policy

The European Union's Emissions Trading System in perspective

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PEW CENTER ON Global CLIMATE CHANGE

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Prepared for the Pew Center on Global Climate Change

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Foreword *Eileen Claussen, President, Pew Center on Global Climate Change*

To meet its obligations to reduce greenhouse gas (GHG) concentrations under the Kyoto Protocol, the European Union (EU) established the first cap-and-trade system for carbon dioxide emissions in the world starting in 2005. Proposed in October 2001, the EU's Emissions Trading System (EU ETS) was up and running just over three years later. The first three-year trading period (2005-2007)—a trial period before Kyoto's obligations began—is now complete and, not surprisingly, has been heavily scrutinized. This report examines the development, structure, and performance of the EU-ETS to date, and provides insightful analysis regarding the controversies and lessons emerging from the initial trial phase.

Recognizing their lack of experience with cap and trade and the need to build knowledge and program architecture, EU leaders began by covering only one gas (carbon dioxide) and a limited number of sectors. Once the infrastructure was in place, other GHGs and sectors could be included in subsequent phases of the program, when more significant emissions reductions were needed. As authors Denny Ellerman and Paul Joskow describe, the system has so far worked as it was envisioned—a European-wide carbon price was established, businesses began incorporating this price into their decision-making, and the market infrastructure for a multi-national trading program is now in place. Moreover, despite the condensed time period of the trial phase, some reductions in emissions from the covered sectors were realized.

The development of the EU-ETS has not, however, proceeded without its challenges. The authors explain some of the controversies regarding the early performance of the EU-ETS and describe potential remedies planned for later compliance periods:

- Due to a lack of accurate data in advance of the program, allowances to emitters were overallocated. Now with more accurate emissions data and a centralized cap-setting and reporting process, the emissions cap should be sufficiently binding;

- Concerns about program volatility emerged when initially high allowances prices (driven largely by high global energy costs) dropped precipitously in April 2006 upon the release of more accurate, verified emissions data. Late in the trial phase, there was another sharp decline in allowance price because there were no provisions for banking emissions reductions for use in the second phase of the program. Improved data quality and provisions for unrestricted banking between compliance periods will help moderate price fluctuations in the future;

- Windfall profits by electric power generators that passed along costs (based on market value) of their freely issued allowances resulted in improved understanding of how member country electricity sector regulations affect the market and calls for increased auctioning in subsequent phases of the program.

Interest in developing a national cap-and-trade program in the United States has intensified in recent years. The first comprehensive greenhouse gas reduction bill ever to be reported out of a committee emerged from the Senate Environment and Public Works Committee in December 2007. As debate continues on this landmark legislation, the House of Representatives has signaled its intention to design its own emissions trading program. This report provides an excellent resource for those developing U.S. proposals. As Europe's experience with the EU-ETS suggests, everything does not have to be perfect at the outset of a cap-and-trade program. We do, however, need to get started and, for this, the EU-ETS has provided valuable lessons for us all.

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Executive Summary

The performance of the European Union's Emissions Trading System (EU ETS) to date cannot be evaluated without recognizing that the first three years from 2005 through 2007 constituted a "trial" period and understanding what this trial period was supposed to accomplish. Its primary goal was to develop the infrastructure and to provide the experience that would enable the successful use of a cap-and-trade system to limit European GHG emissions during a second trading period, 2008-12, corresponding to the first commitment period of the Kyoto Protocol. The trial period was a rehearsal for the later more serious engagement and it was never intended to achieve significant reductions in CO_2 emissions in only three years. In light of the speed with which the program was developed, the many sovereign countries involved, the need to develop the necessary data, information dissemination, compliance and market institutions, and the lack of extensive experience with emissions trading in Europe, we think that the system has performed surprisingly well.

Although there have been plenty of rough edges, a transparent and widely accepted price for tradable CO_2 emission allowances emerged by January 1, 2005, a functioning market for allowances has developed quickly and effortlessly without any prodding by the Commission or member state governments, the cap-and-trade infrastructure of market institutions, registries, monitoring, reporting and verification is in place, and a significant segment of European industry is incorporating the price of CO_2 emissions into their daily production decisions.

The development of the EU ETS and the experience with the trial period provides a number of useful lessons for the U.S. and other countries.

- Suppliers quickly factor the price of emissions allowances into their pricing and output behavior.
- Liquid bilateral markets and public allowance exchanges emerge rapidly and the "law of one price" for allowances with the same attributes prevails.
- The development of efficient allowance markets is facilitated by the frequent dissemination of information about emissions and allowance utilization.

- Allowance price volatility can be dampened by including allowance banking and borrowing and by allocating allowances for longer trading periods.

- The redistributive aspects of the allocation process can be handled without distorting abatement efficiency or competition despite the significant political maneuvering over allowance allocations. However, allocations that are tied to future emissions through investment and closure decisions can distort behavior.

- The interaction between allowance allocation, allowance markets, and the unsettled state of electricity sector liberalization and regulation must be confronted as part of program design to avoid mistakes and unintended consequences. This will be especially important in the U.S. where 50 percent of the electricity is generated with coal.

The EU ETS provides a useful perspective on the problems to be faced in constructing a global GHG emission trading system. In imagining a multinational system, it seems clear that participating nations will retain significant discretion in deciding tradable national emission caps albeit with some negotiation; separate national registries will be maintained with some arrangement for international transfers; and monitoring, reporting and verification procedures will be administered nationally although necessarily subject to some common standard. All of these issues have had to be addressed in the trial period and they continue to present challenges to European policy makers.

The deeper significance of the trial period of the EU ETS may be its explicit status as a work in progress. As such, it is emblematic of all climate change programs, which will surely be changed over the long horizon during which they will remain effective. The trial period demonstrates that everything does not need to be perfect at the beginning. In fact, it provides a reminder that the best can be the enemy of the good. This admonition is especially applicable in an imperfect world where the income and wealth effects of proposed actions are significant and sovereign nations of widely varying economic circumstance and institutional development are involved. The initial challenge is simply to establish a system that will demonstrate the societal decision that GHG emissions shall have a price and to provide the signal of what constitutes appropriate short-term and long-term measures to limit GHG emissions. In this, the EU has done more with the ETS, despite all its faults, than any other nation or set of nations.

I. Introduction

A. Motivation

As the world's first cap-and-trade program for carbon dioxide (CO_2) emissions, the European Union's Emissions Trading System (EU ETS) has attracted a lot of attention, some of it favorable and some of it unfavorable. Based on what can be observed to date, this paper attempts to place the EU ETS in perspective for the observer who is interested in understanding the key features and performance of this important public policy experiment. In the following sections, we describe the principal design features of the EU ETS; we highlight two contextual features that are important in understanding the development of the EU ETS; we provide a brief evaluation of the performance of the EU ETS to date; and finally we discuss several of the controversies that have arisen during its first three years of operation.

B. Description of the EU ETS

The EU ETS was inspired by the Kyoto Protocol but it is also independent of it. The EU ETS would not exist if it were not for the Kyoto Protocol and it is the "flagship measure" by which the member states of the EU will meet their obligations under the Kyoto Protocol during the first commitment period from 2008 through 2012 (Delbeke (ed.), 2006). Yet, the EU ETS exists independently of the Kyoto Protocol. It was enacted before the Kyoto Protocol became legally binding in international and EU law and it would have become operational even if the Kyoto Protocol had not entered into force in February 2005. In particular, the trial or first trading period from 2005 through 2007 was wholly outside of the Kyoto Protocol, although conceived as a means of ensuring the EU's compliance with the Kyoto Protocol during 2008-12, when the second trading period of the EU ETS would occur. Finally, the EU ETS is expected to continue beyond 2012 whatever the shape of the Kyoto Protocol or a successor agreement as concerns the post-2012 period.

The EU ETS is a classic cap-and-trade system. However, it also contains some significant design differences from those reflected in cap-and-trade systems for other emissions that have been implemented in the U.S. The common features are that 1) an absolute quantity limit (or cap) on CO_2

emissions has been placed on some 12,000 emitting facilities located in the European Union, 2) tradable allowances have been distributed to these facilities (typically for free) in an amount equal to the cap, and 3) these facilities must measure and report their CO_2 emissions and subsequently surrender an allowance for every ton of CO_2 they emit during annual compliance periods. The primary differences from U.S. experience with cap-and-trade mechanisms relate to how the cap is set, the process for allocating emission allowances, banking and borrowing provisions, the monitoring, reporting, and verification procedures, and the linking or off-system provisions.

While the basic outline of the EU ETS was established during the trial period, significant changes in the design of the system have been proposed by the European Commission in a set of amendments to the Emissions Trading Directive, the authorizing legislation for the EU ETS, which was made public in late January 2008. These proposed amendments resulted from a process that was mandated by the Directive, known as the ETS Review, and which was to consider changes to the Directive in light of the first three years' experience. Consultations with stakeholders have been held over the past year and a half and the proposed amendments will now be taken up by the European Parliament and the European Council in the European Union's co-decision process.[1]

The Cap-setting Process

A first important difference between the EU ETS and the classic cap-and-trade model is the decentralized nature by which the cap has been determined. There was no initially determined overall limit; it was the sum of 25 (now 27)[2] separate decisions concerning the total number of European Union Allowances (EUAs) that each member state could distribute to affected installations within its jurisdiction. Each member state proposed a quantity of EUAs, but that quantity was subject to review and approval by the European Commission according to procedures and criteria specified in the EU Emissions Trading Directive.

A second significant difference is that the long-term trajectory of the overall cap and of the member state allocations was not known initially since the decentralized cap-setting process is repeated for relatively short sequential multi-year "trading periods." The EU ETS Directive mandates a first, three-year trading period for 2005-07, often called the pilot or trial phase, to be followed by a second, five-year trading period for 2008-12 that corresponds to the First Commitment Period under the Kyoto Protocol,

and subsequent post-2012 trading periods. The cap for the first period was determined in mid-2005 and the 2008-12 cap was not finalized until late 2007, just before the second trading period began. For the period after 2012, the European Council has declared that the EU's greenhouse gas (GHG) emissions will be at least 20 percent lower than the 1990 level by 2020.[3] This goal has been translated into more concrete terms in the recently released amendments which propose that the next trading period be eight years long, from 2013 through 2020, and that the annual cap for the EU ETS will decline indefinitely at an annual rate of 1.74 percent.[4]

A third difference of the EU ETS is that it is a cap within a cap from 2008 on. The Kyoto Protocol, as modified for the EU15 by the Burden Sharing Agreement (BSA)[5] imposes an economy-wide cap on all greenhouse gas emissions.[6] The EU ETS includes only CO_2 emissions and only a subset of the economy—the power sector, specified industrial sectors,[7] and all combustion facilities with a thermal input of greater than 20 MW regardless of the sector in which they are found (including commercial and institutional establishments).[8] The sectors included under the EU ETS comprise about half of EU CO_2 emissions and about 40 percent of the GHG emissions covered by the Kyoto Protocol. GHG emissions from sources not included in the EU ETS, notably transportation and buildings, are to be limited by other policies and measures. The Emissions Trading Directive anticipates the inclusion of other GHGs and other activities in an expanded EU ETS in subsequent periods and a proposal to include CO_2 emissions from aviation beginning in 2011 is expected to be approved in the course of 2008.

Temporal Trading: Banking and Borrowing

Another notable feature of the EU ETS is that effectively there is no restriction on banking or borrowing of allowances *within any given multi-year trading period*. Allowances are issued annually but they are valid for covering emissions in any year within the trading period. Moreover, each year's issuance of allowances occurs at the end of February, two months before allowances must be surrendered for the preceding year. As a consequence, installations can cover shortages in any given year by allowances issued for the next year. This arrangement effectively allows year-ahead borrowing within the trading period.

The rules governing trading *between* trading periods are, however, more complicated. Most importantly, no banking or borrowing was allowed between the first (2005-2007) and second (2008-2012) trading periods.[9] This limitation effectively made the trial period self-contained and it is one

of the major design flaws of the trial period. However, the reason it was adopted is understandable: to prevent any compliance failures during the trial period from spilling over into the second trading period and thereby complicating the attainment of the EU's commitments under the Kyoto Protocol. For the second and subsequent trading periods, unrestricted *inter*-period banking, but not borrowing, will be allowed.

The Linking Directive

An important but less noticed complement to the Emissions Trading Directive is the Linking Directive, which was formally adopted in November 2004. Up to a certain limit, it allows affected installations to comply by submitting qualifying credits for emission reductions accomplished outside of the European Union. The only credits allowed are those created through the provisions of the Kyoto Protocol relating to the Clean Development Mechanism (CDM) or Joint Implementation (JI) and known respectively as Certified Emission Reductions (CERs) and Emission Reduction Units (ERUs).[10] Even so, credits generated by certain CDM activities cannot be used for compliance in the EU ETS, namely, those associated with nuclear power and from CO_2 sinks. Interestingly, however, credits generated by non-CO_2 GHG emission reduction projects outside the EU are acceptable.

The use of these credits by EU ETS installations for meeting compliance requirements is limited to be consistent with the supplementarity criterion of the Kyoto Protocol. This criterion aims at ensuring that a significant proportion of the expected reduction of emissions occurs within each country. While no specific limit is specified in the Kyoto Protocol, this criterion is generally understood to imply that at least half of the reduction implied by the country's assigned limit must be accomplished domestically. In the case of the EU ETS, this limit on CER and ERU use is specified as a percentage of the allocation to an installation for most member states.[11] Thus, if an installation's allocation were 100, its emissions 115, and the limit on CER/ERU use 10 percent, it could use only 10 CERs or ERU's for compliance. The remaining 105 allowances must be EUAs. This limit is specified in each member state's National Allocation Plan (NAP) and it varies among member states and, in some cases, even by sectors within a member state.

While the Linking Directive concerns only project-based credits, the ETS Directive anticipates future links with other compatible cap-and-trade systems whereby the allowances from the two systems would be interchangeable without limit. Moreover, the pre-existing Agreement with the European Economic Area (Norway, Iceland, and Liechtenstein) establishes a procedure whereby new Community

legislation can become part of the national legislation of these countries. Pursuant to the latter, Norway's pre-existing but now expanded CO_2 cap-and-trade system was effectively linked to the EU ETS as of January 1, 2008.

