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WHAT IS THE EU EMISSIONS TRADING SYSTEM?

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Abstract

In 2005, the European Union introduced the largest and most ambitious emissions trading program in the world to meet its Kyoto commitments for the containment of global climate change. The EU Emissions Trading System has some distinctive features that differentiate it from the more standard model of emissions trading. In particular, it has a relatively decentralized structure that places much of the decision-making responsibility with the individual member states. And this gives the EU-ETS some unusual properties. This paper examines, at a conceptual level, the specific structure of the EU-ETS and explores some of the issues raised by its decentralized character.

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On the first of January, 2005, the European Union initiated the world's largest and most ambitious emissions trading system with an estimated value of emissions allowances roughly twenty times that of the U.S. SO_2 program (Kruger and Pizer 2004, 13). The EU-ETS integrates all 25 countries in the expanded European Union into a single trading bloc for purposes of restricting CO_2 emissions to comply with their overall target under the Kyoto Protocol. This is a policy experiment on an enormous scale with potentially momentous implications for the future of environmental policies worldwide. Should the system fail to deliver on its promises, the case for emissions trading systems will suffer a major setback.

Much of the motivation for the European experiment comes from the U.S. experience with such systems, most notably the SO_2 system for addressing the acid-rain problem and the NO_x Budget Trading Program for managing tropospheric ozone in the Northeastern and mid-Atlantic states. However, the EU system has some important features that distinguish it in certain basic ways from the U.S. SO_2 system. In particular, the EU system is much more decentralized in its structure and operation. This gives it some distinctive properties that are in certain respects problematic. My purpose in this paper is to examine the structure of the EU-ETS at a conceptual level to try to understand the nature and properties of this system and their implications for member country decisions. There are a number of major administrative issues concerning the

role and capacities of the individual member countries for accounting, monitoring, and enforcement matters, but they are beyond the scope of this paper. The question I pose is "How should we think about the design of the EU-ETS system?" Basic economics provides, I think, some useful insights into an answer to this question.[1]

1. The Standard Emissions Trading System: A Benchmark

In the conventional system of emissions trading, an environmental authority imposes a limit or "cap" on total emissions and then issues allowances (or permits) for units of emissions, where the total number of allowances equals the cap. In establishing the permit market, the authority makes three fundamental decisions. First, it defines who will participate in the market: it enumerates the sources of emissions who can buy and sell permits. Note that this effectively determines the demand in the permit market, since the demand curve is simply the horizontal summation of the demand curves of the individual sources.[2] Second, it sets the supply in the market when it specifies the cap, which determines the number of permits that will be available. And, third, it sets the market in motion by actually allocating the permits among the sources. This can be done in either of two ways: an auction of the permits or a free distribution of the permits among sources (often by some sort of formula based on historic emissions or output)–or

[1]For a very insightful and comprehensive treatment of the structure of EU-ETS and the associated issues, see Kruger and Pizer (2004).

[2]In more technical terms, if we treat emissions in the standard way as an argument in the source's production function, then the source's demand curve for emission permits is simply its marginal value product curve for emissions (i.e., the mirror image of its marginal abatement cost curve). The market demand curve for permits is then the horizontal summation of the sources' demand curves.

by some combination of the two methods.

The resulting market equilibrium will determine the actual pattern of emissions among the sources. A cost-minimizing source will purchase (or sell) permits until its marginal abatement cost (MAC) equals the market (rental) price of a permit. This implies that, in equilibrium, the MAC of all sources will be equal; this satisfies the necessary condition for minimizing the aggregate abatement cost of realizing the cap. Note, in addition, that (in the absence of transactions costs), this outcome does not depend upon the pattern of the initial allocation of permits among sources: the actual emissions of the various sources are independent of the initial distribution of permits (whether done by auction or some kind of free distribution). Thus, the emission trading system, in principle, generates the least-cost pattern of emissions among sources. And, in addition to minimizing control costs, the system provides a continuing incentive for R&D in abatement technology; by finding more effective and less costly ways to reduce emissions, sources can reduce the number of permits they need and thereby increase their profits. This is basically the model, for example, for the U.S. system for trading SO_2 allowances.

