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Policy Suggestions for Emissions Trading in the U.S.A.

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Light Pollution in the U.S. [1]

Abstract

This honors thesis will examine current and theoretical "cap and trade" emissions trading schemes in an attempt to make recommendations on how to improve this regulated commodity market. The various control mechanisms available to regulators will be discussed: including allocation methodology, benchmarking, banking, variation in design frameworks, etc. To aid and support the proposed policy recommendations, this paper will investigate the design framework of the SOx emission trading scheme in the US, the Kyoto Protocol, and the European Union Emissions Trading Scheme (ETS). The political, social, and economic context of these schemes will be taken into account when considering the policy impact of each design framework.

After this discussion is complete, this paper will propose recommendations on the design and implementation of a domestic 'cap and trade' scheme. Possible control mechanisms for a design framework will be recommended. In addition, a relatively new component of the "cap and trade" scheme will be introduced. This paper will propose the creation of a congressionally appointed committee to oversee the carbon allowances market in a theoretical U.S emissions trading scheme. Its objective will be to: (1) prevent dramatic short-term flux in allowance values; (2) provide politically shielded oversight capabilities; (3) assess the impact of the domestic design framework; (4) update allowances when new information becomes available; (5) encourage 'green' technology implementation and R&D; (6) raise investor confidence in a cap and trade scheme.

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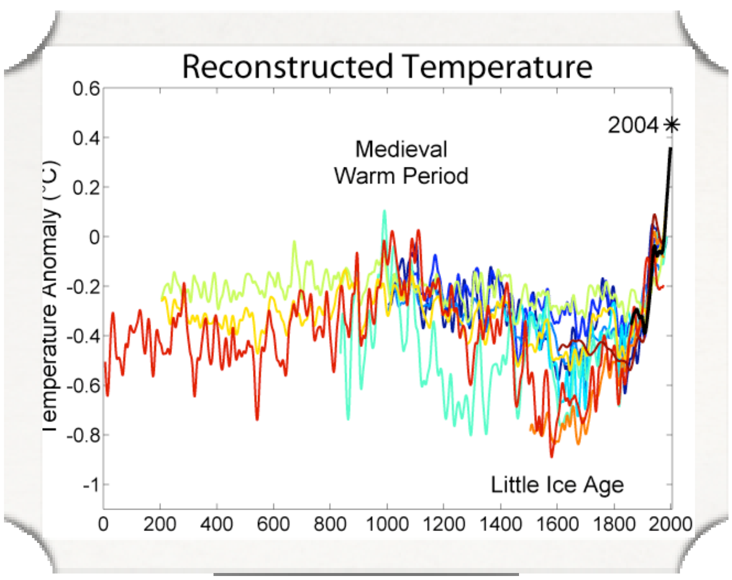
Introduction

Climate Change and CO_2 Concentrations

According to the International Panel on Climate Change (IPCC), global surface temperatures increased 1.33 (+/- 0.32) • during the 20th century.[2] The panel attributed most of the observed temperature increase since the mid 20th century to human activity, stating that causality was "very likely."[2] The IPCC report demonstrates that current trends are the result of Earth's climate responding to variations in atmospheric composition, namely variations in greenhouse gas concentrations (water vapor, CO_2, CH_4, O_3, etc.).[2] It goes on to indicate that global surface temperatures will raise another 2.0 - 11.5 • during the 21st century, which will have severe implications for most of the global population. These findings have sparked an intense debate on the proper course of action to mitigate or prevent the negative implications of the predicted increase in temperature.[2]

Figure 1.1- Temperature trends over the past 2000 years. [3]



Global concentrations of carbon dioxide have increased by 36% since 1750, from 280 parts per million to 382 ppm in 2006.[4] CO_2 concentrations are currently increasing at a rate of 1.9 ppmv/year, with almost all of the observed increase in carbon dioxide due to human

activities.[2] According to the EPA, "the radiative forcing contribution (since 1750) from increasing concentrations of well-mixed greenhouse gases (including CO2, CH4, N2O, CFCs, HCFCs, and fluorinated gases) is estimated to be +2.64 Watts per square meter - over half due to increases in CO2 (+1.66 Watts per square meter)."[4] This finding is significant because it demonstrates that greenhouse gases cause climate change. In addition, it shows that the majority of the greenhouse gas effect is due to rising CO2 concentrations.

Domestic Emissions

Although climate change is global in scope, there is much domestically that can be done to address the problem. The United States emits 5,752,289 thousand metric tons annually of carbon dioxide, accounting for 20.2% of global CO2 emissions.[5] Fossil fuel use from stationary sources accounts for ~ 50% of these emissions. Thus by targeting only stationary sources, the U.S. can potentially reduce world CO2 emissions by 10%. Per capita emissions for U.S. citizens weigh in at 18.99 metric tons CO2/year- roughly 77% higher than the world average.[5] As a major contributor (in both gross and per capita emissions) to the current increase in greenhouse gases, we have a responsibility to the global community to reduce our emissions as much as possible. It is a moral imperative for the U.S. to act, if not lead, in the fight against climate change.

In addition to the moral and ethical considerations, there are several ancillary benefits from reducing our carbon "footprint," including potentially significant health, ecosystem, water quality, and air quality benefits. In the U.S, fine particulate matter emitted by fossil fuel burning power plants results in over 30,000 deaths per year (which is significant when compared to the drunk driving death rate of ~ 16,000/year).[6] This pollution also causes more than 600,000 asthma attacks per year, some of which result in hospitalizations. All told, the health costs of

fossil fuel use for electric generation total in excess of $100 billion/year. This number excludes the costs resulting from the 48 tons of mercury and 71.1 million tons of fly ash produced annually by coal power plants.[7] For a complete cost benefit analysis of potential ancillary benefits, please refer to source.[8] These costs, combined with the discounted potential benefits of combating climate change, add up to a significant increase in societal welfare if action is taken to reduce/eliminate fossil fuel use.

Legal Ramifications

The legal ramifications of combating climate change must be considered before action is taken to reduce domestic emissions. In 2007, the Supreme Court ruled in the case Massachusetts v. the Environmental Protection Agency that the regulation of greenhouse gases was required by the Clean Air Act.[9] The Court further required the EPA to review its contention to forgo regulating greenhouse gases, forcing the agency to provide a stronger rationale before pursuing inaction.[9] Many sources, including those inside the EPA, believe that agency is "ill-suited for the task of regulating global greenhouse gases."[9] In other words, an alternative to EPA regulation is preferable in regards to regulating GHG emissions. The EPA would be excused from the responsibility of regulating greenhouse gases if the U.S. Congress passes legislation to perform this task.

The best legislative option for reducing greenhouse gas emissions is currently under much debate. This paper will attempt to shed some light on this issue by presenting the most prominent emissions reduction strategies and demonstrating that an emissions quota is the most politically feasible approach. It will then examine current and theoretical cap and trade schemes in global and domestic markets including: the Kyoto Protocol, the EU-ETS, and the

SOx market in the U.S. in order to recommend a design framework that will ensure an efficient and successful implementation of a domestic cap and trade scheme.

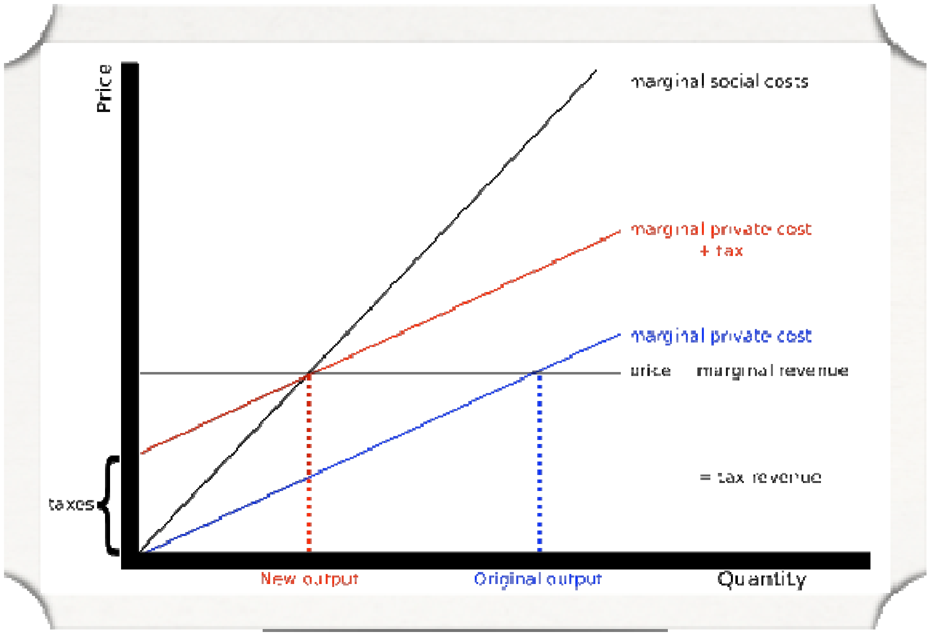
Emission Reduction Strategies

A variety of strategies have been proposed to reduce emissions from stationary sources- the most prominent of which are an emission tax and an emissions quota.