Allocation, Registries, and Enforcement

The decentralized character of the EU ETS is not limited to cap-setting; it extends to almost all aspects of the system. The distribution of allowances, the operation of the registries for tracking allowances and emissions, and the monitoring, reporting, and verification procedures that underlie enforcement are all responsibilities of each member state, albeit guided by criteria and coordinated by procedures established by the European Commission. In many ways the EU ETS can be seen as 27 largely independent trading systems that have agreed to make their allowances commonly tradable and to adhere to certain common criteria and procedures in order to make the system work.

This coordinated process begins with the development of a National Allocation Plan by each member state for each trading period. In the NAP, the member state proposes and justifies the total number of allowances created for the trading period, provides a list of covered installations, and explains how those allowances are to be distributed. In its review and approval of NAPs for the first and second trading periods, the Commission has been concerned mostly with the level of the proposed member state "caps",[12] with attempting to ensure a consistent definition and inclusion of affected installations, and with prohibiting allocation rules that would inhibit trading, such as ex post adjustments. By and large, member states have been free to allocate to sectors and installations within their jurisdictions as they see fit. While the principles applied in these internal allocations have been remarkably consistent (Ellerman, Buchner and Carraro, 2007), national circumstances have led to considerable differences in the allocations to like facilities in various member states, especially in the power sector. These differences have led in turn to a demand for greater "harmonization" in the allocation of EUAs among the member states.

Each member state also maintains its own registry to record the creation, transfer, and surrender of allowances; however, a high degree of uniformity is maintained through the Registries Regulation (European Commission, 2004b) which applies directly to all member states.[13] Transfers of EUAs among installations located in *different* member states are not only recorded as such in the respective member state registries but also reported to a central registry in Brussels, called the Community Independent

Transaction Log (CITL). By this means, the Commission would be able to block transfers from any member state that fails to gain approval of its National Allocation Plan or is otherwise out of compliance with the EU ETS. Finally, member states report allocations and verified emissions at the installation level to the central registry.

Member states also develop their own monitoring, reporting, and verification procedures subject as always to the EU Monitoring and Reporting Guidelines (European Commission, 2004a). The basic structure is similar to financial reporting by which firms self-report based on pre-specified procedures of measurement and calculation. And, like the financial analogue, these reports must be audited (or verified in emissions trading parlance) by external parties. Emissions are generally not measured directly, but determined by calculation based on fuel consumption, specified emission factors, and the thermal efficiencies for combustion units and on output and other chemical and engineering estimates for process emissions. In order to avoid undue cost, the specific monitoring, reporting, and verification procedures vary according to the size of the installation with higher "tier" or more accurate and more costly techniques being applied to larger installations than to smaller ones. Each member state is responsible for certifying verifiers and more generally for ensuring compliance through the deduction of allowances from accounts in the *national* registry equal to the verified emissions reported for each installation. However, the compliance penalties are specified in the Emissions Trading Directive. This is the only EU law to prescribe financial penalties that must be applied automatically for non-compliance.

II. Context

A fair appraisal of any policy requires an understanding of the conditions under which it was adopted and in which it is implemented. For an American observer, this perspective is especially important because the conditions influencing the creation and operation of the EU ETS are different from what would likely apply to the design and implementation of a cap-and-trade program to control GHG emissions in the United States. Two contextual factors are particularly important: the nature of the trial period and the multi-national character of the European Union.

A. The Trial Period (2005-2007)

The decision to establish a trial period beginning in 2005 compressed the time schedule for the development and implementation of the EU ETS to an almost impossible extent. The rushed result shows that everything need not be perfect, but it also accounts for many of the rough edges that can be observed in the subsequent performance of the EU ETS.

The adoption of a trial period was motivated by the perception of a "performance gap" in the European Union's ability to meet its commitments under the Kyoto Protocol and by a recognition that the institutions and experience needed to successfully implement an EU-wide cap-and-trade program could not be taken for granted. This warm-up phase was expected to provide the experience and establish the infrastructure to ensure success in the "real" mitigation period corresponding to the First Commitment Period under the Kyoto Protocol.

A few years after the negotiation of the Kyoto Protocol, it came to be recognized that more aggressive mitigation actions than had originally been anticipated would be needed if the EU's Kyoto commitments were to be honored. The downward trend in GHG emissions that was experienced in the 1990s had reversed and emissions seemed likely to be considerably above the Kyoto target for the EU15 of minus eight percent in relation to 1990 emission levels. Various policies and measures were being undertaken by member states, but something more was needed at the EU level. An EU-wide CO_2

emissions tax was not possible since one had been proposed and rejected in the 1990s. A cap-and-trade approach was chosen because it guaranteed a limit on a significant part of the EU's emissions, it was compatible with the emissions trading provisions of the Kyoto Protocol (adopted at U.S. insistence, ironically), and it was the only other instrument available.

While a cap-and-trade approach seemed appropriate, it was also recognized that there was virtually no experience with emissions trading in Europe and less familiarity with market-based instruments than in the U.S., where cap-and-trade programs had been successfully implemented. Only the UK and Denmark had conducted limited experiments in emissions trading and there was no precedent for a cap-and-trade system covering more the one country.

A cap-and-trade program was first suggested as an important component of the European Climate Change Programme in a Green Paper issued in March 2000 (European Commission, 2000). This concept paper explained how cap-and-trade mechanisms worked, pointed out important issues that would have to be resolved, and generally discussed what would be involved in the design of an EU CO_2 trading system. A concrete and specific implementing directive was not proposed until October 2001, barely three years before the program was to start. A common reaction at the time was succinctly stated in an editorial in Point Carbon's September 2001 edition of *Carbon Market Analyst*:

> *"We believe that the chance of having a community-wide trading scheme in place by 2005 is a low-probability scenario."*

It took nearly another two years, until the summer of 2003, for the proposed Emissions Trading Directive to wend its way through the EU's co-decision process. The final approval by the Council of Ministers occurred in July 2003, and the Directive was formally issued in October 2003, barely a year before the program was to begin.

An EU Directive is only a framework that has to be given legal force and implementation through a process called transposition, which requires member state governments to issue legislative and regulatory measures to implement the directive within each national jurisdiction. As agreed in July and issued in October, the Emissions Trading Directive called for implementing regulations to be in place by the end of 2003 and for National Allocation Plans to be submitted by the end of March 2004. And, as if

this were not enough, ten mostly East European countries acceded as new member states in May 2004 and greatly increased the scope of the scheme, as well as the difficulties of its implementation.

The result was that only five National Allocation Plans were submitted to the European Commission on time and the last member-country's plan, for Greece, was not approved until June 2005, six months *after* the trial period had begun. Moreover, when the trial period started on January 1, 2005 there was only one operating national registry, in Denmark, and it was another year and half before the last of the initial East European registries, in Poland, became operational.

The time taken to develop and implement the relatively complex EU ETS was much less than was the case for the simpler U.S. SO_2 cap-and-trade program. The initial Bush Administration proposal that became the basis of the eventual U.S. legislation was put forward in April 1989, almost seven years before the intended start in 1996. Subsequent changes in Congress moved the start date to 1995, but even so the legislation was voted out of both Houses of Congress and signed by the first President Bush in November 1990, a little more than four years before the program's start. More importantly, the aggregate SO_2 emission cap and the initial allocations had been determined during the legislative process so that attention could focus thereafter on implementing regulations and the development of the registry, all of which were in place when the program started on January 1, 1995.

B. A Multinational System

The multinational character of the EU ETS is a second feature to keep in mind in evaluating its performance from an American perspective. In brief, the European Union is not the United States of Europe. The federal structure of the EU is unique of course, but for an American historical analogy, it has far more in common with the Articles of Confederation than it does with the post-Constitution, post-Civil War United States of America. Member states of the European Union are sovereign nations that have ceded some authority to the central institutions in Brussels, but they retain prerogatives and authority beyond that of any American state. Unlike U.S. states, each has a seat in the United Nations and each maintains its own diplomatic representation abroad. Moreover, the differences in economic circumstance among member states of the EU are considerably greater than those among American states.[14] These underlying political and economic realities cannot fail to be reflected in the EU ETS and they are.

The main point of contention in the relations between Brussels and the individual Member States with respect to the EU ETS has appeared in the negotiation of member state emission caps. Member states have in the main accepted the Commission's decisions, although several have brought legal challenges before the European Court of First Instance. During the allocation process for the trial period, the UK and Germany brought relatively technical law suits concerning whether the UK could revise its total after approval by the Commission and whether Germany could make ex post adjustments to its allocation to facilities in covered sectors. The current allocation process for the second trading period has produced more challenges. Nine Member States, all of the initial East European accession countries except Slovenia, have contested the Commission's significant reduction in the emission caps proposed by these member states. Their primary argument is that the Commission's methodology to determine member state totals is inappropriate to their circumstances either because they are small or that the ongoing structural transformation of their economies has not been properly taken into account. These legal challenges will take three to four years to resolve; in the meantime, all are expected to continue to participate in the EU ETS on the basis of the Commission's decisions[15]

This decentralized cap-setting and allocation process is very different from that in the U.S. SO_2 cap-and-trade system (Ellerman et al., 2000). In the U.S. SO_2 program, the cap and the allocations to affected installations were determined centrally in the Congressional legislation; the registry was maintained at the national level; and affected facilities reported emissions directly to the federal U.S. Environmental Protection Agency (U.S. EPA). The states are invisible in this program except for some allocation provisions in the legislation that provided additional allowances to installations located in certain states.

The NOx Budget Program comes closer to being similar to the EU ETS in structure, although even here there are differences (Aulisi et al., 2005). In this program, the U.S. EPA assigns an emission budget to the state and the state is free to allocate allowances to covered installations within its jurisdiction without further review. Most states have allocated allowances in a manner that is reasonably similar, but there are some striking differences, such as the updating provisions in New Jersey and a few other states, which in European parlance would be deemed ex post adjustment. In the NOx Budget Program, the NOx emissions are reported to the federal level and the federal EPA maintains a separate tracking system or registry for the NOx allowances created by the states. The states are, however, responsible for enforcing compliance, like in the EU ETS, and unlike in the U.S. SO_2 cap-and-trade system.

As noted by Kruger, Oates and Pizer (2007), all of the decentralized aspects of the EU ETS are "problematic." Some have precedents or analogues in American experience with cap-and-trade systems, but most do not. The underlying issue in achieving greater coordination is not so much desirability as it is political feasibility. The decentralized features of the EU ETS are not inherent in cap-and-trade systems as such; but they are the political manifestation of the multinational character of the European Union.

The current highly decentralized structure of the EU ETS will be almost entirely eliminated if the draft amendments to the Emissions Trading Directive recently put forward by the Commission are enacted. The EU-wide cap would be determined centrally; the distribution of allowances within member states would be harmonized by mandatory auctioning for the power sector and a rapid phase out for others; there would be common rules for allocating the residual free allowances; National Allocation Plans would no longer be required, and national registries would be collapsed into the central EU registry. These proposed amendments will provide a good test of whether the political reality within Europe has advanced to embrace this degree of centralization.

III. Performance

The performance of a cap-and-trade system has many dimensions, including: (a) the development of liquid, transparent markets for allowances, (b) the incorporation of allowance prices into business decisions, (c) the impact on covered emissions, (d) the costs of controlling emissions, (e) the relationship between emissions prices and the marginal cost of abatement, and (f) the effectiveness of monitoring and verification protocols. In this section of the paper, we discuss the development of the market for EUAs and the results of the verified emission reports for the years 2005 and 2006, the first two years of the trial period.[16] The behavior of allowance prices and the relationship between emissions and allowance allocations, including the overall EU cap, are the source of many of the controversies concerning the EU ETS. This chapter provides the empirical basis for understanding these controversies and for evaluating the EU ETS during the trial period.

A. The Emergence of a Single Price

A visible single price for a given product is the pre-requisite for an efficient market for a homogenous product without transportation costs. In cap-and-trade systems, a single price leads to least-cost attainment of the emissions constraint since the price provides a common signal to participants of the marginal cost that can be economically justified in reducing emissions and adjusting production.

Figure 1 displays the evolution of price of EUAs since January 1, 2005, when the EU ETS went into effect. The two price series shown are those for the trial period, 2005-07, as represented by the futures contract for delivery in December 2007, and for the second trading period, 2008-12, as represented by the contract for delivery in December 2008. Each of these is a different product because of the absence of banking from the first to the second period.

The difference between first and second period prices has been evident since the December 2008 contract was first introduced in September 2005, but it became most significant and sustained after September 2006 when first period prices began their decline toward zero. The extraordinary discount

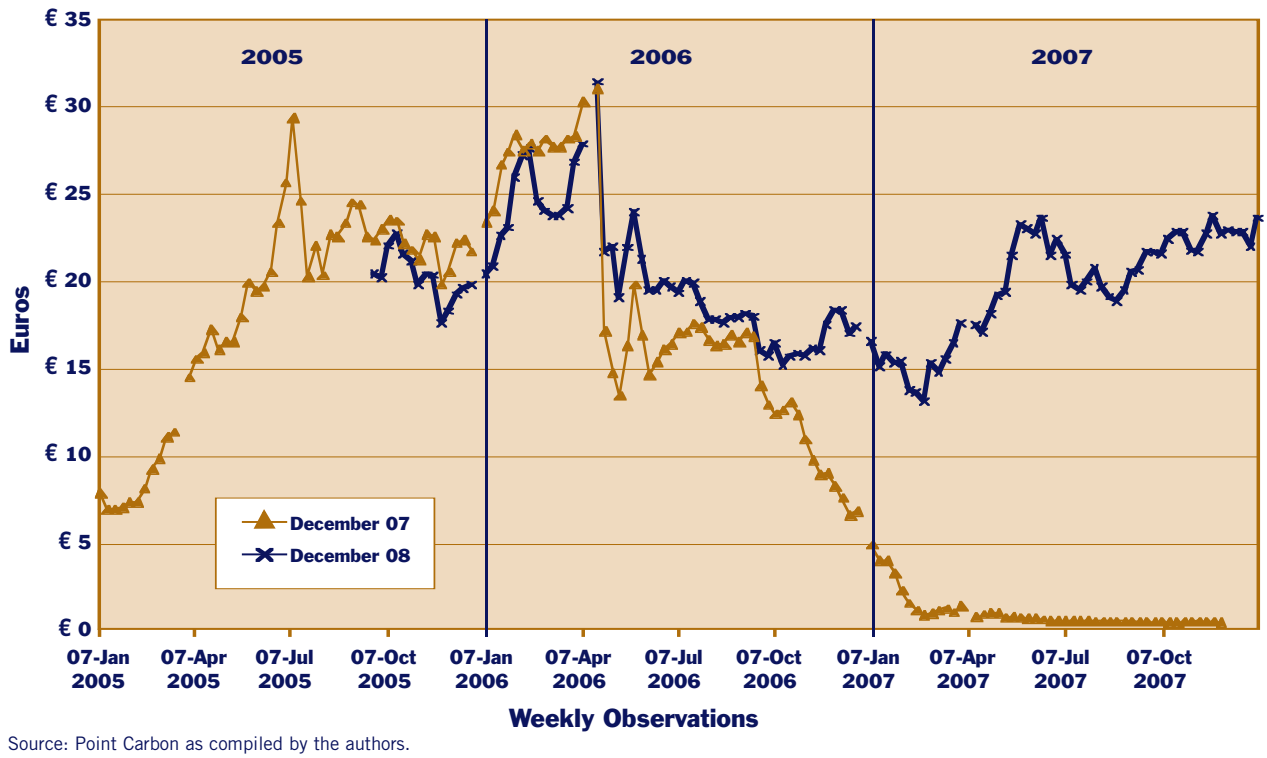
applied to the trial period EUAs from September 2006 on, as well as the premium paid for these same EUAs prior to April 2006, are largely explained by one phenomenon: the restriction on trading between the first and second periods. This restriction effectively made trading during the trial period self-contained and virtually assured that the trial period would be either in surplus or deficit when the final accounting for 2007 emissions is completed and announced in April 2008.[17]

Another salient and much noted feature of the evolution of EUA prices is the sharp decline that occurred in late April 2006 for both trial period and second period EUAs. In the space of less than a week, prices fell from over €30 to about €20 for second period EUAs and to €15 for trial period EUAs. The precipitating event was the reporting of 2005 emissions by several member states in amounts that were significantly less than expected.