It is important to note one additional property of the "standard" system. As pointed out, the initial allocations of permits among sources have no effect, in principle, on the ultimate market equilibrium and hence on the resulting pattern of emissions. Under some form of free distribution, these initial allocations constitute a one-time transfer of wealth to the sources. Each source receives an asset whose value is equal to the number of permits in its allocation multiplied by the price of a permit. But from this point on, a cost-minimizing source simply buys or sells permits until its MAC equals the price of permits. In this general setting, the initial allocation of permits has no effect either on marginal abatement costs or the marginal cost of

output.[3]

The U.S. system for trading SO_2 allowances has this basic structure. The "cap-and-trade" system establishes a limitation or cap on overall national emissions for trading sources and a mechanism for allocating the permits that relies primarily on historic emissions. This has been a carefully studied "grand experiment" in environmental policy-making. And, as Burtraw and Palmer (2004) describe in their recent review of the program, it has been highly successful in achieving its goal of reducing emissions, doing this in a relatively low cost way, and in a way that has encouraged new approaches to emissions control. It has become "...an international model for cap-and-trade programs" (p. 58).[4]

2. The Structure of the EU Emissions Trading System (EU-ETS)

The EU system for emissions trading differs in some important ways from the standard

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[3]This proposition assumes a setting of competitive markets with marginal-cost pricing. In fact, markets in energy-generating sectors are often regulated markets, where the form of regulation effectively results in some kind of average-cost pricing. In such a regulated setting, the way in which permits are allocated matters for output and pricing decisions. Under an auction of permits, for example, the cost of permits tends to be passed through in the form of higher energy prices. This need not be true where permits are subject to a free distribution. As Burtraw et al. (2001) show, this can have important implications for the functioning of emissions trading programs. Their simulations of U.S. energy markets suggest that an auction program has much more favorable effects in terms of economic efficiency (as well as quite different distributional effects) compared to a program that allocates allowances free on the basis of historic generation. As Ian Parry pointed out to me, this issue may become moot as deregulation becomes more pervasive in the EU. The proposition also assumes a once-and-for-all allocation of permits. Where permits are reallocated periodically (especially where such reallocations are based on input or output levels), the allocation process can have distorting effects on outcomes [On this issue, see, for example, Burtraw et al.(2001) and Fischer (2001). As Bohringer and Lange (forthcoming) show, such an allocation rule need not be distorting if the permit distribution is strictly proportional to past emissions.]

[4]For an excellent review of the experience with trading programs, see Stavins (2003).

model.

Most significantly, it adopts a more decentralized structure of decision-making that leaves much of the authority for key decisions to the member nations. This, as we shall see, has some important implications for the way the market operates. The starting point for the EU system is an overall cap on total emissions from all 25 member countries equal to the EU commitment under the Kyoto Protocol. Given this overall cap, the central EU authority has specified the sectors of the economy that will participate (at least initially) in the emissions trading system. This encompasses four broad sectors: iron and steel, certain mineral industries (including, for example, the cement industry), energy production (including electric power facilities), and pulp and paper.[5] It is estimated that this includes over 12,000 installations that account for about 46% of CO_2 emissions in the EU. The EU cap will be met by a combination of efforts by sources in the trading sectors and by controls on sources in the non-trading sectors.

Each member country has its own aggregate allowance, which is equal to its national target under the Kyoto Protocol. In addition, each country has the responsibility for developing its own National Allocation Plan (NAP). Among other matters, the NAP defines the allocation of the national allowance in two steps. First, it allocates the country's total allowance between the trading and non-trading sectors. And, second, it specifies how the permits in the trading sector will be distributed among the individual sources.[6] Note especially that the decision as to how

[5]For a more detailed description and assessment of the EU Emissions Trading System, see Kruger and Pizer (2004). An EC Green Paper (2000) also provides some useful background on the design of the system.