Emissions Tax

A GHG emissions tax is an indirect tax on any regulated activity that produces GHG emissions. It functions as a price instrument, adding a transaction cost to emissions causing activities, thus raising the marginal cost of emissions to a socially appropriate level. An emissions tax is considered a Pigovian tax, which is used to correct for market failures in the event of a negative externality. In this case, the market fails to take into account the societal and environmental costs of GHG emissions, graphically:

Figure 2.1: Pigovian Tax [3]



-A Pigovian tax shifts the marginal private cost curve up by the amount of the tax. Faced with this cost increase, the producers have an incentive to reduce output to the socially optimum level by reducing the marginal externality to the marginal tax. The total tax revenue (which could be used to mitigate the effect of the negative externality) is equal to the size of the tax times the new output (the shaded area).[3]

Unfortunately, in today's economy an additional carbon tax may be unpalatable. This has prompted the Environmental Defense Fund to believe "[the chances of] passing a new (emissions) tax fall somewhere between zero and nil."[10] An alternative to the emissions tax is an emissions quota, or "cap and trade."

Cap & Trade

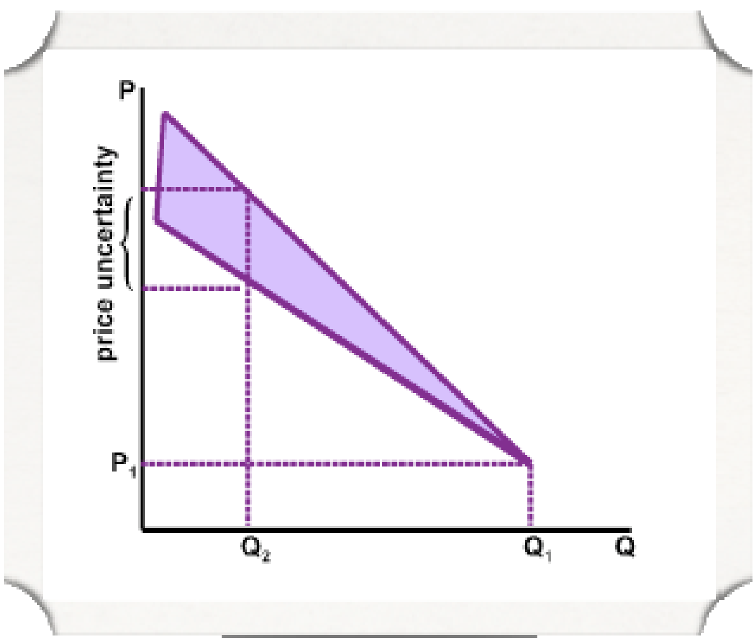
From the EPA website: "Cap and trade is an environmental policy tool that delivers results with a mandatory cap on emissions while providing emission sources flexibility in how they comply."[4] It is an administrative approach to control emissions that is based on economic

incentives. Cap and trade has the potential to provide environmental accountability without inhibiting economic growth.

In a cap and trade policy, the administration sets an overall cap on emissions per compliance period for sources of a targeted pollutant. Emissions allowances are then allocated to these sources, with the total number of allowances never exceeding the cap. At the end of each compliance period each source is required to report all emissions for the targeted pollutant and then relinquish a number of allowances equal to emissions. Allowance trading allows firms to comply by exchanging credits on a regulatory market.

From an economic standpoint, Cap and Trade functions as a quota instrument- a cap is set on emissions quantities, allowing price to be determined by market forces.

Figure 2.2 Cap and Trade[11]



Referencing figure 2.2, quantity is restricted in a cap and trade scheme from the value Q1 to value Q2. This restriction alters price from P1 to P(2/3), resulting in the same end result as shown in figure 2.1 from a Pigovian tax, with social costs equal to private costs on the margin. By restricting quantity in lieu of a tax, a quota relieves the regulating body from determining the appropriate price at which social and privatized costs are equal. Given the many differing opinions in the scientific community on the desirable level of allowance prices, many policy advocates argue that cap and trade is the only practical solution to combating climate change.[8, 12-17]

A cap and trade program attempts to minimize the private and social costs of reducing greenhouse gas emissions. For this objective to be realized, the administrator must ensure the scheme results in real emissions reductions without causing undue economic and regulatory hardship on participating industries. With this in mind, there are four distinct potential outcomes that may come from instituting a cap and trade scheme.[18]

1. The scheme imposes no significant costs upon economic activity, causing little reduction in GHG emissions. There is no change in consumer or producer surplus. (status-quo)

2. The scheme succeeds in imposing significant costs upon some parties, but the costs are passed-through to the end user. This price hike increases the demand for lower cost alternative fuels, which gain market share and help to reduce GHG emissions. (win-lose) Producer surplus is increased at the cost of consumer surplus, yet social surplus still exceeds the dead weight loss caused by this alteration.

3. The scheme imposes costs on generators, but the costs are passed-through to the end user. Alternative fuel sources are not supplied, resulting in higher consumer costs without any

reduction in GHG emissions. Producer surplus is increased at the expense of consumer surplus, resulting in no change in social surplus and an increase in dead weight loss. (lose-lose)

4. The scheme imposes costs on generators, who then modify their behavior to avoid the potential costs of emitting past available allowances. GHG emissions are decreased without generating undue consumer or producer surplus. Social surplus is maximized by minimizing dead weight loss. (win win)

Figure 2.3 Potential Outcomes

	Outcome 1	Outcome 2	Outcome 3	Outcome 4
Consumer Surplus	Not Affected	Decreased	Decreased	Not Affected
Producer Surplus	Not Affected	Increased	Decreased	Not Affected
Social Surplus (Net Benefits to Society)	Not Affected	Increased	Decreased	Increased
Dead Weight Loss	Not Affected	Significant, but SS still +	Significant	Minimized

The administrator should attempt to ensure that the domestic cap and trade scheme implemented results in outcome 4, as this satisfies the stated goals of a domestic cap by utilizing the most cost effective and efficient approach. There are a number of control mechanisms and policy options available for this purpose.

Control Mechanisms

There are several different control mechanisms administrators have at their disposal to regulate the allocation and trade of allowances:

- Upstream v. Downstream Allocation: In an upstream cap and trade system, allowances are given to emission producers, importers, and other generators. In a downstream system, allowances are given to the end-user, or consumer.[12]
- Phase-in Program: A phased implementation approach enlists firms into the domestic scheme over the course of set project timetable. Large emitters are regulated initially, with coverage expanding to a point set by the administrator. This approach can help to alleviate the difficulty in implementing a large system at once.[12]
- Opt-in Program: An opt-in approach allows for firms to voluntarily participate in the scheme on a permanent or project-by-project basis. Opt-in sources must publish baseline emissions and have an adequate monitoring plan to be allowed to participate.[12]
- Buyer v. Seller Liability: The administrator must determine standing in terms of legal liability for verification and reporting of allowances. Seller liability puts monitoring and reporting requirements on the seller. Buyer liability means the buyer is liable in the event of fraudulent or counterfeit credits. The legal term for buyer liability is Caveat Emptor.
- Grandfathering v. Auctioning Allowances: The administrator must choose between grandfathering and auctioning permits to permit holders. Grandfathering schemes award existing firms allowances based on historical and current data. New sources generally must purchase allowances from these firms to enter the market. Auction schemes adopt a pay-to-play approach, where firms bid for allowances on an open market. Existing firms are not awarded for historical production levels.

- Output based allocation: Allowances are allocated based on production levels. This method does not create scarcity rents since it provides no incentive to raise the price-cost margin.
- Allowance Banking: The administrator may allow firms to bank and borrow permits across compliance periods. This will enable firms to better address short term cost concerns.

