. This formulation reflects the circumstance that abatement decisions typically concern the rate of emissions and that emissions depend also on output, which responds to other considerations. The usual conditions apply to this short-run cost function, namely,

3. Obviously, where regulatory treatment intervenes, the results may differ. The purpose here is to understand the effects in the most basic case before taking institutional factors into account.

$\partial C/\partial q > 0$, $\partial^2 C/\partial q^2 > 0$, $\partial C/\partial r < 0$, $\partial^2 C/\partial r^2 < 0$.

Short-term profit maximization involves both a production and an abatement decision. These are assumed to be independent so that any level of abatement can be achieved with any level of feasible production. The standard first-order conditions (FOCs) are

$$p = \frac{\partial C}{\partial q} + vr \quad \text{and} \quad v = \frac{-\,\partial C/\partial r}{q} \tag{2}$$

The environmental constraint introduces a new element into output decisions, the per-unit cost of emissions, which creates a wedge between the price of output and the marginal cost of producing output without regard to emissions. The environmental constraint also adds another component to the optimization process, which then requires that the marginal cost of abatement per unit of output be equal to the emissions price. A typical example is provided by a coal-fired electricity generating plant choosing among coals of differing sulfur content with higher prices attached to lower sulfur coal. Switching to a lower sulfur coal would result in a higher cost for all the coal required to produce q.

2.2 Long-run Optimization with Fixed Allowances

The long-run profit equation requires that initial capital expenditure enter the equation and that the prices be recognized as expectations.

$$\Pi = \hat{p}q - C[q,r] - \hat{v}(rq - a) - \delta z[r]K^*[q] \tag{3}$$

Where:
Π = Long-term expected profit at the time of investment
δ = capital recovery factor to account for depreciation and interest cost
z […] = initial investment cost per unit of capacity
K^* […] = optimal capacity

First, Π is used to denote long-run expected profit, which is different from that in equation (1) both in including the last right-hand-side term for capital recovery and in being based on expected output and emissions prices over much longer periods of time approximating the life of the investment. Second, the circumflexes over the output and allowance prices signify means of the distribution of expected prices over the time of the investment. In a sense, output, q, and the emission rate, r, could also be considered to be expectations, but these variables are under the control of the operator. Finally, the capital recovery term is a function of output, which determines capacity, and abatement, which determines the initial capital cost per unit of capacity. For simplicity, it is assumed that both of these functions are linear and that the first derivatives take the following form.

$$\partial K/\partial q > 0 \quad and \quad \partial z/\partial r < 0 \tag{4}$$

The FOCs of the long-run profit equation indicate the expected prices required to justify investment in output and abatement.

$$\hat{p} = \frac{\partial C}{\partial q} + vr + \delta z \frac{\partial K}{\partial q} \quad and \quad \hat{v} = \frac{1}{q}\left(-\frac{\partial C}{\partial r} + \delta K \frac{\partial z}{\partial r}\right) \tag{5}$$

Both of these can be seen as thresholds, or entry prices, that trigger investment in capacity either to produce or to abate. The expected output price, $\hat{p}$, must be equal to short-run marginal costs plus an expected surplus that would allow the value of the initial capital investment to be recovered. Production might well be expected to occur at prices lower or higher than $\hat{p}$, but the expected short-run profit surplus integrated over time would allow recovery of the initial capital investment. The variable, $\hat{v}$, expresses the same requirements and relations with respect to capital investment in abatement.

2.3 Long-run Conditions with New Entrant Provisions

The distinguishing characteristic of short and long-run profit maximization in the preceding two sections is that the endowment of allowances, a, does not appear in any of the first order conditions. The allowance endowment has an effect on both short and long-run profits that compensates for the added environmental cost element, but it has no effect on output or abatement decisions of a profit-maximizing agent. The effects are purely financial.[4] New entrant and closure provisions invalidate this observation for long-run optimization since the decision to invest in added capacity brings an endowment with it and a decision to close existing capacity involves the forfeiture of an existing endowment.

The exact specification of the endowment to be given to new facilities differs considerably among the national allocation plans of the 27 member states of the European Union. Most provisions resolve into some form of endowment per unit of capacity or expected output.[5] Implicitly, if not explicitly, the endowment assumes some emission rate, usually reflecting some notion of best available technology, and, if based on capacity, some level of utilization, often that for comparable existing facilities. Whatever the basis for determining the new entrant endowment, it is fixed once it has been granted and it does not vary according to actual production, unless the facility is closed. The effective prohibition on adjusting allowance endowments according to actual production implies that the allowances new entrants receive do not enter the short-run profit condition, as

4. Åhman et al. (2007) provides a good discussion of these effects, which notes that financial effects can be important.