[6]The EU Directives allow member countries to auction off a small fraction of their permits (5 percent or less during the initial phase of the program); the bulk of the permits are to be distributed free of charge through a mechanism specified in the NAP.

many permits to allocate to the trading sector also determines residually the stringency of a country's emission controls on those sectors outside the trading system.

The EU-ETS system is being introduced in phases. The first phase runs from 2005 to 2007 and is being regarded as a kind of "warm-up" phase, during which there will be an opportunity to develop some experience with the program and see how it needs to be modified in later periods. The second phase from 2008-2112 coincides with the period when the EU must meet its Kyoto commitment. The EU then envisions subsequent five-year phases. There are a variety of further EU-imposed procedures on member countries concerning, for example, registries of permit allocations and trading along with measures for compliance and enforcement. But my concern here is with the economic implications of the basic structure of the EU trading system; to this, we turn now.

3. The Economics of the EU-ETS

To understand the essential character of the EU trading system, we must determine the source of demand and supply in the permit market. This is not so obvious as in the standard case, where the central authority determines both demand and supply by specifying the participants in the market and by setting the overall cap on emissions. In the EU system, the authority is shared between the EU central agency and the member countries themselves. However, the structure of the market is, in fact, fairly straightforward. First, it is clear that the central authority still determines the demand for permits. The EU has specified which sectors of the economies of the member countries will participate in the market, and this determines the aggregate demand for permits. Once again, the market demand curve is simply the horizontal sum of the demand

curves of all the sources in the trading sectors across the member nations. Note that the sector allocations of permits (as determined in the member countries) have no effect on the demand function. By knowing who is in the market, we can directly determine, in principle, the demand curve for permits in the EU.[7]

The determination of supply, however, is a different matter. Each of the member countries determines what fraction of its national emissions allowance that it will allocate to the trading sectors. Thus, each country is effectively creating a certain number of permits. The aggregate supply of permits is simply the sum of these allocations over all the member countries. Thus, we have a rather curious system of tradeable emission permits in which the demand curve is centrally determined at the EU level, but the (vertical) supply curve is determined jointly by the decisions of the member countries.[8]

This has some important implications for the working of the system. First, it is difficult to predict what the market price of permits will be, since one would have to know all the individual NAPs. If, for example, the member countries devote a relatively small share of their national allowances to the trading sector, the supply of permits in the EU market will be comparatively low and their price high. Second, it means that member countries have little control over the emissions coming from their trading sectors. There has been some unfortunate confusion over the use of the term "sector caps" to describe country allocations to their trading sectors. The term "caps" appears to imply a limitation on emissions, but it cannot, of course, mean this at all.

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[7]The EU, based upon its experience in the first phase of the program, may decide to include other sectors and greenhouse gases in the trading system in the later phases of the program.

[8]The EU does have some indirect control over supply through its process of approval of member country NAPs.

The actual emissions coming from a country's trading sources will depend upon the behavior of these sources in the EU market–on the number of permits they buy and sell. What the member country determines is the number of permits it allocates to its own sources in the trading sectors, not a cap on their level of emissions.

There is, in fact, a straightforward modification to the EU-ETS system that would restore control over the supply of permits to the EU, but at the same time leave some discretion to the member countries. The EU could specify the fraction of each country's overall cap that must be allocated to the trading sectors. This would effectively determine the number of tradeable permits that each country creates and thus would determine the total quantity of permits available in the EU permit market. At the same time, the actual allocation of permits within the member countries could be left to the countries themselves. This, incidentally, would create a system similar in spirit to the NO_x trading program in the U.S. under which each participating state distributes its fixed NO_x "budget" among the sources within the state (Burtraw and Evans 2004).

Such a modification would thus place the determination of both the demand and supply of permits under central control. Is this desirable? The answer to this question is not immediately obvious. Decentralized determination of the division of control efforts between trading and non-trading sectors has some appeal. From an efficiency perspective, we might wish each country to allocate the burden of CO_2 abatement between trading and non-trading sources so as to equalize (at least roughly) their MACs. Suppose, for example, that the EU were to require each member nation to divide its national allowance equally between sources in the trading and non-trading sectors. This could easily lead to serious imbalances and associated efficiency losses in

countries where such an allocation resulted in large differences in abatement costs between sources in the trading sectors and those in the non-trading sectors.