Addressing Price Uncertainity

The goal of a cap and trade scheme for GHG emissions is to reduce emissions in a way that minimizes costs and maximize benefits for a given society. It seeks to correct the market failure that occurs when negative externalities are not accounted for in the traditional market. For a successful domestic policy to be implemented, a cap and trade scheme must instill investor confidence by providing a degree of certainty in allowance prices. This confidence is vital for minimizing the economic impacts and costs of any proposed cap and trade scheme.

Uncertainty in allowance prices can come from a variety of factors. In the short-term, demand may vary as a result of fluctuating emissions. Baseline GHG emissions will change year to year due to a variety of factors, including weather, economic activity, energy supply, etc. [14] Short term supply will also vary due to the fluctuating availability of allowances. Both volume and price of available allowances are subject to uncertainty caused by regulatory change, supply constraints, estimation errors, and natural variation.[14] In the long run, allowance prices can significantly deviate from expected values as a result of unforeseen technological or economic variation.[14] These inherent uncertainties must be overcome if an efficient domestic cap and trade policy is to be implemented.

There are several policy options for addressing uncertainty in allowance prices, including:

- Establish a committee to review program targets and timetables every compliance cycle. This committee will have the authority to change these targets if long-term abatement costs prove different than expected. [14]

- Increase public investment in green technologies. This will signal to investors that the government is willing to substantially back the emissions quota scheme. [14]

- Allow banking and borrowing of credits to reduce potential excessive price volatility. [14]

- Establish a Safety Valve or explicit limit on future program costs. This functions as a price ceiling on the allowance markets, meaning that if costs rise above this ceiling emissions will be governed by price rather than quantity constraints and emissions will rise above the cap. [14]

- Establish an Allowance Reserve. This reserve would hold a pool of allowances, in addition to and separate from the current-year emissions budget, that could be drawn upon to temporarily expand supply if specified market conditions are met. [14]

- Establish a Carbon Market Board. [14] This board would have discretionary authority to intervene in GHG allowance markets to ensure smooth functionality. It would be set up as an independent agency, separate from Congress and the administration. The specifics of this board will be discussed later.

From the variety of options presented in this section, it becomes clear that there are multiple possible combinations and levels of control available to the administrator. However, it is not clear which combination of the above variables will give the greatest possible chance for outcome 4, the win-win situation. We will now explore the effect of the design framework of current emissions quota markets on market functionality and efficiency. From this, we will

qualitatively select the most desirable variables to be included in a domestic scheme. The political, economic, and social context of these frameworks will also be considered in order to provide comparative context for a potential domestic scheme. This contextual information will provide an overview of potential obstacles that a domestic scheme will have to overcome in order to ensure congressional consideration. A CBA of each of the above variables on a domestic scheme and a stakeholder analysis of this project are both excellent future research opportunities for those interested.

The Kyoto Protocol

Introduction

In the 1990's many countries joined the United Nations Framework Convention on Climate Change to address the growing concern over climate change and global warming. The Kyoto Protocol was the brain child of this coalition, initially adopted on December 11, 1997 in Kyoto, Japan and effective as of the 16th of February, 2005.[19] The Protocol is an international treaty to reduce GHG emissions.

The objective of this protocol is the "stabilization and reconstruction of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."[19] To do this, the protocol established a legally binding international agreement which required participating nations to reduce GHG emissions by 5.2% from 1990 levels by the year 2012. [19] This target dropped to about 2% after the 2000 review conference in The Hague.[20] The four greenhouse gases regulated under Kyoto are CO_2, CH_4, NOx, and sulphur hexafluoride. [19] Only Annex 1, or industrialized nations, are required to meet these emissions quotas, and international aviation and shipping are excluded from this treaty. [19]

As of November 2009, 37 Annex 1 countries and 187 states have signed and ratified the protocol. [19]

The five principal concepts of the Kyoto Protocol are: [19]

- Commitments to reduce greenhouse gases that are legally binding for annex I countries, as well as general commitments for all member countries;
- Implementation to meet the Protocol objectives, to prepare policies and measures which reduce greenhouse gases; increasing absorption of these gases and use all mechanisms available, such as joint implementation, clean development mechanism and emissions trading; being rewarded with credits which allow more greenhouse gas emissions at home;
- Minimizing impacts on developing countries by establishing an adaptation fund for climate change;
- Accounting, reporting and review to ensure the integrity of the Protocol;
- Compliance by establishing a compliance committee to enforce commitment to the Protocol.

Design Framework

Emission targets for industrialized country Parties to the Kyoto Protocol are expressed as levels of allowed emissions, or "assigned amounts", over the 2008-2012 commitment period. Such assigned amounts are denominated in tons (of CO_2 equivalent emissions). [19] Industrialized countries must first and foremost take domestic action against climate change, but the Protocol allows them a certain degree of flexibility in meeting their emission reduction commitments through three innovative market-based mechanisms. [19]

To participate in these mechanisms, Annex I Parties must meet, among others, the following eligibility requirements:

- They must have ratified the Kyoto Protocol.
- They must have calculated their assigned amount in terms of tons of CO2-equivalent emissions.
- They must have in place a national system for estimating emissions and removals of greenhouse gases within their territory.
- They must have in place a national registry to record and track the creation and movement of ERUs, CERs, AAUs, and RMUs (explained later) and must annually report such information to the secretariat.
- They must annually report information on emissions and removals to the secretariat.

Kyoto Mechanisms [19]

The three Kyoto mechanisms are: Emissions Trading – known as "the carbon market" – the Clean Development Mechanism (CDM) and Joint Implementation (JI). [19] The carbon market spawned by these mechanisms is a key tool in reducing emissions worldwide. It was worth 30 billion USD in 2006 and is set to increase. [19]

JI and CDM are the two project-based mechanisms that feed the carbon market. JI enables industrialized countries to carry out joint implementation projects with other developed countries (usually countries with economies in transition), while the CDM involves investment in sustainable development projects that reduce emissions in developing countries. [19]

The mechanism known as "joint implementation," defined in Article 6 of the Kyoto Protocol, allows a country with an emission reduction or limitation commitment under the Kyoto

Protocol (Annex B Party) to earn emission reduction units (ERUs) from an emission-reduction or emission removal project in another Annex B Party, each equivalent to one tonne of CO_2, which can be counted towards meeting its Kyoto target.

Joint implementation offers Parties a flexible and cost-efficient means of fulfilling a part of their Kyoto commitments, while the host Party benefits from foreign investment and technology transfer. A JI project must provide a reduction in emissions that is additional to what would otherwise have occurred. Projects must be approved by both parties to be authorized to participate by a Party involved in the project. Projects starting in 2000 and later are eligible for JI status, for ERU's the start date is 2008.

If the host party is eligible to transfer/acquire ERUs, it is allowed to verify JI projects and issue the appropriate quantify of ERUs. This procedure is commonly referred to as the "Track 1" procedure. If a host Party does not meet all, but only a limited set of eligibility requirements, verification of emission reductions or enhancements of removals as being additional has to be done through the "Track 2" procedure. In "Track 2," an independent entity accredited by the JISC has to determine whether the relevant requirements have been met before the host Party can issue and transfer ERUs. A host Party which meets all the eligibility requirements may at any time choose to use the verification procedure under the JISC (Track 2 procedure).

The Clean Development Mechanism (CDM), defined in Article 12 of the Protocol, allows a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol (Annex B Party) to implement an emission-reduction project in developing countries. Such projects can earn salable certified emission reduction (CER) credits, each equivalent to one ton of CO_2, which can be counted towards meeting Kyoto targets. It is the first global,

environmental investment and credit scheme of its kind, providing a standardized emissions offset instrument, CERs. A CDM project must provide emission reductions that are additional to what would otherwise have occurred. The projects must qualify through a rigorous and public registration and issuance process. Approval is given by Designated National Authorities. Public funding for CDM project activities must not result in the diversion of official development assistance. The mechanism is overseen by the CDM Executive Board, answerable ultimately to the countries that have ratified the Kyoto Protocol. Operational since the beginning of 2006, the mechanism has already registered more than 1,650 projects and is anticipated to produce CERs amounting to more than 2.9 billion tons of CO2 equivalent in the first commitment period of the Kyoto Protocol, 2008–2012 .