The sharp break in pricing at this time reflects a phenomenon that is found in many cap-and-trade programs: initial expectations about prices are often wrong. The problem is not the cap, which is known from the beginning, but expected aggregate emissions, which determines actual demand for allowances.

Figure 1

Evolution of EUA Prices 2005-2007



Source: Point Carbon as compiled by the authors.

The uncertainty concerning the demand for allowances is especially large at the beginning of any program because it reflects not only the usual unpredictable variables of economic activity, weather, and energy prices, but also, and perhaps more importantly, the amount of abatement that will take place in response to the new price on emissions.

The first public release of emissions data provides the means to calibrate expectations with actual demand and prices adjust accordingly. This is what happened in the EU ETS and it happened in the U.S. SO_2 trading system (Ellerman et al., 2000). In both cases, the initial emissions reports revealed lower emissions than expected and the resulting adjustment of expectations reduced the price of allowances significantly, albeit more rapidly in the case of the EU ETS than for the U.S. SO_2 trading system. Once the first emissions reports have provided reliable data to calibrate expectations, later reports have much less if any effect on pricing. For instance, the April 2007 release of verified emissions for 2006 had no effect on EUA prices.

The magnitude of the price adjustment in responding to an initial calibration and the speed with which it occurs depend on the frequency of the releases of emissions data and the length of time over which adjustments in demand (i.e., emissions) can occur. When the data releases are frequent and the adjustment period long, the adjustment in the level of emissions can be spread over a longer period of time and the immediate price effect will be smaller. However, when horizons are truncated, as is the case for the first period of the EU ETS, the adjustment period is shorter and the immediate price effect will be greater. For the EU ETS, the sharp price decline in April 2006 reflected both the annual data reporting and the self-contained three-year trading period. Almost half the period had elapsed before expectations could be calibrated and adjustments in emissions could occur.

The effect of the truncated horizon can be observed in the different response of first and second period EUA prices to the revelation of information in April 2006 and in the subsequent evolution of those prices. When the adjustment took place, first period prices dropped by 50 percent and second period prices fell by 33 percent. The prices for both periods were affected because for the first time there was reliable information concerning the magnitude of aggregate covered emissions and the associated demand for allowances. The first period price fell farther because of the relatively short time remaining in the period to work off the unexpected surplus. As the trial period proceeded towards its conclusion and the remaining uncertainties were resolved, the price for first period allowances fell slowly but steadily from

over 15 euros in September 2006 to zero in March 2007. In contrast, the second period price has remained in the vicinity of €20 since late 2005 and has provided a relatively stable signal to participants concerning the expected value of emission reductions in 2008-12.

B. Why EUA Prices Were So High and Then So Low

During the first half of the trial period, the dominant question among market analysts was: Why are prices so high? Prices had been expected to be between €8 and €12 and they had started out within that range when the program got underway in January 2005. However, as can be seen in Figure 1, prices climbed rapidly over the next five months to €20 and they stayed at or above this level until the release of the 2005 verified emissions data in April 2006. The explanations at the time for the higher than expected prices in 2005 and early 2006 cited fundamental factors: a cold late winter in early 2005, a dry summer in southern Europe, and high natural gas and oil prices that made coal more attractive. A not uncommon reference was to the switching price, the CO_2 price level at which switching generation from a representative coal-fired unit to representative natural gas-fired unit in the power sector would be profitable. This switching price was always higher than the observed EUA price and that fact sustained a belief of strong demand for EUAs and a possible shortage of trial period allowances. An example of this frame of mind was the headline of the front-page guest editorial in Point Carbon's April 21 edition of *Carbon Market Europe*, which affirmed on the eve of the price collapse: "CO_2 price still too low."[18]

In retrospect, it is evident that another factor was at work in propelling EUA prices to these high levels and maintaining them there: an institutionally caused imbalance in the presence of buyers and sellers in the EUA market. In brief, companies with installations that were short allowances and needed to cover their emissions were disproportionately present and the companies that held long positions were not as active in the market.

The companies that were short were almost entirely electric power generators located in the EU15. They were short as a result of an explicit policy decision taken by many EU15 governments to allocate the expected member-state gap between business-as-usual emissions and EUAs to the electric power generating sector. The rationale for doing so was (a) that electric utilities had more means of abatement available in the short run than did other industries (e.g. switching from coal to gas) and (b) that they did

not face international competition with countries outside of the EU. Adding to the buying pressure was the hedging demand of electric utilities with respect to the carbon liabilities implicit in forward power contracts. In 2005 and early 2006, this meant increased demand for first period allowances at a time when potential sellers were not as active.

The potential sellers—non-power companies in the EU15 and all companies in Eastern Europe—were largely absent from the market for several reasons. First, installations with a long position are under no compulsion to sell to the market, unlike companies with short positions who must acquire allowances to cover emissions for the current year. Companies with a long position can take a wait-and-see attitude and many appear to have done so. Many were small firms not inclined to trade in the market anyway or were located in Eastern Europe where, even if they wished to sell, the registries necessary to deliver EUAs to buyers were not yet in place.

These factors changed in 2006 and explain the behavior of prices during the last half of the trial period. All the registries and other trading institutions were in place and operating well. Companies who were long in their allowance positions, and who kept their extra allowances for possible later use, came to realize that their first period needs were covered and that selling allowances that could not be used in the second period for a low price was better than getting no sales revenue at all. Finally, trial period EUAs were useless to power companies seeking to hedge 2008 forward electricity contracts. Thus, as 2007 approached and progressed, additional supplies of emissions allowances were released to the market at the same time that the demand for first period allowances by electric generating companies declined.

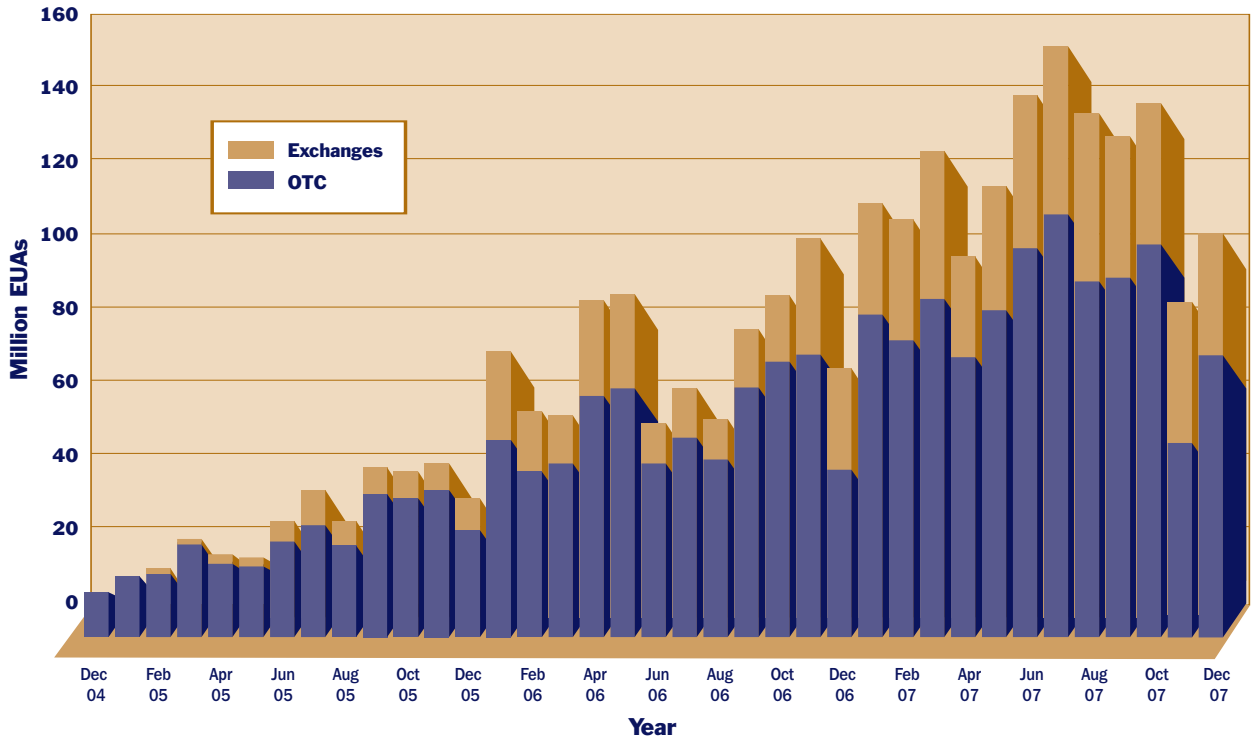
C. The Volume and Types of Trading

Although prices are certainly the most visible manifestation of a market, other attributes of markets and market institutions, such as trading volume, the nature of allowance contracts, and the development of efficient trading platforms, are also important. These attributes facilitate efficient abatement and product sales strategies by companies with affected facilities. As has been the case with allowance markets in the U.S., the volume of trading in the EU ETS has grown steadily as the program got underway. Figure 2 shows the steady increase in trading volume from a monthly average of about 10 million EUAs in the first quarter of 2005 to around 100 million from the first quarter of 2007 on.

An important feature of the EUA market that distinguishes it from U.S. allowance markets is the importance of organized exchanges. Over-the-counter markets, which account for virtually all U.S. allowance trading volume, were the first type of EUA trading platform to appear and they remain the dominant form of trading. Trading on organized exchanges appeared early and grew rapidly to where now about one-third of trades take place on exchanges.[19] The first trading on an organized exchange, Nordpool, occurred in February 2005, but by June of that year, four more exchanges had opened in Leipzig, London, Paris, and Vienna. These exchanges do not all trade in the same instruments. The London Exchange, ECX, offers futures, options, and swaps, while the Paris exchange, Powernext (now Bluenext), started out offering only a spot contract. Each of the other exchanges offers some combination of spot, forward, and futures contracts. The ECX is now by far the largest single platform for trading and it accounts for about 75 percent of the exchange volume. The appearance and continuance of these exchanges provides further evidence that the law of one price emerged early in the EUA market because exchanges could not operate if there were no convergence of prices.

Figure 2

Monthly EUA **Trading Volumes** 2005-2007



Source: Point Carbon and Mission Climat of the French Caisse des Dépôts.

The main trading instruments in the EUA market are forward and futures contracts for delivery in December of the specified year. The December maturity for each year is a convention that conforms to the reconciliation procedures in the EU ETS. Companies must surrender allowances equal to their emissions by the end of April in the following year. Thus, a firm that needs to purchase EUAs to cover emissions or that wishes to hedge its exposure for current production can either purchase the required EUAs in the spot market or purchase a futures contract corresponding to the compliance year for which allowances will be surrendered.

The EUA market has exhibited the same characteristics as markets for tradable permits in the U.S., such as those for SO_2 and NOx. Notably, a market developed relatively quickly without special effort on the part of the government beyond creating the scarcity, distributing the permits, and enforcing compliance. In all cases, there has been no lack of intermediaries to facilitate trading among parties with either long or short positions and to create a single price at any one moment in time for trading instruments with similar attributes. Whether all participants in the EU ETS have taken advantage of that single price to optimize abatement is another question, but there can be no doubt that the pre-requisite is present.

D. Emissions and Allowances: 2005-2006 Results

Market data do not provide information about the actual transfers of EUAs between buyers and sellers for compliance purposes. The activity observed in commodity markets is often motivated more by financial considerations than it is by needs for compliance trading. Financial transactions reflect the desire of emissions sources to hedge their positions as well as the activities of traders taking the other side of these hedges or otherwise speculating on movements in market prices. These transactions involve futures contracts for which many if not most of the positions taken are liquidated prior to their maturity thereby avoiding any physical delivery. Trading for purposes of compliance will always be a part of observed trading but it can be a small part. For evidence of compliance trading, the data on annual allowance allocations and verified emissions published annually in the Community Independent Transaction Log (CITL) must be consulted.

Installations with a net short position must either acquire EUAs from some other installation typically through the market or borrow from its allocation for the

Table 1

EU25 Allowance and Verified Emission Totals 2005-06

	2005	2006
One-third of 3-yr total	2,183	2,183
CITL Allowance Allocations	2,091	2,067
CITL Verified Emissions	2,010	2,028
CITL Indicated Net Long	81	39

Source: Community Independent Transaction Log (as of July 20, 2007).