This suggests that there might be advantages in leaving this division of the national cap to the member countries. But this isn't fully satisfactory either. Consider the following simplified case. Suppose we have two member countries, A and B, which have different compositions of CO_2 emitting sources. In country A, an equal division of the national allowance between trading and non-trading sectors equalizes MAC, while, in country B, equalizing MAC requires that three-quarters of the allowance go to sources in the trading sectors. Will efficient national allocations in these proportions achieve an efficient overall outcome? The answer is, in general, no. Once the market is set in motion, sources in the trading sectors will engage in purchases and sales of permits across country borders. If sources in A have a relatively high MAC, then trading sources in A will buy permits from sources in B. Thus, in the end, trading sources in A will end up with lower MACs than non-trading sources in A (and vice-versa in B). This is a complicated issue, but the basic point is that allowing a decentralized division of allowances between the trading and non-trading sectors will not, in the end, result in a cost-minimizing pattern of emissions between trading and non-trading sectors even within each member country.

This is really part of a more general problem that arises because the EU-ETS is operating simultaneously on several different margins. First, there is the margin between sources within the same country which are in the trading sector and those outside the trading sector. Second, there are trading sources in the different member countries, which are part of the EU-wide emissions trading market. And third, there are the non-trading sources in different countries. In terms of static efficiency gains, what the EU-ETS achieves is the equating of MACs across all

the trading sources in the EU. But this leaves the problem we saw above of differences between the MACs in the trading and non-trading sectors within each member country, as well as divergences in MACs between non-trading sectors across the member countries. We thus have a complicated second-best problem on our hands. And it is hard to reach any general conclusion as to whether or not it is best to delegate the decision on allocating allowances to the member countries rather than making a centralized determination.[9]

From a political-economy perspective, the rationale for leaving this decision to the member countries seems to stem largely from the widespread concern in Europe with "competitiveness" and unfair subsidies to particular sources or groups of sources. To pursue our initial example further, suppose again that the EU were to require every member country to divide its overall country allowance evenly between sources in the trading sectors and those in the non-trading sectors. Under such a formula, a country with a relatively large fraction of its sources in the trading sectors would find that it could allocate only a relatively small number of tradeable permits to each of its sources as compared to its EU neighbors. Does this matter? As discussed, the free distribution of permits constitutes a one-time wealth transfer to the sources. This does raise some equity and other concerns. Although, in principle, the allocation of permits to a source has no impact on its abatement or production decisions, it can affect its liquidity, including, for example, the need to resort to capital markets for funds. Moreover, as noted earlier in footnote 3, there can be some impact on output and prices in regulated sectors. The

[9]More generally, it requires a general equilibrium analysis to compare the efficiency properties of alternative regimes. In one such CGE study of alternative policies for reducing carbon emissions, Parry and Williams (1999) find (among other things) that a relatively narrowly based ETS, encompassing only a limited number of sectors, can, in some circumstances, be more cost effective than a broad-based ETS system.

importance of this concern may, however, be somewhat exaggerated. Over the longer haul, these initial wealth transfers diminish in significance and may have little impact on the profitability of sources. But the issue seems to loom large in European thinking. Indeed, the EU must itself review and approve each member country's NAP, in part to ensure that there are no elements of unfair competition present.[10]

Let me mention two further matters. First, there is a potentially important qualification to the proposition that the supply of permits is equal to the sum of the member country allocations to their trading sectors. Beginning with the second phase of the EU program, there exists the limited possibility of obtaining offsets for some EU emissions from outside Europe. The EU program contains a provision for Kyoto offsets under Joint Implementation (JI) and the Clean Development Mechanism (CDM). Such offsets can obviously provide an expansion in the supply of allowances. Under existing provisions, these offsets cannot account for more than 6% of the EU overall cap. But this is subject to later review. This is of some importance, for there is a widespread recognition that member countries have been overly generous in their allocations of allowances to sources in their trading sectors. This implies that very stringent controls will be required on sources in the non-trading sectors if member countries are to meet their Kyoto commitments. In fact, the EU Commission, in its review of member countrys' NAPs, has actually required some countries to revise their allocations to cut back on the distribution of