Registry Systems [19]

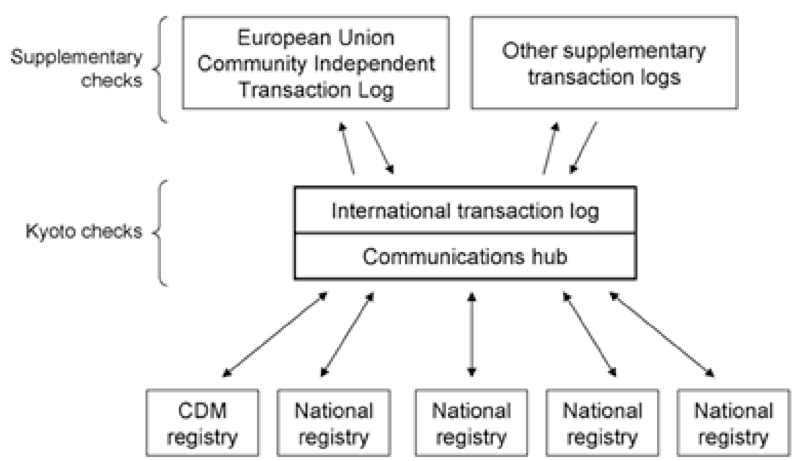
The ability of Parties to add to their holdings of Kyoto units (e.g. through credits for CDM or LULUCF activities) or move units from one country to another (e.g. through emissions trading or JI projects) requires registry systems that can track the location of Kyoto units at all times. Two types of registry are being implemented:

- Governments of the 38 Annex B Parties are implementing national registries, containing accounts within which units are held in the name of the government or in the name of legal entities authorized by the government to hold and trade units.
- The UNFCCC secretariat, under the authority of the CDM Executive Board, has implemented the CDM registry for issuing CDM credits and distributing them to national registries. Accounts in the CDM registry are held only by CDM project participants, as the registry does not accept emissions trading between accounts.

In addition to recording the holdings of Kyoto units, these registries "settle" emissions trades by delivering units from the accounts of sellers to those of buyers, thus forming the backbone infrastructure for the carbon market.

Each registry will operate through a link established with the International transaction log put in place and administered by the UNFCCC secretariat. The ITL verifies registry transactions, in real time, to ensure they are consistent with rules agreed under the Kyoto Protocol. The ITL requires registries to terminate transactions they propose that are found to infringe upon the Kyoto rules.

Figure 3.1 Registry Diagram [19]



In verifying registry transactions, the ITL provides an independent check that unit holdings are being recorded accurately in registries. After the Kyoto commitment period is finished, the end status of the unit holdings for each Annex B Party will be compared with the Party's emissions over the commitment period in order to assess whether it has complied with its emission target under the Kyoto Protocol.

In order to address the concern that Parties could "oversell" units, and subsequently be unable to meet their own emissions targets, each Party is required to maintain a reserve of ERUs,

CERs, AAUs and/or RMUs in its national registry. This reserve, known as the "commitment period reserve", should not drop below 90 per cent of the Party's assigned amount or 100 per cent of five times its most recently reviewed inventory, whichever is lowest.

Reporting Requirements [19]

The Kyoto Protocol's effectiveness is dependent upon two critical factors: whether Parties follow the Protocol's rulebook and comply with their commitments; and whether the emissions data used to assess compliance is reliable. Recognizing this, the Kyoto Protocol and Marrakesh Accords, adopted by CMP 1 in Montreal, Canada, in December 2005, include a set of monitoring and compliance procedures to enforce the Protocol's rules, address any compliance problems, and avoid any error in calculating emissions data and accounting for transactions under the three Kyoto mechanisms (emissions trading, clean development mechanism and joint implementation) and activities related to land use, land use change and forestry (LULUCF).

The Protocol's monitoring procedures are based on existing reporting and review procedures under the Convention, building on experience gained in the climate change process over the past decade. They also involve additional accounting procedures that are needed to track and record Parties' holdings and transactions of Kyoto Protocol units - assigned amount units (AAUs), certified emission reductions (CERs) and emission reduction units (ERUs) - and removal units (RMUs) generated by LULUCF activities.

Articles 5, 7 and 8 of the Kyoto Protocol address reporting and review of information by Annex I Parties under the Protocol, as well as national systems and methodologies for the preparation of greenhouse gas inventories.

Enforcement

UNFCCC is charged with the authority to regulate participants in the Protocol. If the enforcement branch determines that an annex I country is not in compliance with its emissions limitation, then that country is required to make up the difference plus an additional 30%. In addition, that country will be suspended from making transfers under an emissions trading program. [19] This is designed to provide a check on illicit behavior in the emissions trading scheme.

Summary

First, I would like to thank the UNFCCC website for their detailed explanations of the design framework of the Kyoto Protocol. The mechanism, registry, and reporting requirements are listed in full on their website- the above summary is not exhaustive.

In essence, The Kyoto Protocol is an international agreement based on upstream, grandfathered allocation of credits, which are measured in gross tons of eCO_2. Allowances are not based on output. The treaty is set up as completely voluntary, thus it is an opt-in program, with UNFCCC participating countries allowed to "phase-in" upon ratification of the treaty. With all the monitoring and reporting requirements, the protocol instills seller liability in the market. Price uncertainty mechanisms, such as safety valves, banking, etc, are largely left to the individual countries for implementation. The only uncertainty mechanisms in the protocol are: the commitment period reserve; (discussed above) and the exhaustive monitoring and reporting requirements overseen by the CDM executive board and the member Annex 1 countries.

In the next section, the economic impact of the Kyoto Protocol will be discussed and a determination will be made on if the protocol fulfilled its objectives. This information will enable a qualitative selection of "best" quantity, allocative, uncertainty, and price controls for a

domestic scheme. The potential impact of international trading on a domestic scheme will also be discussed.

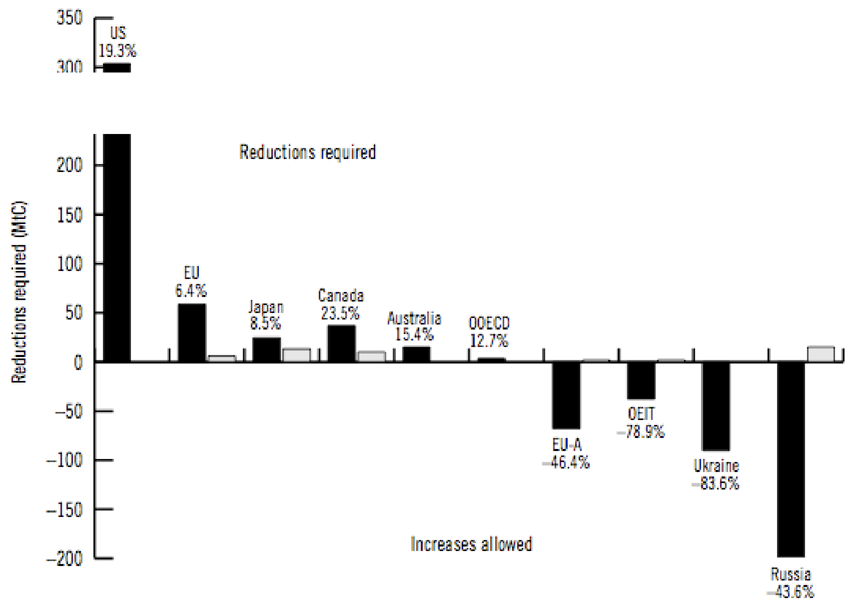
Policy Impact

Unfortunately, the Kyoto mechanisms have failed to deliver any real reduction in GHG emissions, accounting for a trivial 2 ppm drop in CO2 concentrations.[20, 21] Where emissions reductions have happened, they were typically the result of unrelated policies. In the former communist countries of Eastern Europe, the collapse of highly inefficient polluting industries reduced emissions.[20] In Britain, the government substitution of coal with North Sea gas significantly reduced reliance on coal power and its associated GHG emissions.[20] Most annex one countries have actually increased emissions since becoming a signatory, achieving required reductions almost exclusively through: surplus credits in Eastern Europe annex one countries, JI, and CDM mechanisms.[20] The cumulative result of these projects is a predicted ~ 20 ppm drop in CO_2 concentrations by 2050, causing a 0.3 • decrease in temperature. [21] Barely a drop in the bucket.

The protocol failed due to at least three major factors: the withdrawal of the U.S.; revision of Russian/Ukrainian/Eastern Europe energy projections which greatly increased their projected allowance surplus; and the subsequent Bonn/Marrakech deal on carbon sinks.[22] The relative impact of these events can be represented by the diagram below:

Figure 3.2 Kyoto commitments and Trading Potential[22]

Figure 4: Kyoto commitments and trading potential



Note: The main (single or larger) bars show the gap between 2000 emissions and Kyoto commitments for the principal countries/groups in Annex I. The smaller bars alongside show the maximum allowance that each can claim for carbon absorbed from managed forests under the Marrakech Accords (excluding the US which is not included in that agreement), which can in effect be deducted. % numbers show the percent cut required to get from current levels to the Kyoto targets (−ve numbers indicate the corresponding % growth from current levels for EITs).