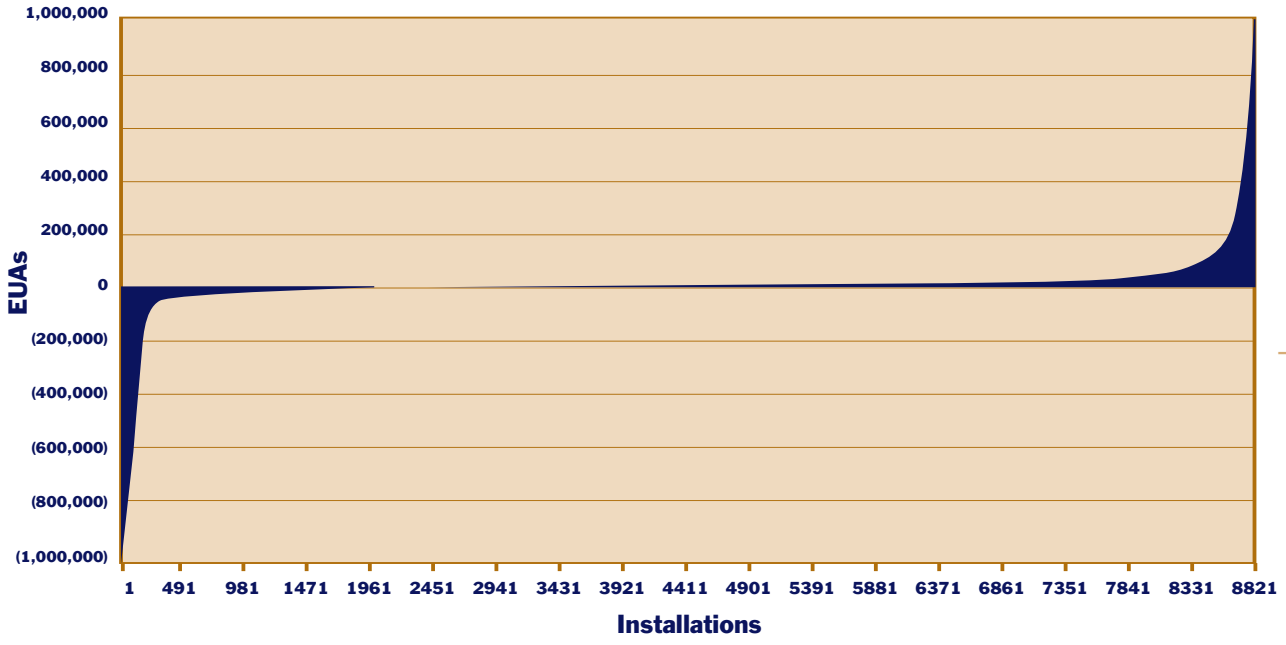
next year. In sum, each such installation is a potential buyer. Conversely, every installation with a net long position is a potential seller. In the aggregate, the EU ETS has been long for both 2005 and 2006. The total number of allowances created for the EU25 for the first trading period is approximately 6.55 billion, which implies an annual distribution of about 2.18 billion. Table 1 reports the aggregate allowance and emissions position of the EU ETS as a whole.

The number of allowances allocated to installations in the CITL is fewer than one-third of the three year total because of allowances held back for auctions and new entrant reserves. As a result, the net long position as shown in the CITL is less than the true long position. Verified emissions will almost surely be greater in 2007 than in 2006, and perhaps show a short position in the CITL; however, as indicated by the evolution of EUA prices toward zero, no one expects the likely increase of emissions in 2007 to create a shortage for the period as a whole.

A net long position for the trial period as a whole does not imply that every installation, member state or sector has a long position. Figure 3 presents the distribution of net physical positions by installation in 2006, truncated at plus and minus one million. The 2005 distribution is similar.[20]

Figure 3

Distribution of **EU ETS Installations** by Net Positions in 2006



Source: CITL

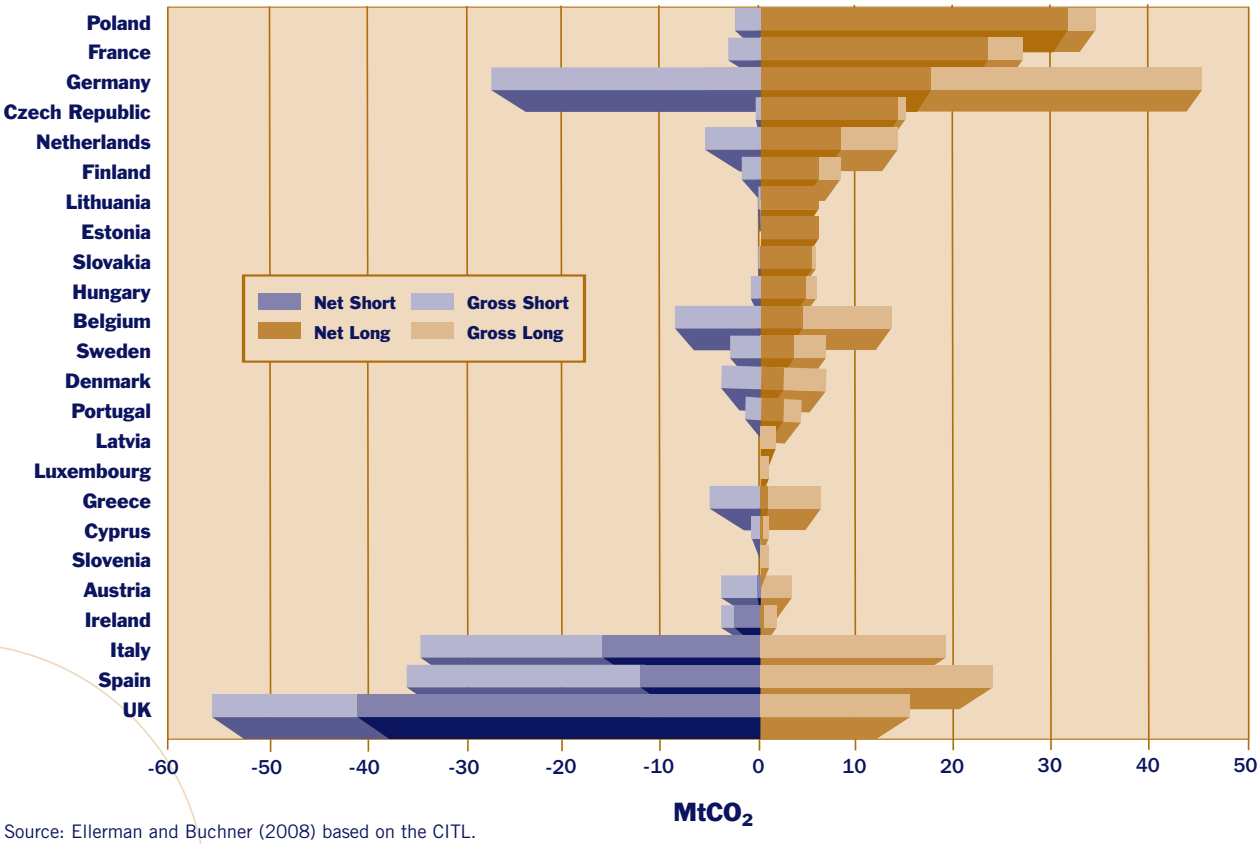
As can be readily seen, the bulk of the physical market resides in the tails. Fully two-thirds of the 9000+ installations depicted in this graph have surpluses or deficits smaller than 10,000 EUAs and less than 1 in 9 had a net physical position greater than 50,000 EUAs, approximately 300 of which were on the minus side and 700 on the plus side. The net short or long positions for individual installation could be very large. The largest long positions were 6.2 million and 5.2 million in 2005 and 2006, respectively, and the largest short positions were 6.2 million and 8.2 million in the same years.

When aggregated at the member state and sector levels, there is also considerable heterogeneity. Figure 4 shows the average member state position for the first two years of the trial period.

The light colored bars in Figure 4, labeled gross long and gross short, represent the sum of all the installations with net long and short positions in that member state; and the darker portion of the bar, denoted as net long or net short, indicates the net position of the member state. These darker portions of each bar indicate the potential for transfers of allowances among the member states. For example, in

Figure 4

Distribution of Long and Short Positions by Member State 2005-2006



Source: Ellerman and Buchner (2008) based on the CITL.

Great Britain, the sum of all short positions averaged almost 56 million EUAs for these two years and the sum of the long positions at UK installations was about 15 million EUAs. Although some of the surplus positions may have been sold or transferred to installations outside the UK, the net annual demand for allowances from other member states by installations in the UK was about 41 million EUAs.

It can be easily seen that the bulk of the physical demand (95 percent) for EUAs from individual member states came from the UK, Italy, and Spain and that the largest but by no means only potential suppliers were Poland, France, Germany, and the Czech Republic, which together accounted for 64 percent of the total net long positions. Of the other 17 member states, two are in net short positions, Ireland and Austria, and the remaining 15 are in net long positions.

The registry data for individual installations also indicate that the extent of compliance trading is significant and the patterns of trade diverse. Table 2 on page 22 presents these patterns for two large power plants in the UK for 2005 and 2006.

Drax is the largest coal-fired power plant in the United Kingdom and it was short by significant amounts: 6.2 million allowances in 2005 and 8.0 million in 2006. As indicated by the last three rows, slightly more than a quarter of its short position was covered by EUAs originating in the UK in both years and the remaining EUAs were acquired from abroad, presumably by purchase. However, the sources of this supply shifted significantly between the two years from the EU15 to the new member states.

Ferrybridge is another coal-fired power station in the UK, somewhat smaller than Drax, but also significantly short in both years. Its compliance strategy differed markedly from that of Drax. In 2005, it covered all of its short position by EUAs originating in the UK, but in 2006 only a small fraction of its entire surrender requirement originated from within the UK. The registry data do not allow analysts to determine whether the UK allowances surrendered in excess of the installation's allocation for 2005 were bought from UK installations or borrowed from Ferrybridge's 2006 allocation. However, the dramatic reversal the next year, is consistent with "borrowing" its 2006 allocation to cover 2005 emissions and then making up the difference by later purchases. Most installations don't reveal this pattern and it would not normally be observed unless the operator believed that future prices would be lower and was willing to "short" the next year's allocation. If this was the case at Ferrybridge, it was a profitable strategy since it avoided a large cash outlay when EUA prices were very high and allowed the "short sale" to be covered when prices were lower.

While only illustrative, these two installations show that the flexibility available through emissions trading is being used by participants in the EU ETS. Allowances were acquired by these two plants alone from 22 of the 25 member states (excepting only Slovenia, Cyprus and Malta). It is also readily seen that Eastern Europe became a significantly larger seller in 2006 than in 2005 in part due to the delayed development and approval of registries in those member states. Finally, the behavior of Ferrybridge suggests that borrowing against the next year's allocation is done and that it can prove profitable for those willing to take the risk of the allowance equivalent of shorting the next year's allocation.

Table 2

Illustrations of Compliance Trading for Two UK Plants (thousand EUAs)

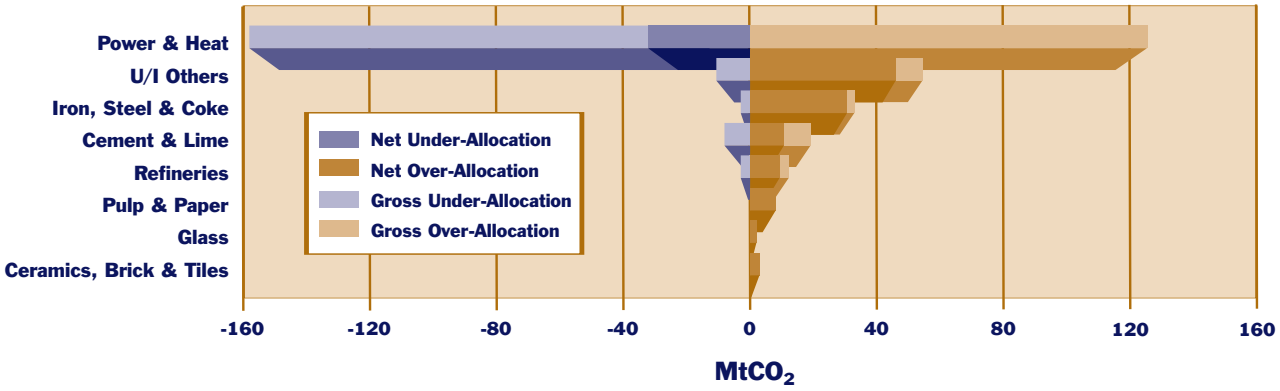
Originating Registry of Allowances Surrendered	Drax		Ferrybridge	
	2005	2006	2005	2006
United Kingdom	16,258	16,683	8,413	201
Austria	14	25	—	37
Belgium	601	5	—	—
Czech Republic	675	130	—	257
Germany	963	236	—	705
Denmark	224	236	—	293
Estonia	895	2,740	—	627
Spain	5	511	—	—
Finland	238	26	—	373
France	485	541	—	875
Greece	—	50	—	779
Hungary	—	187	—	538
Ireland	3	30	—	—
Italy	—	41	—	85
Latvia	80	76	—	103
Lithuania	—	—	—	1,085
Luxembourg	—	—	—	100
Netherlands	206	458	—	402
Poland	—	341	—	643
Portugal	—	87	—	273
Sweden	18	32	—	250
Slovakia	87	82	—	1,159
Total EUAs Surrendered	20,772	22,516	8,413	8,784
EUAs Allocated	14,554	14,554	4,785	4,785
Net Short Position	6,217	7,962	3,628	3,999
From the UK[a]	1,704 (27%)	2,129 (27%)	3,628 (100%)	–4,584 (–115%)
From other EU15	2,777 (45%)	2,190 (28%)	0	4,171 (104%)
From New Member States	1,737 (28%)	3,643 (45%)	0	4,412 (110%)

Source: CITL, as compiled by the authors.
Notes: a. After deduction of allocated allowances.

The individual installation data can also be aggregated by sectors as is done in Figure 5. The imbalance between supply and demand by sectors is readily evident. Virtually all of the demand for allowances to cover emissions comes from the power and heat sector, which is mostly the generation of electricity. The supply side is more balanced with nearly half of the potential supply coming from installations in the power and heat sector that are long and the other half from the remaining non-power sectors. This imbalance in the distribution of long and short positions by sector reflects more the decision of many EU15 member states to allocate the expected shortage to the power sector than it does any failure to abate by that sector or greater willingness to reduce emissions by the non-power sectors. The decision to assign the shortage to the power sector was not consistent across member states, but when done, it created significant short positions for many power companies.