5. Assuming some optimal relation between expected output and capacity, the two are equivalent.

shown in equation (1), and that short-run output and abatement decisions are not affected.[6] In the following equations, the new entrant endowment is modeled as a fixed endowment, $\tilde{e}$, that is scaled to optimal capacity, which is in turn a function of planned output. This endowment will typically be a multi-year grant so that it is greater than *a*, the portion of the endowment relevant to short-run maximization. The long-run profit equation now takes the following form.

$$\hat{\Pi} = \hat{p}q - C[q,r] - \hat{v}(rq - \tilde{e}K[q]) - \delta z[r]K[q] \tag{6}$$

The FOCs are:

$$\hat{p} = \frac{\partial C}{\partial q} + \hat{v}r + \left(\frac{\delta z - \hat{v}\tilde{e}}{q}\right)\frac{\partial K}{\partial q} \quad and \quad \hat{v} = \frac{1}{q}\left(-\frac{\partial C}{\partial r} + \delta K\frac{\partial z}{\partial r}\right) \tag{7}$$

There are three important points to draw from these conditions. First, the allowance endowment affects the entry price condition for determining investment in output capacity, unlike the case depicted in equation (5), because the endowment is contingent on the decision to invest in new capacity. Second, the endowment functions effectively as a lump-sum payment that helps to offset the annual capital recovery charge by the expected value of the endowment. The third point to note is that the new entrant provision has no effect on abatement. While the agent receives an endowment that can be considered an offset to emissions cost, the agent is still required to pay the full market price for emissions. This follows from lump-sum character of the endowment and the scaling of the endowment to capacity, not to emissions or to investment in abatement. Consequently, the only direct effect of a new entrant endowment is to increase output capacity.

In both the political and more academic discussion of new entrant provisions, there is considerable confusion about whether the agent is thereby freed from considering emissions cost. It is natural to think of the new entrant endowment as an offset to emissions cost, but it does not function in that manner. The agent must pay for emissions regardless and, so long as the new entrant endowment is invariable, the agent will optimize abatement as in equations (1) and (2). However, the new entrant endowment also does not have the same character as an up-front cash subsidy of initial capital cost, as might be suggested by equation (7). It would if emissions and financial markets were sufficiently developed that the endowment could be capitalized and sold for cash, but that will generally not be the case. In the EU ETS, the endowment is a promise from the government of an annual lump-sum endowment to compensate for emissions cost, although whether it will compensate more or less than fully will depend on the short-run abatement

6. The policy of no ex post adjustment adopted by the European Commission has been appealed to the European Court of First Instance by Germany who would adjust new entrant endowments according to deviations between predicted output, upon which the German new entrant endowment is based, and actual output.

decisions of the agent. From a long-run or planning standpoint, how the offset is described doesn't make much difference; its effect upon the entry price condition will be the same.

A final point is that the value of the new entrant endowment is not insignificant. The Danish NAP is wonderfully explicit in stating exactly what a new power plant will receive: 1,710 EUA's[7] per year per MW of installed capacity. This number is based on a natural-gas-fired combined cycle unit realizing 60% efficiency and running 5000 hours a year. At 20 euros a ton of CO_2, the value of this endowment is 34,200 euros annually. A reasonable estimate of the capital cost of a combined cycle unit is perhaps 600 euros per KW of capacity. With an annual capital charge rate for depreciation and interest of 15%, the annual capital recovery requirement is 75,000 euros. Almost half of this requirement is offset by the new entrant endowment! The percentage of the annual capital charge offset will vary depending on the capital cost per unit of capacity and the endowment of allowances per unit of capacity, and it might be expected to be less for other types of electric generation plant or for facilities in other industries. Each case would need to be analyzed separately, but it seems likely that a potentially substantial incentive to increased capacity has been provided.