[10]The EU has, in fact, established a set of allocation criteria that the member states must meet in their National Allocation Plans. Among these criteria, "State Aid" (i.e., unfair subsidies) is a major issue. The EU consults these criteria in its review of the individual NAPs. It is also worth noting that the introduction of some kind of "fairness constraint" to harmonize allocations in order to create a "level playing field" among sources in the EU further complicates the problem of allocating allowances in the member countries. Bohringer and Lange (2005) show that it is impossible to achieve such harmonization in the allocation of allowances without some sacrifice of the objective of cost minimization.

allowances to trading sources. It is the sense of some observers that the only way the EU will be able to meet its Kyoto cap is by acquiring emissions offsets from other countries, most notably through the Clean Development Mechanism (or perhaps from some of the 10 new accession states that may have excess emissions allowances). Of particular concern is the prospective growth in emissions from the transport sector which is outside the trading system; emissions from this sector are projected to grow by over 30 percent from 1990 levels by 2010. But a heavy reliance on offsets from sources outside Europe raises some serious political issues concerning the extent of the commitment of the EU to their own efforts to contain global climate change.

Second, there is a provision that allows member countries to allocate a small fraction of their allowances to the trading sectors through an auction. An EC Directive indicates that member countries may auction up to 5% of their allowances in the first phase and up to 10% in the second phase of the program. The recent economics literature has made a strong efficiency argument in favor of auctioning rather than a free distribution of permits, but the potential role for auctions in the prospective EU system appears small (in large measure because of fears of putting EU industries at a competitive disadvantage in world markets).[11]

4. Two Further Issues: A Safety Valve and Banking

As one element of the compliance and enforcement mechanism in the EU trading system, an EU Directive specifies penalties for emissions from sources that exceed their permit holdings: 40

[11]There exists a large literature that explores the efficiency implications of different forms of market incentives in a setting with pre-existing distortions in the economy. Parry, Williams and Goulder (1999), for example, find that auctions of tradeable CO_2 permits promise significantly larger efficiency gains than do programs which grandfather permits, largely because the revenues from the auctions can be used to reduce the rates on existing distorting taxes. For a large collection of papers on this issue, see Goulder (2002).

Euros per ton of CO_2 in the first phase and 100 Euros per ton in the second phase of the program. These are largely seen as a "punishment" for sources that fail to meet their emissions limitation. However, as the economics literature has long made clear, such a penalty can play an important role as a "price" that makes the system operate more efficiently. This price effectively functions as a "safety valve"in that it allows sources to expand their emissions temporarily during periods when controls (as a result of various kinds of shocks to markets) become inordinately expensive. The safety valve thus provides some temporal flexibility in emissions control that, over the longer haul, allows emissions targets to be met at lower cost.

Such a safety valve makes especially good sense in the context of EU-ETS (Pizer 2001). The exact timing of CO_2 emissions is of little importance in terms of their environmental impact; what matters is the aggregate level of emissions over a long period of time (years or even decades). It thus makes economic sense to provide flexibility in the timing of emissions so as to reduce emissions during periods when abatement costs are relatively low and increase them when these control costs are comparatively high. This can be accomplished by setting the "penalty" or "trigger price" at a reasonable level so that sources can expand emissions during periods when permit prices become unusually high. Pizer (2002), for example, finds that a trigger price far below the EU penalty rate would provide very large cost savings relative to a prohibitively high penalty on excess emissions. The projected penalty of 100 Euros per ton of CO_2 under the second phase of EU-ETS seems inordinately high–and will surely result in excessive costs. In addition, the EU requires, first, the publication of the names of sources who are not in compliance and, second, that any excess emissions be offset in the following year (even though the penalty has already been paid!). All this suggests that the EU sees the role of

this "price" primarily as a punishment mechanism. Instead, it should be seen as a useful instrument for making the system function more efficiently. It is worth noting that a sensible trigger price, by reducing control costs, could also go some distance in allaying fears in Europe over the impact of EU-ETS on the competitiveness of EU industries. This could be especially important since, as we have seen, the EU does not have direct control over the supply of permits and hence over permit prices.[12]