Figure 5

Distribution of Long and Short Positions by Sectors 2005-2006



Source: CITL, Ellerman and Buchner (2008)
Note: "U/I Others" includes installations for which the sector could not be identified and combustion installations in other sectors.

IV. Controversies

The EU ETS did not arouse nearly as much public controversy when the Directive was being debated as it did once it went into effect. During its development, it was seen as one of several measures to achieve a goal that had broad public support, the fulfillment of the EU's obligations under the Kyoto Protocol. However, it was not long after January 1, 2005, that the program became the object of highly vocal public criticism.

Most of the criticism has focused on two issues: "windfall profits" and "over-allocation." The former refers to the higher electricity prices and consequent higher corporate profits that resulted from the free allocation of allowances and the latter implies an emissions cap that was not sufficiently constraining or at least not demanding enough. These two main critiques are somewhat inconsistent as concerns electricity prices. The "windfall profits" critique is motivated in large part by a concern about the effects of higher electricity prices, and suggests that electricity prices would have been lower but for the passing through of the market value of freely allocated allowances. At the same time, the "over-allocation" critique asserts that the cap was too lax and implies that it should have been tighter, which implies a higher CO_2 price and consequent higher electricity prices.

Surrounding these two main critiques are others concerning the allocation process, the volatility of EUA prices, and the linkage provisions. In this chapter, we seek to explain these controversies. In many respects, these controversies reflect either a misunderstanding of how cap-and-trade systems work in a market economy or fundamental disagreement with basic provisions of the EU ETS.

A. Windfall Profits

The windfall profits critique is focused almost exclusively on wholesale electricity prices and real or imagined additional profits earned by some electric generators to which allowances were allocated for free. Critics point to rising wholesale power prices during the first half of the trial period and allege that power supply bids "improperly" included the market value of freely allocated allowances, instead of their zero cost, into

power supply bids thereby causing higher wholesale power prices and significantly higher profits for some generators. The proposed remedy has usually been for the government to auction the allowances instead of allocating them for free. As usually presented, the windfall profits critique glosses over a number of contextual, conceptual and empirical difficulties.

Context: An Electricity Sector in Transition

During the time when the EU ETS was being designed and implemented, the European Union was also proposing and adopting various policies to "liberalize" wholesale and retail electricity markets. The long-term goal was to achieve deregulated competitive wholesale and retail markets in which electric generators and retailers would compete to meet the needs of residential, commercial and industrial consumers.

Freely allocated allowances will have a very different effect on electricity prices depending on the degree of liberalization in each member country. While there are many variations, the basic contrast is between a non-liberalized, regulated system, in which electricity generators are assured of cost recovery in electricity rates but only of incurred operating and capital costs, and a liberalized, deregulated system in which there is no assurance of cost recovery but generators can receive the market price of electricity regardless of their incurred costs. In the former more traditional regulatory system, the market value of freely allocated allowances would not be passed through to customers in electricity rates. The only CO_2 costs that could be recovered would be those of purchased allowances, and they would be offset by any revenues received from the sale of unneeded allowances. Nor would generators receive the wholesale market price of electricity, which could be higher or lower than their actual operating costs. In the deregulated version, the generator would receive the market price for electricity which will reflect the marginal cost of generation for that time and location, which in turn would be expected to include the market value of CO_2 allowances. Consequently, in member states with fully liberalized electricity markets the market value of allowances was included in wholesale prices regardless of whether these allowances were received for free or purchased. In the end, free allocation would not cause as much of an increase in electricity prices in a traditional regulated setting as in a more liberalized one. Nor would free allocation lead to an increase in generators' profits in the regulated system; in effect, the market value of the freely allocated allowances would be passed through to retail customers. Auctioning becomes attractive as a remedy because it would lead to similar increases in electricity prices regardless of regulatory regime and

it would not increase the profits of power companies operating in liberalized markets. It would, however, increase electricity prices for regulated customers.

These differences in regulatory regime for the power sector create problems when liberalization proceeds at widely varying paces among the participants in a cap-and-trade scheme. In the EU and by 2005, the electricity sectors in some EU countries (e.g. UK, the Netherlands, and the Nordic countries) had achieved, or were close to achieving, full wholesale and retail electricity market liberalization. Generating plants earned all of their revenues in unregulated competitive wholesale power markets and their profitability depended on the difference between competitive wholesale market prices and their generating costs. In these countries, changes in wholesale market prices were reflected in retail prices relatively quickly because retail supply contracts typically had durations of only one or two years.

In other EU countries (e.g. France, Spain, and Italy), the liberalization process was slower and only partially complete. In these countries, "transition contracts" of one type or another committed generating companies for some period of time to supply various categories of retail consumers at regulated prices that did not reflect prevailing wholesale market conditions. Generators earned some of their revenues from these regulated transition contracts and some from sales in the competitive wholesale markets. Retail consumers with regulated transition contracts were insulated from changes in wholesale market prices, while those who had chosen to be served under competitive retail supply arrangements (typically industrial customers) were not.

This situation of variable and incomplete electricity sector liberalization meant that the distributional impacts of introducing CO_2 emissions prices into the market would vary greatly among member states and among suppliers within member states that had partially liberalized their electricity markets. In those with fully liberalized wholesale and retail electricity markets, generators and consumers would quickly realize the cost, price, and profit effects of CO_2 pricing or other changes in competitive wholesale market prices. In those member states where a significant fraction of the sector continued to be subject to regulatory arrangements that kept retail prices from fully adjusting to changes in wholesale market conditions, the impacts of CO_2 pricing on retail electricity prices and on generator profits were muted. Of course, since it was and is EU policy to fully liberalize electricity sectors over the next few years, the experience of those member states with liberalized electricity markets provided a preview to other member states of what they can expect when their electricity sectors are completely deregulated.

Conceptual Issues: Opportunity Costs and Windfalls

In retrospect, it seems evident that the effect of the EU ETS on wholesale and retail power prices and generator profitability when the electricity sector was being liberalized was not widely understood. This reflected limited understanding of both the consequences of electricity sector liberalization and of the most basic principles of competitive market "opportunity cost pricing." For example, the argument that "windfall profits" caused higher electricity prices reflects a misunderstanding of how competitive electricity markets work. It assumes incorrectly that competitive market prices would reflect the zero acquisition cost of freely allocated allowances instead of their opportunity cost.

Whether an electricity generator in a competitive market has received the allowances for free or not, the relevant consideration in making offers to sell electricity is the opportunity cost of using the allowance to cover emissions. Since every allowance used to cover emissions means the loss of the opportunity to sell that allowance, an opportunity cost is incurred and that cost is the foregone market price for allowances. Accordingly, whether allowances are distributed for free or through an auction will typically have no effect on market prices in competitive electricity markets, although it will affect individual supplier profitability.

Another conceptual difficulty concerns the definition of windfall profit and its relation to free allocation. Nuclear generators operating in liberalized electricity markets in Europe have benefited to the extent that the market prices for electricity have incorporated CO_2 costs, yet they received no allowances. Their higher profits could be seen as a windfall, but they are generally not seen as such perhaps because they result from the higher prices created by the carbon constraint and not from allocation policy.

Empirical Issues: Electricity prices, fuel costs, and CO_2 cost pass through

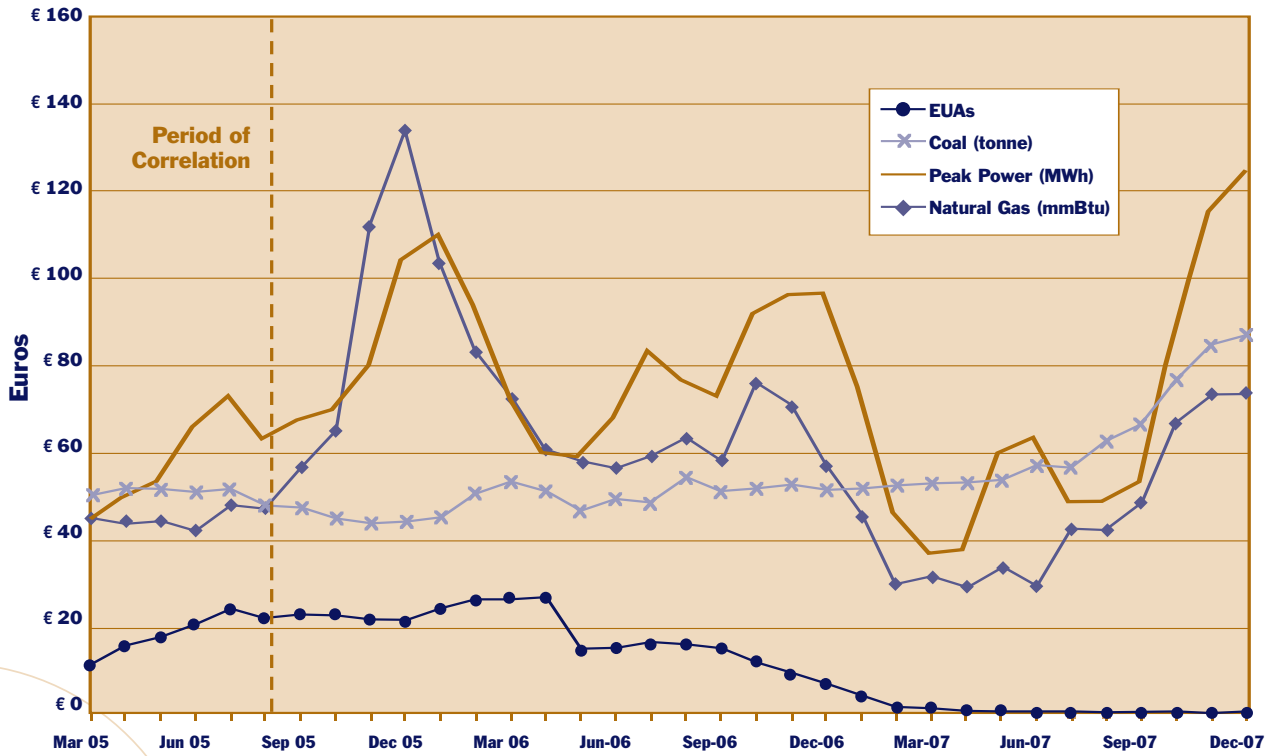
The increase in electricity prices that was experienced in Europe during the first year of the EU ETS imparted much impetus to the windfall profits controversy. Yet much of that price increase was due to increased fuel prices, as shown by Figure 6, which tracks the evolution of spot or near-term prices for coal, natural gas, CO_2 and electricity.

There was a brief period during the first seven months of 2005 (to the left of the dotted line in Figure 6) when electricity and EUA prices moved together. Electricity prices increased from about €40 per megawatt-hour (MWh) in early 2005 to €70 per MWh by the summer at the same time that EUA prices went from about €10 per metric ton to over €20, while fuel prices remained relatively unchanged. Thereafter, peak electricity prices rose to as much as €110 per MWh, but their movements were far more closely related to the price of natural gas than to that of EUAs. And since spring 2007, electricity prices have increased from €40 per MWh to over €120 per MWh in keeping with fuel costs and at a time when the CO_2 price has been insignificant.

Once the concept of opportunity cost is understood, the issue of how CO_2 allowance prices are "passed through" in the final prices for electricity or for other goods and services must be addressed. The extent to which allowance prices are reflected in the prices of final goods is a complicated matter even when markets are fully competitive. In theory, and in a perfectly competitive market, the marginal

Figure 6

Prices for Electricity, Coal, Natural Gas and EUAs 2005-2007



Source: Compiled by the authors from *Tendances Carbone*.

supplier that clears the market will pass through that supplier's full marginal (acquisition or opportunity) cost of allowances per unit of output. Infra-marginal suppliers will be affected in different ways depending on their CO_2 intensities and whether or not they must purchase allowances to cover their emissions. However, in real electricity markets, there are many conditions that can lead to more or less than full pass-through of marginal costs. Finally, to the extent the market is not perfectly competitive, the full carbon cost will not be passed through and some degree of previous oligopoly profit will be given up as firms adjust to the new cost circumstances.

Research conducted by Jos Sijm at the Energy Research Centre of the Netherlands and his collaborators finds that CO_2 costs have been passed through to wholesale electricity prices but that generators have not been able to recover the full market value of their free allocations. In a careful study of wholesale electricity markets in Germany, the Netherlands, Belgium and France from January through July 2005, Sijm et al. (2005) estimated that the average pass-through rates varied from 40 percent to 70 percent depending on the country and whether it was a peak or off-peak demand period.

Whatever the effect of CO_2 costs on wholesale electricity prices, the effect on retail customers depends on the degree of liberalization in retail markets. In many EU member states and for many customer categories, retail power prices continued to be regulated based on historical costs rather than wholesale market prices. For instance, in Spain, the increase in retail prices for regulated customer classes was limited to a set percentage increase and any greater cost incurred by generators for fuel or CO_2 allowances is booked as a regulatory asset to be recovered later. Moreover, the Spanish regulator has recently stated that companies would not be able to recover the opportunity costs of freely allocated allowances. And, in the UK, the regulatory authority has proposed that the market value of freely allocated allowances be recaptured by some means and used to help customers in fuel poverty. [21]

What can be generally said is that, for retail customers in many member states although not all, the higher wholesale prices resulting from CO_2 emissions costs have not been passed through. Large industrial customers are more likely to have faced retail prices reflecting higher wholesale electricity prices, although for these customers as well, much depends on the progress of market liberalization in each member state. Even so, as pointed out in a study on this subject conducted by the International Energy Agency (IEA, 2007), large industrial customers are often protected by long-term contracts and other financial means of hedging wholesale power price volatility.

Auctioning as the remedy

A commonly advocated remedy for windfall profits is auctioning allowances instead of allocating them freely to existing units (Sijm, Neuhoff, and Chen, 2006). This remedy would not cause electricity prices to be any lower, but it would end the granting of the scarcity rent associated with the free allocation of allowances to fossil generators. Advocates advance two main virtues of auctioning. It would ensure that carbon prices are passed through into retail prices where electricity markets have not been liberalized (thereby improving efficiency) and it would raise substantial revenue for the government that could be used for other purposes some of which could improve efficiency and equity. In opposition, it is argued that auctioning raises equity issues for suppliers who made investments when there were no constraints on CO_2 emissions and whose profits may be adversely affected by unanticipated carbon emission costs ("windfall losses"). If these suppliers are not compensated in some way, they are likely to oppose efficient market-based CO_2 emissions control mechanisms or to lobby for complicated tax credit, deduction, and other mechanisms to protect themselves.