Key: EU-A = the 10 EU candidate countries heading for early accession. OEIT = the 5 other countries applying for EU membership. OOECD = all other OECD countries. Data represent CO_2 total national emissions.

Source: 2000 emission data: Energy Information Administration, USA

Figure 3.2 represents observable data on the potential supply-demand balance in 2000. [22] The main bars show the gap between countries' emissions and their Kyoto allocation. US emissions in 2000 would have to be reduced by 19.3 % to reach their Kyoto allocation, while Russia would have a headroom of ~ 200 MtC (Kyoto Allocation = 7% of 1990 levels). In fact, the headroom of eastern annex one countries was about as large as the shortfall of western annex one countries, providing an aggregate emissions equal to 5.2% below 1990 levels--- albeit with a tremendous east-west discrepancy. [22]

This balance was completely disrupted in 2001, mainly due to the three factors highlighted above. Inefficient Eastern European economies were collapsing; the Marrakech Accords granted countries a certain allowance of carbon sinks from managed forests as shown in Figure 4, flooding the market with non-additional offsets; and the U.S. declined to ratify the Protocol. The result of these factors was to leave a tremendous potential supply set against reduced demand. [22] The relative impact of these three different elements varies between studies, yet all acknowledge that the withdrawal of the US was the primary factor. [22] This imbalance caused the price to comply with the Protocol to become negligible for annex one countries, resulting in almost no GHG emission reductions.

The CDM and JI mechanisms contributed to this imbalance by flooding the market with CERs and ERUs. The design of these mechanisms enabled annex one countries to achieve reductions at lower cost than the depreciated trading market, further crippling the protocol. This excessive use of flexibility mechanisms also increased the incentive for fraudulent transactions. One glaring example is refrigerant (HCFC) CDM trading in Annex 2 countries. "Carbon-trading expert Michael Wara calculates that Asian HCFC manufacturers can earn almost twice as much from Kyoto CDM credits for scrubbing HFC-23 as they can from selling refrigerants, providing a perverse incentive to increase their production. He also estimates that under the CDM, manufacturers will be paid $800 million for HFC abatement, while the cost to manufacture is only $31 million."[20] This example is not isolated to refrigerants, one study projects that CDM activity could have potentially directed as much as 250-600 MtC of GHG 'abatement' to fraudulent activities. [22]

With tremendous supply demand imbalance, it becomes clear why the protocol failed. The question now is- why was it so sensitive to these factors? An international agreement should

have been robust to macroeconomic risk factors. It also should have been able to continue even if an annex one country reneged on ratifying the Protocol-- it was not. The answer to this question lies in the politics of this treaty.

The political foundation for the Kyoto Protocol was tumultuous by all accounts. The Protocol was adopted "against a background of hugely disparate perspectives concerning the urgency of action, the costs of limitations, and the appropriate instruments."[21]. There were tense negotiations over which countries would be responsible for mitigating GHG emissions. Eventually, the council reached an agreement that charged the industrialized countries (annex one) with assuming all costs for reducing global GHG emissions because of their high gross and per capita emissions [21]. The council implicitly assumed that as countries developed they would be brought into the system over time, thus the global problem of climate change was to be addressed with a global solution. This implicit assumption caused the council to base the success of the agreement on collective cooperation and participation with the protocol. Thus, if any annex one country decided to not commit, the resulting imbalance could cause it to fail.

In an attempt to gain unanimous support for the treaty, the protocol's emission targets were crafted to gain as many signatories as possible. This 'lowest common denominator' approach was the council's attempt to ensure that all annex one countries remained committed through the ratifying process. To satiate all committed annex one countries, the council agreed on the following compromises:

- Allocation of credits based on 1990 levels: By distributing credits on historical data, rather than allowing quantities to be tied to output (output-based allocation) the council opened the carbon market to a variety of macroeconomic risk factors including: fossil fuel prices, commodity prices, the consumer price index, economic recession, etc. When credits are tied

to output, "Carbon futures are only remotely connected to macroeconomic risk factors. The results are robust to the introduction of energy and institutional variables, which have been identified as determinants of CO2 price variation in previous literature, and to a wide range of sensitivity tests. Price fundamentals on the carbon market are essentially a function of allowance supply." (ref ID 68)

- Allowing JI and CDM flexibility mechanisms in addition to emissions trading: The JI and CDM flexibility mechanisms undermined the carbon market by providing lower cost alternatives to emissions trading. This depreciated the already imbalanced market by flooding it with alternative, lower cost supply.
- Limited enforcement capabilities: The limited enforcement capabilities of the council was shown to be an insufficient deterrent for counties in non-compliance.[21] This lack of enforcement allowed fraudulent CDM and JI activities to occur and allowed the free-rider problem to become statistically significant in the treaty. [21]
- Delegating market controls and allocative control to the ratifying countries: By delegating this control, the council allowed credit costs and controls to be heterogeneous across countries. This heterogeneity, checked in part by the registry and reporting requirements discussed above, allowed for some countries to gain a competitive advantage in the carbon market. This advantage served to undermine the treaty's objectives by creating a perverse incentive to design a 'least' cost, inefficient (in terms of emissions reductions) framework for allocation and control.

These compromises had severe implications on the design framework of the treaty, resulting in a commitment that was incapable of fulfilling its objectives. When crafting a

domestic scheme, it is important to learn from the mistakes in the design framework of the Protocol, so that a U.S. scheme is not sensitive to the same risks as the international treaty.

The European Union Emissions Trading Scheme (EU ETS)

Introduction

The EU ETS is the agreement adopted in 2005 by member countries of the European Union to achieve compliance with the Kyoto Protocol. It was the first cross-border tradable permit scheme to address GHG emissions, coordinating the efforts of 25 nations and over 9,000 installations across the EU [18, 23]. The cap and trade model adopted by this scheme was designed to minimize the overall cost of reducing GHG emissions while still achieving the goals set forth by the Kyoto Protocol.

The scheme was the result of intense negotiations between the European Commission, stakeholders, the Council of Ministers, and the European Parliament. To raise support for the EU ETS, the Commission sponsored research with the University of Gothenburg, the Center for Clean Air Policy (a Washington D.C. and Brussels based environmental think-tank), the University of Athens, and the Institute for Prospective Technological Studies[18]. These teams investigated the impact and likelihood of success of the EU ETS on reducing GHG emissions to Kyoto limits. After their collective findings were presented to the Commission, the EU ETS was adopted unanimously by the Council of Ministers and by a large majority in the European Parliament.[23]

In addition to EU endorsement, the scheme enjoyed widespread support from NGO's and industry professionals.[23] This support was the result of allocative and control compromises that were favorable to large generators of GHG emissions. The nature of these agreements will be discussed in the design framework, below.

Design Framework

The EU ETS is a decentralized, heterogeneous approach to cap and trade. Under the scheme, the holder of one allowance (EUA) is granted the right to emit one ton of CO_2. The amount of EUA allocated to each generator are set by National Allocation Plans (NAPs) prepared by the Member States and approved by the European Commission.[23] The EU Commission is responsible for oversight and enforcement, leaving allocative and 'cap-setting' control to each Member State. The five sectors covered under the scheme are: Power and Heat Generation, Oil Refineries, Metals, Pulp and Paper, and Energy Intensive Industry. Only large generators in these sectors are subject to regulation, which cumulatively account for ~40% of annual EU emissions. The definition of 'large' generators is determined on a state-by-state basis as specified by their respective NAP. NAPs must be renewed by the Member States for each trading period. The first trading period was from 2005-2007, the second one from 2008-2012, and the third period will start in 2013.

National Allocation Plans

Each Member State in the EU ETS is required by the EU Commission to prepare and implement a NAP. The NAP determines and specifies the total quantity of CO_2 allowances allocated to participating industries. Each Member State must determine allocation ex-ante (before each trading period) based on all relative criteria as specified in the EU ETS Directive.[24] This Directive requires that the proposed quantity of allowances must be in line with each Member State's Kyoto Target[24]. The use of Kyoto flexibility mechanisms (CDM & JI) are allowed in NAPs under the 'Linking Directive' if specified ex-ante[24]. Plans are forbidden to grant competitive advantage to industry sector or participating firms, and must be in compliance with EU's competition and state aid rules[24]. Other criteria relate to provisions in the plan for new entrants, the accommodation of early reduction efforts and clean technology[24]. Plans must

set limits to guarantee that a significant reduction of GHG emissions occurs domestically (within the EU) [24].