2.4 The Effect of Closure Provisions

As used in the EU ETS, and more generally, closure is a decision concerning the capacity to produce, not production itself.[8] The profit equation for a closure decision is a cross between short-run and long-run conditions discussed previously. It is like the long-run condition in affecting capacity and in involving price expectations, although over shorter time horizons. It is like the short-run condition in that the capital is sunk and there is consequently no capital recovery term. To denote this shorter period, the profit and price terms are marked by a prime. As an initial point of reference, the profit equation for non-closure and the corresponding FOCs are stated for situations in which there is no emissions constraint.

$$\hat{\Pi}' = \hat{p}'q - C[q] \geq 0 \quad and \quad -\hat{p}' = \partial C/\partial q \quad for\ q > 0 \qquad (8)$$

For any level of positive output, the expected profit must be non-negative and short-run marginal cost, no greater than the expected output price over the horizon that is relevant for the closure decision. Since no capital term is stated in the profit equation, the closure price, $\hat{p}'$, is lower than the corresponding entry price for new investment. It is simply the price expectation that would recover short-run marginal cost of output over the relevant horizon.

7. European Unit Allowances, the formal name of allowances in the EU ETS.

8. Closure is variously described. Often it is tied to the retirement of the environmental permit to the facility. Sometimes a minimum level of production is prescribed.

When an emission constraint is introduced, the non-closure condition becomes as in equations (9a) and (9 b) below according to whether the facility's allowance endowment, $\tilde{a}$, is retained despite closure (9.a) or not (9.b). The FOC for abatement is not shown since it is unaffected by closure and equal to $\hat{v}' = \partial C/\partial r \,/\, q$

$$a.\ \hat{\Pi}' = \hat{p}'q - C[q,r] - \hat{v}'rq \quad and \quad \hat{p}' = \partial C/\partial q + \hat{v}'r$$
$$b.\ \hat{\Pi}' = \hat{p}'q - C[q,r] - \hat{v}'(rq - \tilde{a}) \quad and \quad \hat{p}' = \partial C/\partial q + \hat{v}'(r - \tilde{a}/q) \qquad (9)$$

It is clear from a comparison of equation (9a) with equation (8) that the introduction of a cost for emissions would lead agents to close more facilities than they would if this cost element were not present. A closure provision has the effect of introducing a new term $\tilde{a}$ (> a), which represents the endowment of allowances the value of which, $\hat{v}\tilde{a}$, is forfeited by closure. When stated on a per unit basis, as is done in this FOC, the pro rata share that would enter into the agent's closure decision is this amount divided by planned production. This term implies that less capacity would be closed than would be the case without the closure provision. Moreover, and worse, if production has declined from what it was when the allowance endowment was initially made, so that the term in parentheses is negative, less plant closure would occur than if there were no emission constraint, that is, more than would occur in the situation depicted in equation (8). To the extent that q declines as the facility ages, closure provisions will have a strong distorting effect on capacity.

2.5 The Effect of Transfer Provisions

A transfer provision allows the owner of a closed facility to transfer that facility's allowances to a new facility, which is thereby not eligible for a distribution of allowances as a new entrant. Depending on the specific provisions, the transfer may require common ownership of the closing and new facility, or the two may be linked by contract. Also, the timing of the closure and start of the new facility must be within certain defined time periods (for instance, 18 months before or after in the German NAP). Typically, the transfer is calibrated to the capacity of the closing and new facilities. Thus, if the closed facility is larger than the new facility, only the pro rata capacity share of allowances may be transferred. Similarly, if the new facility is larger, all the allowances of the old facility may be transferred and the new facility will be eligible for a new entrant endowment for the amount of capacity that is greater than that of the closed facility.

The linking of closing and opening facilities, as required by transfer provisions, is in some sense artificial. New investments could be expected to be made, and installations to close, without such linkage. The relevant question is when would it be advantageous to the party or parties involved in such decisions to effect a linkage? From the standpoint of a new entrant, it would be advantageous to make such linkage if the transferred endowment is greater than the new entrant endowment to which the new facility would otherwise be entitled. When ownership of the two facilities is common, the owner would use the transfer rule option only when this was the case. And when ownership is not common, the new facility would be willing to pay only for the quantity of allowances exceeding what it would receive without charge from the new entrant reserve. From the standpoint of the owner of the closing facility, the quantity of allowances equal to what is provided by the new entrant reserve for like capacity will be forfeited regardless. The only advantage in making the linkage is to realize the value of the allowances in excess of what is provided to new entrants for free.