Largely in response to the windfall profits critique, the European Commission has proposed, in the recently released draft amendments to the Emissions Trading Directive, that power generators receive no free allocations beginning in 2013 and that the allowances that would be otherwise allocated to them be auctioned by each member state. The prospective debate as these amendments go through the European co-decision process will provide a good view of the politics resulting from the distributional effects that flow from any significant constraint on CO_2 emissions. The issue of this debate, and of similar ones that will occur in the U.S. where auctioning all allowances is increasingly advocated, will reflect considerations of political economy. The best that economists can do is to focus on minimizing the adverse effects that political concerns can have on the efficiency of programs and on structuring programs that clearly separate distributional decisions from the efficient performance of the system. As pointed out by Stavins (2007), this is one of the chief merits of a cap-and-trade program and this result is achieved whether allowances are distributed by auction, free allocation, or a mix of the two.

In sum, the issues associated with windfall profits and the free distribution of emission allowances are more complicated than they are often presented to be. These issues have not arisen in U.S. cap-and-trade programs for SO_2 and NOx, in part because the effects on electricity prices are small (since emissions per MWh are considerably less for SO_2 and NOx) and the revenues to be received from

auctioning much less than what would be the case in a CO_2 cap-and trade program.[22] It is likely that the same debate that has been occurring in Europe will take place in the U.S., not least because electricity sector liberalization has been implemented in only a third of the U.S. states with little prospect that it will spread (Joskow, 2006). As a result, the differing effects of allocation and auctioning decisions on a partially liberalized electricity sector are likely to be at least as contentious and complicated in the U.S. as they have been in Europe.

B. "Over-Allocation"

The release of the 2005 emissions data in April and May 2006 and the associated sharp fall in EUA prices created another controversy for the EU ETS: over-allocation. Like windfall profits, over-allocation is not a well-defined concept, but it is generally understood to mean that the member states created too many allowances during the trial period to the point even of creating a non-binding EU cap.

A non-binding cap was always a non-trivial possibility in the EU ETS during the trial period. The problem lies in caps that have modest goals for reducing initial emissions below business-as-usual (BAU) levels. A cap that is expected to be modestly constraining can become non-binding when the variation in BAU emissions, due to weather, economic growth and other factors and which can be as much as 5-10 percent, turns out to be on the low side. In this case, what was expected to be a modest shortage becomes a surplus. A similar outcome has recently been indicated as likely for the Regional Greenhouse Gas Initiative in the Northeast U.S. (Point Carbon, 2007), which like the EU ETS has a modest emission reduction goal.[23] Similar variations in BAU emissions occur in all cap-and-trade programs; however, when the reduction goal is more ambitious (50 percent or so), a downward variation in BAU emissions will have much less effect on prices and it will not create a surplus.

The modest ambition of the trial period with respect to emission reductions is explicit in the criteria used to determine member state totals. The Commission's guidance for submission of National Allocation Plans for the first period stipulated that the member state's cap be the lower of expected 2005-07 emissions (e.g., BAU emissions) or the member state's "Path to Kyoto," which was interpreted as a level of emissions that would not preclude the member state's achievement of its Kyoto commitment as modified by the European Burden Sharing Agreement (Zapfel in Ellerman, Buchner, and Carraro, 2007). In fact, member state totals in the trial period were more closely aligned with recent emission levels than

with the Path to Kyoto.[24] At most, the *expected* emission reduction for the EU25 as a whole during the trial period was only one to two percentage points. This modest ambition and the uncertainty in any forecast necessarily implied a high probability that the aggregate cap during the trial period would turn out to be non-binding.

In addition to the modest ambition for emission reductions during the trial period, the difficulty of choosing an appropriate member state total was further compounded by a cluster of problems associated with data, sector definitions, and the use of projections. Setting a cap at or slightly below BAU emissions implies an ability to predict BAU emissions. Such predictions are necessarily uncertain, but when the projection concerns a sub-set of total emissions that has not heretofore been modeled carefully and for which no baseline data are readily available, the problem of defining a binding cap becomes almost insurmountable. In the event, installation data had to be assembled in great haste to meet the tight implementation deadlines and models had to be modified (or even created) to simulate the trading sectors and then calibrated on the hastily gathered and not always available baseline data. Even with good data and well calibrated models, there would have been errors, but those errors were greater because of the poor data and new sector definitions. Finally, the East European member states were continuing to undergo a structural transformation of their economies that made forecasting emissions even more difficult.

In retrospect, it is not surprising that some member states and sectors received allocations that were larger than their expected and actual emissions. Quite aside from obvious political pressures to increase allocations, establishing member state totals and an EU cap that was expected to be binding and that would turn out to be so during the trial period was an exceedingly difficult task. It is understandable that the Commission and the EU as a whole did not get it exactly right.

This problem will disappear with the second and post-2012 periods as the result of incorporating more aggressive emission reduction goals in the emission caps and having the benefit of verified emissions data for 2005 which the Commission has relied upon in determining second period member-state totals. All second period National Allocation Plans are now approved and the second period EU cap will be about 13 percent lower than the first period cap and 6 percent lower than comparable 2005 emissions. Table 3 provides the allocation data by member state with the EU25 ranked according to their first period caps.

Table 3

Comparison of Second Period Caps with First Period Data

Member State	First Period Cap (Mt)	2005 Emissions (Mt)	Second Period Cap[a] (Mt)	% below First Period Cap	% change from 2005 emissions
Germany	499.0	474.0	442.1	- 11.4%	- 6.7%
United Kingdom	245.3	242.4	206.7	-15.7%	- 14.7%
Poland	239.1	203.1	202.2[b]	- 15.4%	- 0.4%
Italy	223.1	225.5	195.8	- 12.2%	-13.2%
Spain	174.4	182.9	145.6	-16.5%	- 20.4%
France	156.5	131.3	127.7	- 18.4%	- 2.7%
Czech Republic	97.6	82.5	86.8[b]	-11.1%	+5.2%
Netherlands	95.3	80.35	81.8	-14.2%	+ 1.8%
Greece	74.4	71.3	69.1	- 7.1%	-3.1%
Belgium	62.1	55.6	53.5	-13.9%	- 3.7%
Finland	45.5	33.1	37.2	- 18.2%	+ 12.4%[d]
Portugal	38.9	36.4	34.0	- 12.5%	- 6.5%
Denmark	33.5	26.5	24.5	- 26.9%	- 7.6%[d]
Austria	33.0	33.4	30.4	- 8.0%	- 9.1%
Hungary	31.3	26.0	25.5[b]	- 18.6%	- 2.0%
Slovakia	30.5	25.2	30.8	+1.1%	+ 22.3%
Sweden	22.9	19.3	20.8	-9.2%	+ 7.8%[d]
Ireland	22.3	22.4	22.3	=	- 0.5%
Estonia	19.0	12.6	12.4[b]	-34.7%	- 1.7%
Lithuania	12.3	6.6	8.8[b]	-28.9%	+32.6%
Slovenia	8.8	8.7	8.3	- 5.7%	- 4.6%
Cyprus	5.7	5.1	5.5	- 3.9%	+ 7.5%
Latvia	4.6	2.9	3.4[b]	- 25.4%	+ 18.3%
Luxembourg	3.36	2.65	2.68	- 21.1%	+ 3.2%
Malta	2.94	1.98	2.1	- 28.6%	+ 6.1%
Romania[c]	74.8	70.8	75.9[b]	+ 1.5%	+ 7.2%
Bulgaria[c]	42.3	40.6	42.3[b]	=	+ 4.2%
EU15	1729.6	1637.0	1494.2	- 13.6%	- 8.7%
EU10	451.8	374.7	385.8	- 14.6%	+ 3.0%
EU25	2181.4	2011.7	1879.9	- 13.8%	- 6.6%
EU12	568.9	486.1	504.0	- 11.4%	+ 3.7%
EU27	2298.5	2123.1	1998.1	- 13.1%	- 5.9%

Source: European Commission, IP/07/1869, dated December 7, 2007.

Notes:

a. Excludes additional installations in second phase with 84.5 Mt of emissions of which the largest are 39.5 Mt in the UK, 11 Mt in Germany, 6.7 Mt in Spain, 6.3 Mt in Poland, 5.1 Mt in France, 5.0 in Belgium, and 4.0 Mt in the Netherlands.

b. Commission-approved cap is being contested in the European Court of Justice.

c. Romania and Bulgaria joined the EU and the EU ETS in 2007. The figures given for the first period cap are for 2007.

d. Favorable hydroelectric conditions in Scandinavia in 2005 and a two-month pulp and paper industry strike in Finland created unusually low 2005 emissions for Denmark, Sweden, and Finland.

The second period caps are as much as 25 percent to 35 percent lower than the first period totals for several countries, mostly in Eastern Europe, although these reductions reflected as much the error in estimation of BAU emissions in the trial period as they did a desire to impose emission reductions on the new member states. When compared to 2005 emissions, the new member states have been allowed a second period total that is almost 4 percent higher, whereas the EU15 total for the same period is almost 9 percent lower.

With an EU-wide cap 6 percent below 2005 emissions and another five years of economic growth from 2005, "over-allocation" is not expected to be an issue in the second period. Another reason for "over-allocation" to disappear as an issue is the proposed further 11 percent reduction in the third period (2013-20) cap and the availability of banking from the 2008-12 to the post-2012 period. With banking, the still tighter third cap will create demand that will tend to sustain the EUA price during the second period.

The over-allocation argument has had the unfortunate effect of implying that there has been no abatement during the trial period. In fact, the surplus that will exist ex post when the final accounting for 2007 is made will be larger by the amount of abatement that occurred when EUA prices were at levels that were considered high for most of 2005 and 2006. While the quantity of abatement during the trial period may not have been great, the early high EUA prices would have created an incentive for short run abatement behavior, in particular by the power sector.

Abatement is very hard to estimate because it involves the construction of a counterfactual estimate of what emissions would have been in the absence of the EU ETS. This counterfactual estimate should take into account actual economic growth, energy prices, and weather since all of these variables affect what emissions would have been absent a CO_2 price. Despite these difficulties, some analyses and estimates are starting to appear.

Ellerman and Buchner (2008) note that 2005 and 2006 emissions were lower than the historical baseline emissions used in the development of the first National Allocation Plans despite continuing economic growth in the EU and increases in oil and natural gas prices that could be expected to increase demand for coal-fired generation. Using a very simple counterfactual based on the extrapolation of pre-2005 emission trends and observed growth in economic activity, they conclude that abatement in 2005 and 2006 was "probably between 50 and 100 million tons in each of these years." This is between 2 percent and 5 percent of covered emissions.

Delarue et al. (forthcoming) provide a more rigorous estimate for the power sector alone of 88 million tons in 2005 and 59 million tons in 2006. Their estimate is based on a modeling simulation of the European power system using actual fuel prices and actual demand for fossil fuel-fired electricity generation. This simulation finds that the largest reduction occurs in Germany because of increased flows of power with lower emission rates from neighboring countries and switching from coal to natural gas fired generation within Germany.

In support of these tentative early research findings, the European Environmental Agency's latest release on EU GHG trends and projections (EEA, 2007) reports that CO_2 emissions from the public electricity and heat production sector were down on a year-to-year basis from 2004 to 2005 for the EU25 as a whole and that the largest source of reduction was Germany.

By its very nature, the trial period would not have led to significant abatement because the abatement goals were modest, allowance prices were expected to be low, and the duration of the trial period was too short to stimulate long-term investment to reduce CO_2 emissions. Still, a modest amount of abatement, perhaps as much as 5 percent, is likely to have occurred in 2005 and 2006. As we have already noted, the primary goal of the EU ETS during the trial period was not to effect significant CO_2 emission reductions, but to develop the cap-and-trade infrastructure that would reduce the cost and facilitate meeting the requirements of the Kyoto Protocol in 2008-12 and that would become the mechanism for more ambitious emission reductions in later periods.

C. The Allocation Process

The term allocation is frequently used in the EU ETS to refer to both cap-setting and the distribution of allowances by the member states to covered installations. This section discusses the latter aspect in which member states had to take into account a number of factors, such as different views about which sectors were in the best position to respond to CO_2 prices, the effects of CO_2 prices on industries that competed with suppliers in other countries inside and outside the EU, industry lobbying, and more generally contending definitions of what is fair and equitable. These distributive aspects of allocation found expression in controversies over benchmarking, harmonization, and auctioning.

"Benchmarking" refers to an allocation whereby installations would receive allowances according to some "benchmark" emission rate times an indicator of the installation's level of economic activity, typically either output or an input such as energy consumption. Benchmarking is typically advocated as a means of rewarding installations with relatively low emission rates and punishing those with comparatively high emission rates. Yet despite the vocal championing of this approach, benchmarking was rarely adopted in the National Allocation Plans for 2005-07. The two main reasons were the heterogeneity of production processes, which reflects differences in final product and local circumstance more than those in efficiency, and the lack of any convenient pre-existing standard that could serve as the benchmark.[25] With only a few exceptions, recent historical emissions provided the basis for allocation to individual installations for they had the merit of recognizing pre-existing differences in fuel use, efficiency, and utilization.

The just completed second round of National Allocation Plans for 2008-12 has seen more use of benchmarking, but almost entirely in the power sector and it still remains the exception. And, as if to emphasize the difficulty of agreeing on uniform product benchmarks, those adopted are typically fuel specific, that is, different for power plants generating electricity from natural gas and coal.

The term "harmonization" refers to the differences in allocation to similar facilities located in different member states. "Harmonization" was not an issue at the design stage of the trial period, but it became one as the results of the National Allocation Plans became evident. Producers on one side of an intra-EU border viewed competitors on the other side that had received a more generous allowance allocation with dismay and complained accordingly. The reasons for these sometimes significant differences in allocations to otherwise similar installations resulted from the different criteria for cap-setting among the member states, notably those originating in the European Burden-Sharing Agreement, and individual member state decisions on how to distribute their allowance total to installations, in particular how to allocate the expected shortage.