Once drafted, a NAP must be submitted to the EU Commission for review. The Commission may choose to accept, partially accept, partially reject, or reject a NAP. Accepted NAPs signal the end of the allocation process. Plans are then finalized and submitted to the Member States' national registry. Rejected NAPs must be changed according to the guidelines set by the Commission, then resubmitted for review. Plans that are partially rejected or accepted need only to implement the proposed changes to qualify for emissions trading, there is no need for further review. After Commission approval, the Member State is allowed to alter the plan if improved data becomes available. However, under no circumstance can the total number of credits increase without resubmitting the NAP. Once the final allocation decision at the national level has been taken and the final plan is published, no more changes whatsoever to the number of allowances in total or per plant can be made[24]. The final allocation decision concludes the allocation process and opens formally the market for allowances in the Member State[24].

Monitoring and Reporting Requirements

All EUA allowances are recorded according to the EU 'monitoring and reporting guidelines' (MRG) in each Member State's National Registry. These Registries are communally linked through the Community Independent Transaction Log (CITL), overseen by the EU Commission. The CITL checks each EUA transaction for irregularities. Article 14 of the EU directive requires Member States to ensure all participating firms accurately monitor and report CO_2 emissions in accordance with 'MRG' guidelines[24].

The MRG define "monitoring methodology" as the methodology used for the determination of emissions; specifying how an operator of an installation will carry out the monitoring and reporting of CO2-emissions for that specific installation[24]. This includes

amongst other things the fuel and material streams to be monitored, the choice of tiers for all elements of the emission calculation, a description of metering devices (location, technology, uncertainty), a detailed description of emission measurement systems (if applicable) as well as QA/QC procedures for monitoring and reporting, e.g. for the processes of data collection and emission calculation[24]. The approved documentation of the monitoring methodology is part of or connected to the permit of an installation[24]. Once approved, the installation has to implement and execute the monitoring of its greenhouse gas emissions in accordance to the approved "monitoring methodology" [24]. This is checked by the national registry as part of the verification process[24].

The tier system (section 4.2.2.1.4 of Annex I of MRG 2004) provides a set of building blocks to determine the appropriate monitoring methodology for each installation[24]. The tier system defines a hierarchy of different ambition levels for activity data, emission factors and oxidation or conversion factors[24]. The higher the number of the tier chosen, the higher the level of accuracy or the more site-specific the monitoring system becomes[24]. Please reference figure 4.1 for a table of applicable tiers. The operator must, in principle, apply the highest tier level, unless he can demonstrate to the competent authority that this is technically not feasible or would lead to unreasonably high costs[24]. Minor sources, being sources which jointly emit 2.5 ktons or less per year or that contribute 5 % or less to an installation's annual emissions can be monitored using lower tiers[24]. The same applies to pure biomass[24]. Minor sources which jointly emit 0.5 ktonnes or less per year or that contribute less than 1 % of total annual emissions of an installation can be monitored using a no-tier estimation method[24]. For complete information on MRG guidelines, refer to[24].

Figure 4.1 Tier Specifications[24].

Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
>500 ktons (CO_2)/yr	50-500 ktons/yr	<50 ktons/yr	<2.5 ktons/yr	<0.5 ktons/yr

Phase One

Cap Setting and Allocation

For the NAPs 1, Member States used differentiated criteria for cap-setting and allocation, ranging from 'less than business as usual', to a 'path consistent with the Kyoto Protocol'[23]. The development of allocation methodologies to distribute emissions rights varied considerably between states, most notably for new entrants/closure provisions (NE/C). These provisions were implemented to offset the market distortions created from 'free' allocation of EUAs in most NAPs. NE provisions allowed new firms to receive a certain amount of 'free' credits based on projected emissions data. C provisions compensated inefficient plants for retiring early, rather than continuing operation in order to receive EUAs during the next cycle (and thus remaining profitable). To illustrate the variance in these provisions, the following example is presented: A cogeneration facility would receive allowances corresponding to 130% of its expected emissions in Germany[23]. The corresponding figures are 120% for Finland, 90% for Denmark and 60% for Sweden[23]. For a new natural gas combined cycle electricity production unit (no heat) the differences are even larger[23]. In Germany the installation would receive 105% of the required allowances[23]. In Finland 100%, in Denmark 82%, and in Sweden 0% (Sweden does not give allowances for non-combined heat and power)[23]. This variation has led to increased complexity, administrative burdens and transaction costs due to the extra effort required to transfer an EUA across borders.[23] In addition, this variance has led to selective sector and firm competitive advantage in both domestic and international markets[23].

Historical and Projected Emissions Data

Many NAPs for phase one were highly dependent on industry supplied emissions projections and historical emissions data. This data was a 'voluntary' effort by stakeholders; with only 3 Member States requiring independent verification[23]. This meant there was no way for participating States to guarantee that the data was accurate. It also created a perverse incentive for participating firms to 'inflate' historical and projected emissions data. The consequence of inadequate data collection was to create a surplus of almost 5% of total annual allowances across the ETS during phase one, resulting in a massive price shock midway through the cycle[23]. This shock will be discussed in the policy impact below.

Benchmarking

The lack of a universal benchmark served to compound the problems caused by variation in allocation methodology and inadequate data collection. Benchmarking refers to the idea of creating a universal standard, ie. best available technology, that acts as a reference point to measure EUA transactions against. Some Member Sates utilized benchmarks for allocation and new entrant/closure provisions, however the metrics varied from state to state. This prevented the potential benefits from being realized across the EU[23].

In phase one, the NAPs designated 95% of the EUA's for 'free' allocation (grandfathering). Phase two reduced the free allocation to 90%. Auctioning was practiced in four Member States, of which only Denmark used the maximum. The principal reason cited for grandfathering EUA's was to 'buy' industry and NGO acceptance[23]. There was significant lobbying by participating firms against auctioning, who believed they had a strong claim to free allocation as a result of prior free use[23]. The policy impact of this decision will be discussed later.

'Green' Technology R&D

One major industry criticism of phase one has been that it discourages investment in new and low-carbon investment in 'green' technology because of the short allocation period (3 years). The uncertainty and risk inherent to new technology R&D typically results in rather long investment cycles(ie. +5-10 years) [23]. In light of this fact, the added uncertainty of floating carbon prices over relatively short periods is said to create a perverse incentive to discourage 'green' R&D[23]. Heterogenic data collection, allocation methodologies, and baseline metrics have added to this uncertainty, prompting participating firms to lobby for a uniform baseline and longer allocation periods for phase three (2013)[23].

Power Installations

NGO's were quick to point out the flaws of EU allocation methodology in the presence of largely oligopolistic national or regional power markets. Power generators operating in non-ideal markets found it easy to pass on the additional costs of the EU ETS to consumers without inducing an end-user switch to low carbon alternatives[23]. This enabled power generators in some areas to receive windfall profits, creating a perverse incentive to hinder investment in low-carbon technologies[23]. This effect occurred almost exactly as predicted (by NGOs) during phase one[23].

Tier System

The tier system was also heavily criticized during phase one. Tier 4 installations were required to participate, accounting for 32% of participating firms, yet only 1% of all emissions[23]. This added tremendous administrative and industry costs to the EU ETS while resulting in a trivial decrease in emissions. Industry lobbyists have pushed for excluding installations that produce <25,000 tons CO_2 from the EU ETS. These installations make up 55% of all participating firms while emitting only 2.4% of total EU emissions[23]. By reducing the number of total installations to 4,700, covered emissions could remain as high as 97.6% of the current coverage[23].

Phase Two

NAPs 2 have shown major improvements over phase one. Member States were given much less leeway on allocation methodology, and data collection. Tightened Commission control of allocation methodology has led to a 9% reduction in NAPs (across 22 Member States) plan emission budgets over phase one [23]. The Commission standardized emissions projections across the board using 2005 verified data[23]. Industry lobbyists have questioned the methodology of these projections; however, there is unanimous consent on the need for standardized emissions data[23]. The Commission failed to implement a universal metric for benchmarking across Member States. Despite this, there has been an increase in benchmarking in domestic power sectors[23]. Auctioning remains limited in phase two[23].