Some further temporal flexibility in emissions can be obtained through a "banking" provision that allows sources to accumulate credits for over-control during some years to be drawn upon at later times. The EU provides some discretion to member states on this issue; they can choose whether or not to allow banking between the first and second phases, but must allow banking thereafter. To date, no member countries have chosen to introduce banking provisions for fear apparently that they might interfere with the attainment of their Kyoto emissions targets.

These two issues of a safety valve and banking serve to highlight some troubling conflicts between economic and political objectives in the design of the EU-ETS. From an economic perspective, both of these mechanisms introduce desirable flexibility in the timing of emissions that can serve to reduce the costs of reducing GHG emissions. But for the EU, the time-profile of emissions has political ramifications. Should emissions be pushed from one phase into another, the EU could find that it is not meeting its Kyoto target in a particular phase. While this is of little importance to the basic goal of containing global climate change, it does have

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[12]As an interesting sidelight, Paul Portney has pointed out to me that under the CAFE program here in the U.S., car-makers not meeting the standards can pay a fine based on the extent to which they fall short. The only auto-makers to avail themselves of this option ("safety valve") are European! Mercedes, BMW, Porsche, and others simply pay the fine every year rather than comply.

symbolic, political significance. The EU seems committed to meeting its Kyoto targets, phase by phase, which may well mean that the overall program will prove substantially more expensive than it need be.

5. Some Concluding Observations

The EU has thus constructed a somewhat novel system of emissions trading with shared control between the center and the member countries. The EU has itself determined the demand curve in the permit market by specifying the sectors of the economy that will participate in the market (i.e., by specifying who the buyers and sellers of permits will be). This list of participants may, incidentally, be amended (probably expanded) in the second phase of the program. But the determination of the supply of permits resides with the member countries, who determine how many permits to allocate to their sources in the trading sectors. These decisions by the member nations jointly set a cap on the total emissions from trading sources in the EU.

Whether or not it is desirable to relinquish control over the supply of permits is not entirely clear. It does allow member nations some discretion in terms of allocating their total allowance in ways that initially reduce overall country abatement costs. But, as we have seen, subsequent trading activity can undo much of this and result in substantial differences in MACs between sources in the trading and non-trading sectors in each member country (and across member countries). This is a complicated issue, one that should be studied closely in the evolution of the EU-ETS.

As mentioned, the system is subject to a three-year warmup period from 2005 to 2007.[13]

[13]In fact, there has been an active futures market in CO_2 allowances in the EU since November 2003. Although the price in this market has exhibited considerable volatility, price

Having an initial three-year phase has some merit. The EU-ETS system has been assembled in a relatively short period of time; in fact, some EU countries failed to meet the schedule for delivering their National Allocation Plans. There will no doubt be several gliches along the way accompanied by other discoveries of features of the system that need to be altered. The warmup period will provide a time to work out such problems. Such a warmup period does, however, have a downside. Sources participating in the system are subject to a variety of uncertainties concerning the ultimate form of the system. For example, a source cannot be sure that the allowances it currently possesses will be available for its use in the second and in subsequent phases; there will likely be reallocations of allowances in the second phase. This creates a serious obstacle to long-term planning and investments in abatement technologies. Nevertheless, this is probably a worthwhile short-run cost from the longer-term perspective of the evolution of the system. The world is watching as the EU launches an enormously important experiment in environmental policy; careful, continuing assessment and, where needed, adjustments will play a critical role in determining its ultimate success.

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movements appear to reflect fairly well prospective changes in market conditions. See Convery and Redmond (2005) for an excellent description and analysis of the experience in this market.

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