In evaluating claims of competitive distortion due to a lack of harmonization, a clear distinction needs to be made between allocation provisions concerning new entrants[26] and closures and those for incumbent facilities that operate throughout the trading period. Provisions that endow new or expanded facilities with allowances and force closed facilities to forfeit post-closure allowances will have distorting

effects since they are contingent on actions that the owners of these facilities take (Ellerman, 2008). Investment in new or expanded capacity might change its location due to a more generous new entrant endowment in another member state. Similarly, a candidate for closure in one member state might stay open if its existing endowment is larger than that for an otherwise similar candidate for closure in another member state.

These distortions do not apply for the vast majority of incumbent installations that operate throughout the trading (and allocation) period and which would not close if they had to pay for their allowances. As noted earlier, the CO_2 cost is the same whether it is an opportunity or acquisition cost, that is, whether allowances are allocated freely or must be purchased. The market price for the goods produced by these installations and the operation of two otherwise identical plants will be the same regardless of how EUAs are acquired. Thus, the failure to harmonize has not had and would not have competitive or efficiency consequences. While operations and prices are not affected by allocation, profits are; and it is the unfairness of these financial effects that creates the demand for harmonization.

Many factors made it difficult to harmonize allocations across EU member states, but the overriding consideration is the political reality of the European Union: whether the constituent member states are willing to delegate the national decisions that created these differences to Brussels. Even if they are, complete harmonization is unlikely since differences in national circumstance, such as those between the West and East European member states, will likely lead to some differentiation of national burdens and resulting differences in allocations to individual installations. Fundamentally, harmonization and differentiation work at cross purposes for both involve distributional issues of equity. Setting aside the distortions due to the new entrant and closure provisions in the EU ETS, the underlying issues are not ones of competitiveness and efficiency.

Like benchmarking, auctioning has seen greater use in the second round of National Allocation Plans than in the first; however, the greater use of auctioning is still far short of what is allowed, not to mention what proponents advocate. Both the percentage of allowances auctioned and the number of member states choosing to auction have increased markedly from the first to the second trading period, although both remain small. Moreover, only one member state, Denmark, has chosen to auction the

maximum percentage allowed by the EU Emissions Trading Directive (5 percent during the 2005-07 period and 10 percent during the 2008-12 period), but only for the first trading period.[27] The second period NAP process is nearly complete so that the member states choosing to auction and their percentages can now be presented in near final form.[28]

Table 4

Percent of Member State

Allowances Auctioned

Member State	Percent of Cap Auctioned 2005–07	2008–12
Denmark	5.0	0
Hungary	2.5	2.3*
Lithuania	1.5	2.9*
Ireland	0.75	0.50
Austria	0	1.2
Belgium	0	0.3
Germany	0	8.8
Netherlands	0	4.0
UK	0	7.0
EU Total	0.13	3.0

Source: National Allocation Plans.
*Proposed but not finally approved

The allocation process as it has existed for both the first and second trading periods would be radically changed by the recently proposed amendments to the Emissions Trading Directive. In essence, the system would be drastically centralized. National Allocation Plans would be abolished; the EU-wide cap would be set centrally; a principle of 100 percent auctioning would be established; free allocation to the power sector would be abolished as of 2013; free allocation to all other sectors would begin at 80 percent of the 2008-12 level in 2013 and be phased out by 2020 with some exceptions if international trade problems can be demonstrated; the rights to auction and to receive the resulting revenue would be assigned to member states; and free allocations would be made by EU-wide rules that would be worked out by the Commission and the member states. This bold proposal would eliminate harmonization as a problem, make free allocation the exception, and presumably rely more on benchmarks than is presently the case. The fate of these provisions in the co-decision process over the next year or two will reveal much about the degree of centralization that can be achieved in a multi-national system, as well as the feasibility of EU-wide benchmarking, identifying trade-impacted sectors, and shifting rapidly to high levels of auctioning. For one thing, allocating auction rights among nations and deciding the use of auction revenues may prove no easier than negotiating caps among nations and allocating allowances to firms.

As this debate unfolds, it will be important to keep in mind that the decision to rely heavily on free allocations of allowances to address distributional concerns and associated issues of political

economy may have been wiser than often viewed. If nothing else, free allocation facilitates getting a program to price CO_2 emissions up and running quickly, rather than spending years with affected interest groups fighting any program at all. As has been pointed out by Raymond (2003), fundamental principles of equity underlie allocation debates. In particular, deep issues concerning the competing claims of prior use and of higher public purpose are involved. Nearly all societies grant considerable deference to prior use claims, in this case to entities that had been freely exercising the right to emit prior to the implementation of the policy. And against these claims must be set those of public purposes that can be served by the value embedded in allowances—a value that is created not by private parties but by an act of government taken on behalf of society. Reconciling claims based on prior use and public purpose, not to mention the difficulty of distinguishing these claims from special interest lobbying, will never be easy or absent from the debate. The coming debate in Europe over the proposed ETS amendments will test these claims and reveal how easy it will be to decide the public purposes to which auction revenues should be devoted.

The criticism that allowance allocation is an impossibly sordid rent-seeking exercise often implies that the problem is avoided with auctioning or a carbon tax. Anyone who has examined revenue earmarks or the income tax codes will understand that the same forces apply. If an auction mechanism or emissions tax were chosen instead, an equally complex set of earmarks, credits, exemptions, and loop holes would emerge through the political process. Whatever the mechanism, any system that seeks to reduce GHG emissions will have broad distributive consequences, and it will create scarcity rents, as well as claimants for the allowances or revenues that have been created. CO_2 prices high enough to stabilize atmospheric concentrations of GHG at target levels around 550 ppm imply that the market value of CO_2 emissions in the EU or the U.S. amounts to hundreds of billions of dollars per year over the next 50 years (Paltsev et al., 2007). With that much money at stake, no one should be surprised that interest groups will lobby hard to influence decisions or that the political system will respond by mitigating distributional effects, whatever emissions control mechanism is chosen. The key policy challenge is to ensure that the mechanisms used to achieve distributional goals and to resolve political economy challenges do not distort abatement behavior or competition.

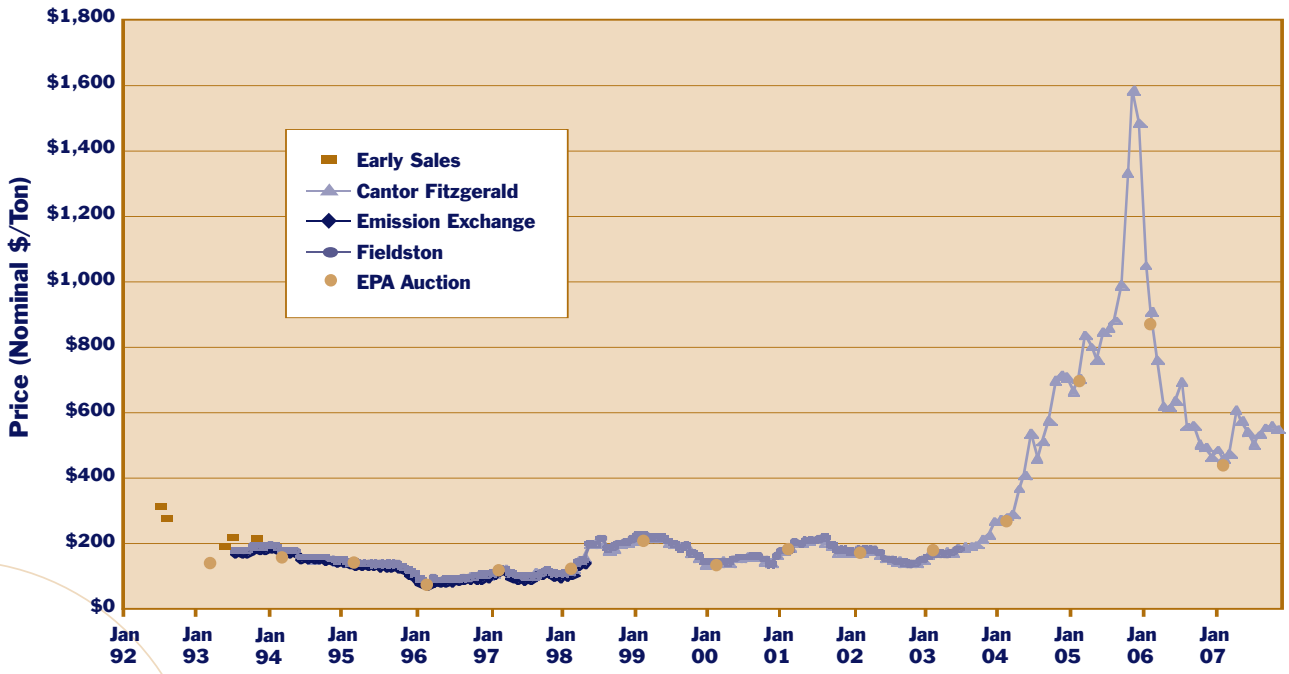
D. Price Volatility

The trial period of the EU ETS has experienced some dramatic allowance price movements. As shown in Figure 1, the allowance price tripled in the first six months, collapsed by half in a one-week period in April 2006, and declined to zero over the next twelve months. Such movements and the implied volatility inevitably raise questions about the effectiveness of allowance prices for providing reliable incentives for abatement and other changes in behavior that reduce the targeted emissions.

The price movements observed during the trial period's three-year duration are not unusual for cap-and-trade systems. The initial price of SO_2 allowances in the U.S. Acid Rain Program (~$130) was about half what was expected (~$250) and after the first two quarterly data releases in early 1995, the price halved again to an all-time low of $70 in early 1996 (Ellerman et al., 2000). The initial prices in both phases of the Northeastern NOx Budget Program also experienced large price spikes at the beginning of the initial ozone season in each phase of that program, which then quickly settled down

Figure 7

SO_2 Allowance Prices 1993-2007



Source: Various sources compiled by the authors.

to levels that were lower than what had been initially predicted (Aulisi et al., 2005). Moreover, price volatility is not limited to the start-up of these programs as evidenced by the evolution of U.S. SO_2 prices as shown in Figure 7.

The extraordinary SO_2 price increase of 2004 and 2005, long after the program began, makes all the earlier price fluctuations seem modest. The steady increase in price in 2004 reflected both the final regulatory decisions on the Clean Air Interstate Rule, which will reduce the SO_2 cap by one-half in 2010 and by another third in 2015,[29] and a concomitant rise in the domestic premium paid for low sulfur steam coal due to a metallurgical and export coal boom. Still this does not explain the extraordinary late 2005 price spike, which also coincided with a sharp rise in natural gas prices. The large bank of allowances should have moderated this price excursion unless it was expected to be permanent, which seems unlikely given the known volatility of natural gas prices and the considerably lower cost of scrubbing.[30]

In the EU ETS, the volatility of the prices for first period allowances was exacerbated by the restriction on trading between the first and second periods. Most obviously, if there had been no restriction on banking between the trial and second period, the price for CO_2 for most of 2007 would not have been effectively zero because the price difference between first and second period allowances would have been arbitraged away. Also, both first and second period prices fell significantly when the verified emissions data were released in April 2006, but the inability to bank caused the first period price to fall by more than the second period price (a reduction of 50 percent vs. 30 percent). This release of relevant information provided a common reliable basis for calibrating price expectations for both what remained of the first period and the second period. In sum, the banking restriction caused first period prices to fluctuate more than would otherwise have been the case.

Furthermore, annual reporting compounded the effects of the self-contained three-year trial period creating the greater volatility of first period EUA prices. Almost half of the trading period had elapsed before the first release of emissions data was available, and that left little time to adjust by increasing emissions and less opportunity for unpredictable but compensating weather or energy price developments to create demand before the end of the period. Had it been possible to report emissions data on a quarterly basis, as is done in the U.S. SO_2 and NOx programs, the initial calibration of expectations would have occurred earlier, there would have been more time to adjust to the new information, and the surprise would have been smaller.

Despite these factors, the volatility of EUA prices and of allowance prices generally has been comparable to that of related energy commodities as shown in Table 5.

The volatility is measured in the standard way as the expected variation in price over a year's time. For all the series except SO_2, the data points given in the ranges are annual volatility calculated over quarterly observation periods from the beginning of 2005 through the first quarter of 2007. The SO_2 values are annual volatilities calculated annually for 1995 through 2006. The December 2006 futures contract is chosen to represent first period prices because it includes the price drop in April-May 2006 while excluding most of 2007 when the near zero prices for the December 2007 contract and for spot transactions resulted in artificially high volatility indicators.[31]

Table 5

Volatility of Selected Commodities

Commodity	Volatility Range in % 2005-2007
EUAs Dec 06 futures	27–161 (57)
EUAs Dec 08 futures	28–91 (62)
SO_2 spot price (1995-2006)	8–44
Natural Gas (Zeebrugge)	55–138
Crude Oil (Brent)	24–32
Coal (ARA)	8–22
Baseload Electricity (Powernext)	35–96
Peak Electricity (Powernext)	42–105

Source: Mission Climat, Caisse des Depots.

NOTE: The figure in parentheses for the two EUA products is the highest observed volatility when the second quarter of 2006 is excluded.

The effect of the inter-period banking constraint can be seen again in the comparison between the volatility measures for the 2006 and 2008 EUA maturities. The banking constraint created more than half again as much volatility in the second quarter of 2006 for the trial period allowances (161 percent vs 91 percent for second period allowances). Outside of this quarter, the volatility of the two contracts was similar.

These data show that, except when the first period price movements of April 2006 are included, the volatility of EUA prices is no greater than that dealt with regularly in natural gas and electricity markets. Participants in all these markets can hedge their forward positions if they desire to protect themselves against adverse price fluctuations. This is commonly done in other commodity markets and the instruments to do so are available in the EU ETS and in most allowance markets.

E. Linkage

Linking refers to any use of credits or allowances from outside the system for compliance, that is, the use of anything other than the system's own allowances. In the case of the EU ETS, the primary source of such offsets are the project credits created under the Kyoto Protocol's Clean Development Mechanism (CDM), and known as certified emission reductions (CERs). The Linking Directive, enacted soon after the Emissions Trading Directive, opened the door to the use of CERs and Joint Implementation credits created by a similar process under the Kyoto Protocol.

Linkage provisions, such as those in the EU ETS are widely recognized as desirable in order to exploit lower cost mitigation options wherever they are located. Since there is no necessary relationship between individual country emissions caps and the geographic distribution of low-cost mitigation opportunities, mechanisms must be found to facilitate the ability of countries with relatively high-cost mitigation options to exploit relatively low-cost mitigation opportunities in other countries. Offsets and other linkage mechanisms provide the means to do so by making it possible for one country (or sources within a country) to get credit for mitigation investments made in another country.