Summary

The EU ETS is a decentralized, heterogeneous approach to Cap and Trade. Its objective is to enable Member States to achieve their Kyoto Targets in the most cost effective and efficient way. To achieve these targets, Kyoto Flexibility Mechanisms are allowed in Member State's NAPs. The EU Commission is responsible for oversight of the National Registries and National Allocation Plans for each allocation period. The first period was from 2005-2007; the second period was from 2008-2012; and the third period will start in 2013. In essence, The EU ETS is an international agreement based on upstream, grandfathered allocation of credits, which are measured in gross tons of eCO_2. Allowances are not based on output. The scheme is neither opt-in or phase-in. The MRG guidelines instill seller liability in the market. Price uncertainty mechanisms, such as safety valves, banking, etc, are largely left to the individual countries for implementation through NAPs. The design framework of the EU ETS was heavily influenced by industry and NGO's, with many compromises made on allocation, data collection, and

benchmarking. The effect of these policy decisions will be discussed in the section on policy impact, below.

Policy Impact

The EU ETS significantly distorted the carbon market through a complicated, heterogeneous design framework. The major variables causing this distortion were: new entrant/closure provisions in NAPs, diverse allocation methodology, a lack of a uniform benchmark, and data collection errors. In addition to the above variables, a flawed tier system increased the administrative and economic burden of the plan, and Kyoto flexibility mechanisms reduced the incentive to curb domestic emissions.

Figure 4.2 illustrates the long-term effect of uniform new entrant/closure (NE/C) provisions in NAPs 1. These provisions were created to offset the market distortion caused from grandfathering EUAs to existing facilities. The NE/C provisions created an incentive to create new generators over modifying existing generators to meet increased demand[25] Although revised in NAPs 2, the NE/C provisions during phase one created a perverse incentive to favor carbon-intensive generators over 'greener' alternatives. In figure 4.2, the resulting increase in CO_2 would hypothetically lead to increased EUA prices, re-stabilizing the level of emissions. The CO_2 increase depicted in the figure was never realized in practice due to the short allocation period of phase one, however the flaw was nonetheless present. Modifications of NE/C provisions in NAPs 2 were sufficient to remove this effect.

Figure 4.2 Long-term effect of increasing levels of uniform new entrant allocation[25]

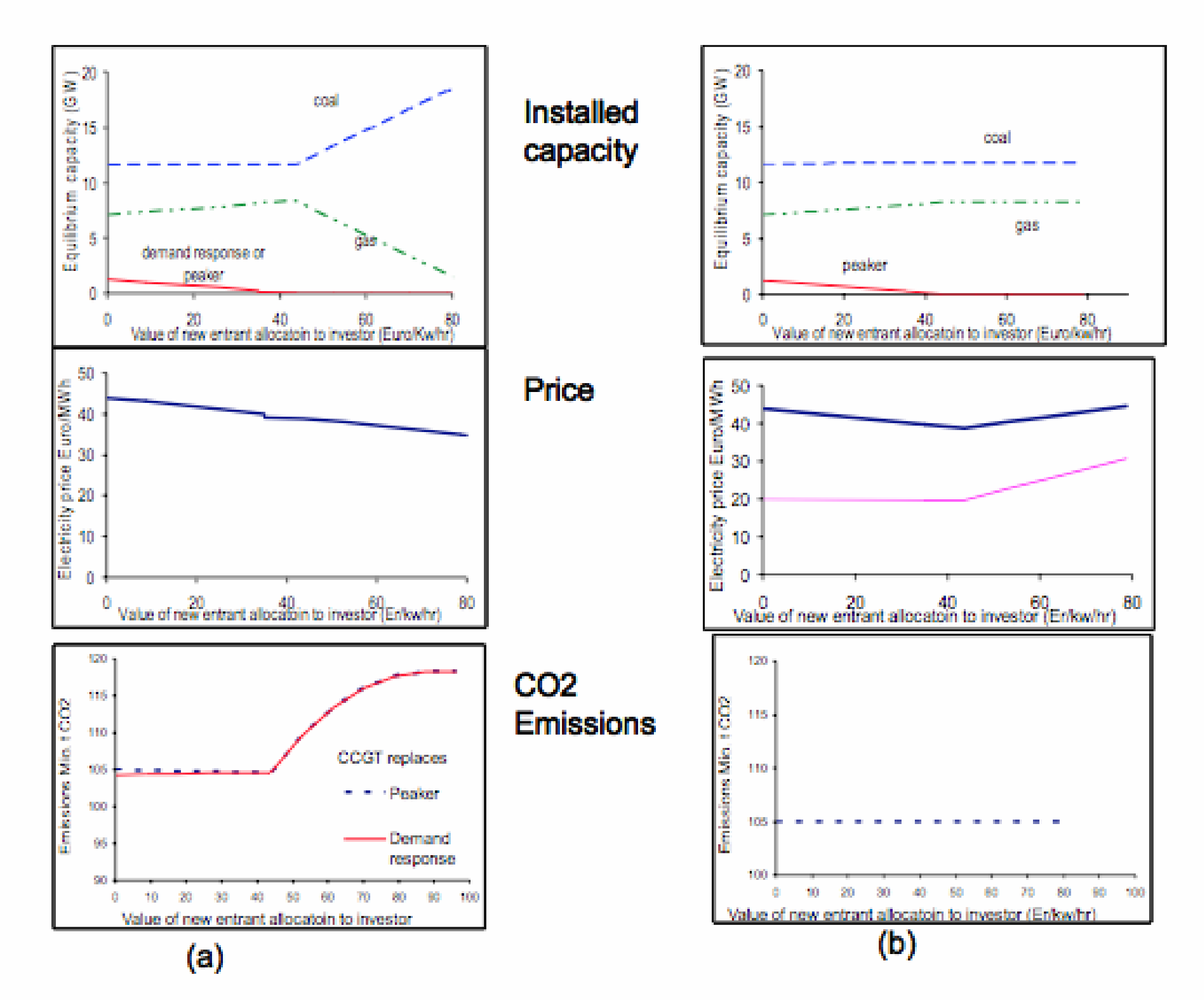


Figure 4.3 shows the effect of allocation methods on the Carbon Market. Most NAPs awarded EUA's using 'baseline emissions' and emissions projections. When baseline emissions are used in NAPs, inefficient generators are awarded a large amount of EUAs, creating an incentive to remain open (to continue to receive allowances). This is shown to distort the carbon market, creating perverse incentives to increase CO2 intensive capacity, choose inefficient fuels, and discourage 'green' technology R&D.

Figure 4.3 Effect of Allocation Method on the Carbon Market[25]

Impacts	Distortions	Allocation Method: Auction	Capacity	Capacity and Technology	Baseline Output	Baseline Output and Technology	Baseline Emissions
Excess CO2 Intensive Capacity	Discourage Plant Closure		X	X	X	X	X
	Discourage Closure of Inefficient Plant			X	X	X	X
Inefficient Fuel Choice	Increase Operation of Inefficient Plant				X	X	X
Less Energy Efficiency Investments	Reduce Incentives for Energy Efficiency Investments						X

Figure 4.4 shows the projected effects of different allocation methodology on the UK. While not inclusive of the entire EU, it provides a snapshot of the effects of allocation on emissions, EUA prices, electric demand, gas use, and coal use in several different scenarios. NE refers to new entrant provisions. FS refers to fuel-specific benchmarking for NE provisions. In phase two some Member States choose to use FS benchmarking for NE provisions, attempting to award EUAs on fuel type rather than emissions. Thus, the cost of a coal EUA is higher than a gas EUA. Uni benchmarking for NE provisions means a universal benchmark (not fuel-specific). Upd refers to updating emissions data and NAPs for each allocation cycle. No closure test refers to the modification of closure provisions to discourage inefficient plant use.