These arguments can be formalized using slightly modified notation for the new entrant and closure decisions when taken alone. Since the technologies used in the new and old units will not be the same, and therefore the variables for output and abatement, it is necessary to distinguish between the new and old capacity by superscripts N and O, respectively. The time horizons are also normalized to that pertaining to closure decisions to make the expected price terms comparable. In equations (10) and (11), the conditions facing new entrants are denoted by sub-equations (a) while those facing potentially closed facilities is given by (b).

$$\begin{aligned} &a.\ \hat{\Pi}'^{N} = \hat{p}'q^{N} - C^{N}[q^{N},r^{N}] - \hat{v}'(r^{N}q^{N} - \tilde{e}K[q^{N}]) - \delta z[r^{N}]K[q^{N}] \\ &b.\ \hat{\Pi}'^{O} = \hat{p}'q^{O} - C^{O}[q^{O},r^{O}] - \hat{v}'(r^{O}q^{O} - \tilde{a}) \end{aligned} \qquad (10)$$

The FOCs with respect to output are

$$\begin{aligned} &a.\ \hat{p}'^{N} = \frac{\partial C^{N}}{\partial q^{N}} + \hat{v}'r^{N} + \left(\frac{\delta z - \hat{v}'\tilde{e}}{q}\right)\frac{\partial K}{\partial q^{N}} \\ &b.\ \hat{p}'^{O} = \frac{\partial C^{O}}{\partial q^{O}} + \hat{v}'\left(r^{O} - \frac{\tilde{a}}{q}\right) \end{aligned} \qquad (11)$$

The effect of the transfer rule is to substitute $\tilde{e}$ for $\tilde{a}$ in equations (10.b) and (11.b). The entry price condition remains unchanged for the new entrant (since the value of $\hat{v}(\tilde{a} - \tilde{e})$ is either purchased or foregone) and the only effect is on the facility being considered for closure. The owners of these facilities are given an incentive to link up with some new capacity in order to realize the value of their allocation in excess of the new entrant endowment. The price required for continued operation is higher as a result and more facilities could be expected to close, and less capacity to be available, than if the closure provision applied without the transfer rule.

Although the effect of the closure rule on capacity is mitigated by a transfer rule, it is not eliminated. The closed facility still gives up an endowment equal to $\tilde{e}$ that is freely available to new capacity. Consequently, the effect of the new entrant endowment remains and it affects facilities being considered for closure as well as new entrants. The effect of both provisions is to increase capacity.

3. EFFECTS ON OUTPUT AND EMISSIONS MARKETS

Market effects depend on how the additional capacity created by the new entrant and closure provisions affects output. This depends in turn on the nature of the markets and in the case of the EU ETS, two situations can be envisaged. In the first one, all participants in the relevant market are covered by the EU ETS as is the case for electricity production. In the other, corresponding to the non-electric industrial sector, those subject to the EU ETS constitute only part of the relevant product market.

3.1 Electricity Markets

In the short-run, electricity demand is famously inelastic and it is not too much of an exaggeration to represent short-run demand as a vertical line that moves back and forth along an upward-sloping supply or dispatch curve according to temperature, time of day, and other vagaries of electricity demand. In this limiting case, output will not be increased. The effect of extra capacity will be to shift the dispatch curve outwards and to reduce the clearing price for some hours depending on the extent to which production from the new capacity displaces existing capacity with higher short-run marginal costs. If the new capacity enters into base-load use and its running costs are lower than existing base-load units, then the clearing prices for most hours could be expected to be lower. Alternatively, if the new capacity has running costs that are relatively high, such that it does not enter into base-load, but instead into cycling or peaking uses, the effect on prices will be less depending on the number of hours of use during the year. In summary, an output price decline of some (probably small) magnitude can be expected.

The effect on emissions markets also depends on displacement effects and the differences between the emission rates for the new and displaced existing capacity. Generally speaking, new capacity can be expected to have lower emission rates than like existing capacity so that it could be expected that the new entrant provisions would lead to less demand for allowances for the same level of output and a lower allowance price. In general, this effect would hold to the extent that production from new coal-fired capacity displaces output from existing coal-fired capacity and that production from new gas-fired capacity displaces output from existing capacity that is either coal- or gas-fired. However, this circumstance might not hold if new entrant endowments differ according to fuel use or if other conditions, such as high natural gas prices, were to make new coal capacity the economic choice despite the higher emissions cost. Also, as is pointed out repeatedly in the literature, new entrant endowments available only to CO_2-emitting plants, whether coal or natural gas, will reduce the investment cost of the latter relative to carbon-free choices, such as renewables or nuclear, and may lead to more carbon-emitting capacity and production than would otherwise be the case. In all these cases, the demand for allowances would be greater for meeting the same demand and allowance prices would be higher, not lower.