The possibility of linkage has not had any practical importance in the trial period of the EU ETS because 1) the registry link that would enable the use of CERs was not expected to be in place until mid-2007, 2) the supply of pre-2008 CERs was never expected to be large, and 3) the bankability of these credits made their use in the trial period uneconomic as soon as the price disparity between first and second period allowances emerged. Still, the prices offered in the EUA allowance market in 2005 and 2006 and for second period allowances since then have provided a strong stimulus to CDM project development, increased the prospective supply of CERs, and made their use an important supplementary means of compliance for the second period. Finally, as issues concerning registry links and certification by the CDM's Executive Board have been resolved in the course of 2007, a sufficiently large secondary CER market has developed that generally recognized price quotes have been available since the summer of 2007.[32]

Linkage provisions are not without controversy. In general, linkage can have distributional impacts that create losers as well as winners (Jaffe and Stavins, 2007). A more commonly cited problem

is "additionality," that is, ensuring that the credited reductions would not have taken place for other reasons thereby creating what has been called "anyway tons" in the United States. This is an always difficult issue for which there is no perfect answer but only methods of assessment that can be applied to ensure that a large part, if not all, of the credited reduction is real. In the case of the EU ETS, this job has effectively been delegated to the bodies and procedures established under the Kyoto Protocol. While controversy about CDM projects remains, there are at least as many complaints about the rigor with which credit certification criteria are applied as there are about the laxness or inappropriateness of some decisions and categories.

A second controversial feature of linkage is the concern about an oversupply of CERs in the 2008-12 period. While the likely supply and demand of these offsets can be debated, the EU ETS has taken measures to guard against over-supply by adopting quantitative limits on the extent to which off-system credits can be used: about 13 percent of the second period allocation. Finally, this particular worry should disappear as a result of the recently proposed amendments to the ETS Directive. Unused authority to import credits during the second trading period can be carried over into the post-2012 period, but the limits in that period are foreseen as being lower (along with a lower cap) and subject to the negotiation of an international agreement or, in its absence, bilateral agreements with the EU. Although not formally stated, the clear intent is to signal to host countries that projects cannot last forever and that continued access to the EU market will require "graduation" to assuming emission reduction responsibilities and the creation of broader sector-level or national cap-and-trade systems that could link to the European or broader international system through mutual recognition.

V. Conclusion: The EU ETS in Perspective

Views about the EU ETS have been heavily influenced by a misunderstanding of what the 2005-2007 trial period was supposed to achieve and the limited goals for emissions reduction that were incorporated into the trial period caps. The primary goal of the trial period was to develop the infrastructure and to provide the experience to enable the successful use of a cap-and-trade system to limit European GHG emissions in 2008-12 and beyond. The 2005-2007 trial period was never intended to achieve significant reductions in CO_2 emissions in only three years. In light of the speed with which the program was developed, the many sovereign countries involved, the unexpected increase in natural gas prices affecting a partially liberalized electricity sector, the need to develop the necessary data and compliance procedures, and the lack of extensive experience with emissions trading in Europe, we think that the system has evolved surprisingly well.

Although there have been plenty of rough edges, a transparent price on tradable CO_2 emission allowances emerged as of January 1, 2005, a functioning market in allowances has developed effortlessly without any prodding by the Commission or member state governments, the trading infrastructure of markets, registries and monitoring, reporting and verification is in place, and a significant segment of European industry is incorporating the price of CO_2 emissions into their daily production decisions. The proof of the value of this experience will be seen as the just begun second trading period progresses. So far, all indications are that the trial period accomplished its goal. The EU ETS has evolved from being an engaging possibility in the 2000 Green Paper (EC, 2000) to being what is now regularly characterized as the flagship of the European Climate Change Program.

The EU ETS is also interesting because it provides some insights into the problems to be faced in constructing a global GHG emission trading system. This will be the next stage in global climate diplomacy if and when the U.S. adopts a cap-and-trade system. In imagining a multinational system, it seems clear that participating nations will retain significant discretion in deciding tradable national emission caps albeit with some negotiation; separate national registries will be maintained with some

arrangement for international transfers; monitoring, reporting and verification procedures will be administered nationally although necessarily subject to some common standard; and it seems doubtful that internal allocations will be "harmonized." As the world moves to develop and to link GHG trading systems, challenges similar to those characterizing the EU ETS will have to be confronted.

The deeper significance of the trial period of the EU ETS may be that its explicit status as a work in progress is emblematic of all climate change programs. Even when not enacted in haste, climate change programs will surely be changed over the long horizon during which they will remain effective. The trial period demonstrates that everything does not need to be perfect at the beginning. In fact, it provides a reminder that the best can be the enemy of the good. And this adage is likely to be especially applicable in an imperfect world where the income and wealth effects of proposed actions are significant and sovereign nations of widely varying economic circumstance and institutional development are involved. The initial challenge is simply to establish a system that will demonstrate the societal decision that GHG emissions shall have a price and to provide the signal of what constitutes appropriate short-term and long-term measures to take in limiting GHG emissions to the desired amounts. In this, the EU has done more with the ETS, despite all its faults, than any other nation or set of nations.

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Endnotes

1. Matters falling within EU jurisdiction are decided by a process that requires approval by both the Council of Ministers, representing the member states, and the European Parliament, whose members are elected by party slates presented to the citizens within each of the member states.

2. With the addition of Romania and Bulgaria in 2007, there are now 27 member states in the EU. There were 25 when the EU ETS began in 2005 and during most of the development of the enabling legislation, there were 15 member states (EU15).

3. In the case of an international agreement, the EU has committed to a 2020 reduction of 30 percent from the 1990 GHG emission level.

4. More specifically, the 1.74 percent factor would be calculated from the 2008-12 cap, starting in 2010 so that it would arrive at a 2020 level that is 21 percent below 2005 verified emissions in the EU ETS. When averaged over the proposed eight years, the third trading period cap would be about 11 percent lower than the second period cap, which is about 6 percent lower than 2005 verified emissions. The European Council goal concerns all GHG emissions in relation to 1990 levels while the proposed ETS amendments concern only CO_2 emissions within the trading sectors.

5. In 1998, the EU15 adopted a Burden Sharing Agreement (EU Council, 1998) that redistributes their uniform assigned amounts under the Kyoto Protocol of 8 percent below 1990 levels in a manner that takes differences in national circumstances into account. This redistribution ranges from + 27 percent for Portugal to – 28 percent for Luxembourg. (See also the discussion in chapter 2 of Delbeke (ed.)., 2006)

6. In addition to CO_2, the Kyoto Protocol includes emissions of methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

7. These sectors are iron and steel, cement and lime, refineries, pulp and paper, ceramics, glass, bricks and tile.

8. The annual emissions associated with this capacity threshold could vary from very little to as much as 40,000 metric tons for a coal-fired plant operating 75 percent of the time. The recently proposed amendments to the EU Emissions Trading Directive would change this threshold to allow installations with annual emissions less than 10,000 tons for three consecutive years to opt-out of the system provided certain other conditions are met.

9. There is no formal ban on banking between the trial period and the second trading period. This decision was left to the member states and all except France and Poland decided not to allow banking. Nevertheless, the Commission's statement of its assessment methodology for the review of the second period National Allocation Plans effectively negated these provisions by requiring that any banked EUAs be deducted from the second period cap.

10. Credits that are created outside of the flexibility mechanisms of the Kyoto Protocol, such as Verified Emission Reductions, cannot be used for compliance.

11. This amount is the greater of 10 percent or a percentage calculated by taking half of the largest disparity observed between the member state's Burden Sharing target and either the Kyoto baseline emissions (generally 1990), observed 2004 emissions, or the Commission's most recent projection of 2010 emissions for the member state.

12. For ease of expression and following common usage, member state totals are equivalently referred to as "caps." It must always be understood that these member state totals do not impose an absolute limit on emissions in any member state since the tradability of allowances issued by any member state is fundamental to the EU ETS. The only absolute limit is at the EU level and even there the Linking Directive would allow emissions to exceed the EU cap if properly offset.

13. A regulation is the strongest legal instrument in the EU in that it applies verbatim and does not allow for national interpretations.

14. For instance, per capita income for the richest member state of the EU (Ireland) is five times that of the poorest (Romania and Bulgaria) while the difference is only a factor of two in the U.S. (between Connecticut and Mississippi). In this comparison, the still higher income levels of Delaware and Luxembourg are not considered because of the small populations and tax-motivated concentration of corporate and financial activity in each.

15. In January 2008, Slovakia withdrew its challenge barely a month after the Commission granted a slight increase in its allowed total, although still far below the initial Slovakian proposal.

16. The 2007 data became available in April 2008 after the writing of this paper.

17. This is not to say that the two periods are hermetically sealed. CERs that are available by early 2008 could be used for first period compliance, but they are also bankable. With a price spread of nearly twenty euro between first and second period prices, all CERs available at the end of 2007 were banked for use in the second period. Also, economic possibilities to move the production of CO_2 intensive goods into the end of 2007 and to build inventory for sale in 2008 were exploited, as were opportunities to shift hydroelectric generation that would have otherwise occurred in late 2007 into early 2008.

18. The author of this typical but ill-timed example noted that the switching price was about €50 and that unless oil prices fell below $45 a barrel, "2008 allowances at €30/tonne may be quite a bargain."

19. The main distinction between OTC and exchange trading concerns guarantees of delivery and payment. Bilateral transactions, which may be arranged through the intermediary services of a broker, depend heavily upon the reputation of the contracting parties for assurance of delivery and payment. Exchanges are organized to guarantee payment and delivery to sellers and buyers who can then operate separately without knowing the identity or caring about the reputation of the counterparty.

20. Units which are long or short in one year tend to be so in the next year. Approximately 1900 installations or 21 percent were short in both years and 5700 installations (63 percent) were long in both years. Of the approximately 1450 installations that changed net positions between the two years approximately half went from being long to short and the other half, the opposite. The correlation coefficient for installation net position between the two years is +0.85.

21. Cf. "Spanish Parliament backs windfall profit tax on phase two EUAs" *Carbon Market Europe*, January 4, 2008, p. 5, and "UK energy regulator says utility windfall profit should go to poor customers" *Carbon Markiet Europe*, January 18, 2008, p. 4.

22. The total allowance value created by the SO_2 program is currently less than a tenth that of the EU ETS, or what is likely to be the value created by a U.S. GHG cap-and-trade program. At current prices of about €20 per metric ton, the value created by the EU ETS's annual cap of about 2 billion tons is approximately €40 billion per year, or about U.S.$60 billion at the current exchange rate. The value implied by a U.S. GHG system that is comprehensive (about 6 million short tons) and clears at a price of $10/ton is comparable. In contrast, the total value of the allowances created by the approximately 9 million ton SO_2 cap is about U.S.$4.5 billion at current allowance prices of about $500.

23. Although the potential for over-allocation has been emphasized in news reports concerning the Point Carbon study, the real message of that study is that the annual variability of emissions in the Northeastern U.S. is very high in relation to the cap and the expected reduction of emissions. The recent downward variation in emissions, experienced subsequent to the setting of the RGGI cap, has made the potential over-allocation evident.

24. A good example is provided by Spain. Its level of baseline emissions (2002-03) was already some 20 percent above its Kyoto/Burden Sharing Agreement target (which was itself 15 percent above 1990 emission levels), but its approved total for the trial period was about 5 percent above the 2002-03 level. Given Spain's rapid economic growth and accompanying increase of emissions, a target 5 percent above the 2002-03 level was expected to be less than actual emissions. As such, it was interpreted as heading towards the Path to Kyoto, if not being on it.

25. In the U.S. SO_2 and NOx trading programs, installation-level allocations are "benchmarked," not because the heterogeneity of production processes is any less but because of the existence of pre-existing standards of considerable institutional and legal force that could serve as the benchmark: the New Source Performance Standards established under various provisions and further regulatory implementation of the Clean Air Act Amendments of 1970. An accepted, pre-existing standard for CO_2 does not exist either in Europe or the United States.

26. Although the term "new entrant" is widespread, it refers to capacity not the owner of the new capacity. Most of the new or expanded facilities are built by existing companies.

27. Denmark's decision not to auction in the second period is explained mostly by the 27 percent reduction in its second-period cap compared to the trial period. In effect, one-fifth of that reduction was taken from the auction and the rest from the free allocation to installations.

28. It deserves note that Norway, which has been linked to the EU ETS since January 1, 2008, has been allowed to auction about half of its allowances instead of having to observe the 10% limit on auctioning that is imposed on the 27 member states of the EU during the 2008-12 period. Norway's high level of auctioning reflects the inclusion in the Norwegian cap of the Norwegian off-shore oil industry that had previously been subject to a $50/ton tax on CO_2 emissions.

29. The tightened SO_2 cap is not related to the acid rain problem that motivated the original SO_2 cap-and-trade program. Instead, states have been offered the opportunity, and they have chosen, to use the existing cap-and-trade infrastructure to meet SO_2 emission reduction requirements motivated by concerns about the effects of micro-particulate emissions on human health.

30. A similar extreme upward price excursion occurred in the Los Angeles NOx RECLAIM Program in late 2000, when the price of allowances went from about $5,000/ton to a peak reported price of more than $70,000 in the space of a few months (Harrison, 2004; Ellerman, Joskow and Harrison, 2003). The causes of this price spike have been well studied and are well understood (Joskow and Kahn, 2002). The absence of banking or borrowing in the RECLAIM program and its very limited geographic scope prevented any supply side adjustment when the California electricity crisis of 2000 placed unprecedented demands on old and little used gas-fired peaking units in Los Angeles with no emissions controls.

31. Fluctuations of a few euro cents around an average price of less than €0.10, as has been the case for much of 2007, will yield very high volatility measures.

32. Secondary CERs are deemed to be virtually equivalent to EUAs in that project and certification risk has been resolved. The primary market refers to CERs from projects that are in an earlier stage of development and still bear these risks.

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This report evaluates the initial trial phase of the EU Emissions Trading System and provides lessons for the EU moving forward as well as for the development of cap-and-trade programs in the United States. The Pew Center on Global Climate Change was established in 1998 in order to bring a new cooperative approach to the debate on global climate change. The Pew Center continues to inform the debate by publishing reports in the areas of policy (domestic and international), economics, environment, and solutions.

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