There is another effect in electricity markets that must be taken into account: the effect on capacity markets. Producers of electricity derive revenue not only from the sale of electricity but also from the sale of capacity for stand-by or on-demand use. The effect of the new entrant provisions is obvious. Regardless of the effects on output and emissions markets, there will be more capacity available and the price for stand-by capacity will be lower. In fact, with highly inelastic demand, the effect of the new entrant provisions can be expected to fall almost entirely on capacity markets.

In sum, the primary effect of the over-capacity induced by the new entrant and closure provisions as they would operate in the electricity sector will be on capacity markets, not on output or emissions markets. The effects on these latter two markets depend on the extent to which production from other units is displaced and on the emission characteristics of the units displacing and being displaced. In general, electricity prices can be expected be lower for some percentage of annual hours, but the effect on the demand for allowances and therefore on allowance prices is ambiguous. If the assumption of no effect on short-run demand is relaxed, output would be slightly greater and this would cause less of a reduction in output price. Some elasticity in demand would also mean more demand for allowances and therefore upward pressure on allowance prices. Still, the basic conclusion for electricity markets would hold: lower output prices and ambiguous effects on allowance prices.

3.2 Non-electricity Markets

The distinguishing characteristic of the non-electric, industrial sectors is that output is sold on a market in which other producers are not subject to the EU ETS. Another characteristic of these sectors is that capacity markets are not important; output can be stored and excess capacity has no alternative use.

Again, the first issue is the effect of the excess capacity on output. In general, the demand curve facing the European producers of industrial output can be expected to be more elastic than would be the case for electricity. The additional European capacity would lead to an increase of output by these producers and an increase in their share of total world output. Depending on the nature of the market, the (world) output price may or may not decline. If it were to do so, then the increase of European output would be slightly larger since the pie from which the increased European share is being taken is bigger. The effect is that of any subsidy to new capacity: more capacity is created than would otherwise be the case and expected result would be an increase in the market share of output. In contrast to the electricity case in which the effects are mostly on output price and only minimally on quantity, the non-electric industrial case can be characterized as de minimus effects on output price and some increase in quantity.

Also, in contrast to the electricity sector, the effects on emissions markets of new entrant provisions for industrial installations are non-ambiguous. Increased output implies more emissions, more abatement with a fixed cap, and a higher price for allowances. The difference in this case is that the displaced productive capacity and the associated emission reductions are outside of the EU ETS. Of course, if the induced over-capacity were to displace other European production, the effects would be similar to those in the electricity case where the emission market effects depend on the characteristics of the displaced and displacing capacity.

4. CONCLUSION

The EU Emissions Trading System has introduced a new feature of emission allowance allocation that is generally not found in previous cap-and-trade systems. The new feature is allowing new entrants to receive an allowance endowment and requiring closed facilities to forfeit their endowments. This essay seeks to explore the implication of these provisions for agent behavior assuming profit maximization and the likely effects on output and emissions markets.

Not surprisingly for something that is contingent on decisions concerning the capital stock, the only direct effects are on capacity. Agents' short-run profit maximization will be affected only to the extent that the change in capacity due to these provisions has an effect on the clearing prices in output or emissions markets. Although these effects differ according to the nature of the market, the general effect will be to reduce output price and to increase output. Where capacity markets exist, as could be the case for electricity, these markets will be strongly affected.

The effects on emissions markets are more ambiguous. In electricity markets, the demand for allowances will depend on the emission rates of the new capacity and that being displaced. This effect could go either way and result in either lower or higher EUA prices. In the case of industrial markets, the displaced capacity will be outside the EU ETS so that the effect of the new entrant and closure provisions will be unambiguously to increase the demand for allowances in the European system and to increase allowance prices.

The conclusions of this exercise in comparative statics assume that the alternative is a carbon constraint without new entrant or closure provisions. When these provisions accompany the introduction of a carbon constraint, as is the case for the EU ETS, their effect will be to mitigate to some extent the effect of the carbon constraint on product markets. As noted by nearly all writers on this subject, this is one of the main reasons for the use of these provisions in the EU ETS.

Still, from the standpoint of allocative efficiency, resources will be diverted to creating more production capacity than is needed and the output and emissions market effects are the simple reflection of the fundamental inefficiency of the over-capacity created by the new entrant and closure provisions. A further question that is not explored here is whether agents, rationally expecting this effect on output price, will adjust their expectations accordingly and thereby mitigate the over-capacity that would be otherwise created.

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