Figure 4.4: Impact from differing allocation methodologies on UK; 2005-2017[25]

	Average CO2 emissions (million tCO2)	Average baseload prices (€/MWh)	Cumulative retirements (MW)	Average Gas use (TBTU)	Average Coal use (TBTU)
No Closure test, High FS NER, High Gas price	241	45.26	12,977	359	1,623
No CO2	226	32.79	556	1,221	1,628
FS Upd, No NER	215	37.01	5,118	1,325	1,440
Closure test, No NER	187	43.28	3,318	1,694	946
Closure test, Uni NER	180	41.86	3,678	1,766	829
Closure test, FS NER	180	41.86	3,678	1,766	829
Uni Upd, No NER	178	39.72	10,640	1,804	776
Auctioning Base Case	178	43.96	10,629	1,798	780
No Closure test, Uni NER	170	41.81	20,597	1,863	670
No Closure test, FS NER	170	41.81	20,597	1,863	670

Figure 12 Impact from allocations for period 2005-2017 (GB simulation only)

As shown by the figure above, each variable significantly alters UK emissions, baseload prices, etc. In addition, NE/C provisions open EUAs to macroeconomic risk variables (i.e. rising gas prices). The greatest reduction in emissions occurs when allowances are auctioned or when benchmarking is applied to NE provisions and C provisions are modified.

Errors in data collection caused a massive price shock in phase one due to an unintended surplus of EUAs. Prices dropped from a peak level in 2006 of €30/EUA to €0.10/EUA in September 2007[25]. This made the price of an EUA irrelevant in participating firm decisions, rendering the EU ETS toothless.

Phase one ETS resulted in a 4.3% increase in emissions among Member States[25]. Significant flaws in the above variables rendered the scheme incapable of curbing domestic emissions, although use of flexibility mechanisms may have served to offset some of the observed EU CO_2 increase. Phase two data is currently being developed, though most observers predict a decrease in CO_2 emissions among member states. When this data becomes available the economic impacts of phase two will be open for future research.

The U.S. Sox Market

Introduction

The 1990 Clean Air Act Amendments (CAAA) introduced the first large-scale cap- and-trade program for air pollution. Title IV of the CAAA established a system of tradable permits for sulfur dioxide (SO2) emissions among utilities in the U.S. The system aimed to remove 10 million tons per year of SO2 emissions from a 1980 baseline by the year 2010. Phase I (1995-1999) of the permit market extracts emission reductions from the 263 most polluting coal-fired electricity generating units with an output capacity greater than 100 megawatts (MW), belonging to 110 power plants located in 21 eastern and mid-western states[26]. These 263 units, also called "Table A units", are allocated a fixed number of permits each year sufficient for an average emission rate of 2.5 pounds SO2 per million Btu of average 1985-1987 heat input[26]. Power plants may select units not originally affected until phase II to enter the program early as substituting or compensating units to help fulfill the compliance obligations for "Table A units"

targeted by phase I[26]. In addition, industrial emission sources, such as refineries and smelters, may voluntarily enter the program if they feel they can make emission reductions at low cost (opt-in units) [26]. Phase II which began in the year 2000, covers the remaining generating units fired by coal, oil and gas with an output capacity greater than 25 MW[26]. Units are allocated permits sufficient for a more stringent average rate of 1.2 pounds of SO2 per million Btu of average 1985-1987 heat input[26]. The SO2 permit trading program has dramatically reduced emissions faster and at far lower costs than anticipated, yielding wide- ranging environmental and human health benefits[26]. Thereby, the SO2 program's successes have encouraged policy makers in many countries to establish emissions trading schemes for other pollutants such as greenhouse gas emissions[26].

Design Framework

Under the CAAA SO_2 permit market, one allowance permits a generator to produce one ton of SO_2. Allowances are fully marketable commodities, which may be bought, sold, traded, or banked for use in future years. Allowances may not be used for compliance prior to the calendar year for which they are allocated.[27] However, regardless of how many allowances a source holds, it is never entitled to exceed the limits set under Title I of the Act to protect public health.[27] In accordance with the introduction, allowances are allocated at an emission rate of 1.2 pounds of SO2/mmBtu of heat input for phase two (2.5 for phase 1). In addition to annual allocations, allowances are also available upon application to three EPA reserves.[27] In Phase I, units could apply for and receive additional allowances by installing qualifying Phase I technology (a technology that can be demonstrated to remove at least 90 percent of the unit's SO2 emissions) or by reassigning their reduction requirements among other units employing such technology.[27] A second reserve provides allowances as incentives for units achieving SO2 emissions reductions through customer-oriented conservation measures or renewable energy

generation.[27] The third reserve contains allowances set aside for auction, which are sponsored yearly by EPA. Anyone can participate in the annual allowance auction which is held at the end of March every year.[27] Units that began operating in 1996 or later are not allocated allowances. Instead, they have to purchase allowances from the market or from the EPA auction to cover their SO2 emissions.[27]

The EPA is responsible for overseeing the monitoring and reporting of SO_2 allowances. To accomplish this, the EPA maintains an Allowance Management System (AMS). Each affected utility source, corporation, group, or individual holding allowances must register an account in the AMS. Parties must notify EPA to have transfers recorded in their AMS account, but it is not necessary to record all transfers with EPA until such time that the allowances are to be used to meet a source's SO2 emissions limitation requirement.[27] AMS accounts are, however, the official records for allowance holdings and transfers used for compliance purposes.[27] To facilitate tracking and recording, EPA assigns every account an identification number and every allowance a serial number.[27] Any person or group, including brokers and investors, wishing to purchase allowances may open a general AMS account. If a source's emissions exceed its allowances, the source must pay a penalty and surrender allowances for the following year to EPA as excess emission offsets.[27]

Policy Impact; provided by[26].

Since the passage of the 1990 CAAA, several studies have attempted to assess the efficiency of the SO2 permit market with mixed results. Joskow et al. (1998) assess the efficiency of the market for SO2 permits by comparing the price of permits auctioned by the Environmental Protection Agency (EPA) between 1993 and 1997 with prices associated with private confidential trades. Joskow et al. (1998) discover that by late 1994 these prices were

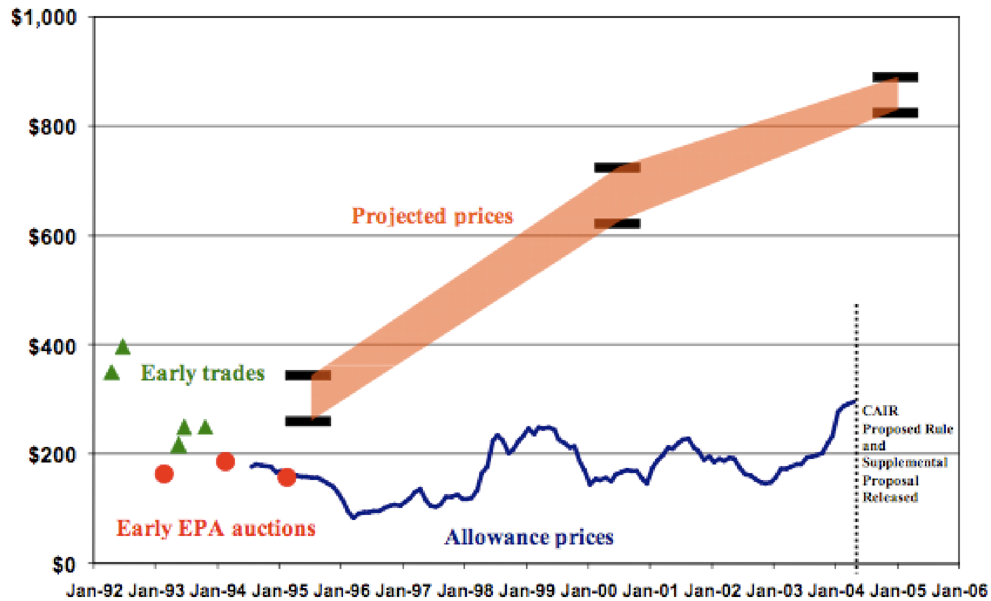
almost identical and thereby conclude that the private market for tradable permits was relatively efficient. Schmalensee et al. (1998) also conclude that the private market for tradable permits was relatively efficient by noting the growth in the level of the trading volume from 1995 to 1997. Ellerman et al. (2000, pp. 185-190) conclude that the flattening of the term structure after 1995 provides evidence of a relatively market efficiency. Carlson et al. (2000) find that the market failed to realize potential gains from trade in the first two years of phase I. Ellerman (2003) and Ellerman et al. (2003) conclude that banking has played an important role in improving the economic and environmental performance of SO2 cap-and- trade program. Arimura (2003) uses the coal price data from 1985 to 1998 and estimates a hedonic model in order to investigate the link between sulfur premium in coal and the permit price. In the first two years of the program, he finds that the sulfur premium was higher than the permit price in the EPA auction for the range of sulfur from 0 to 0.6 pound per mmbtu. Arimura (2003) argues that the deviation is due to the rent exploited by coal mine companies in the west from the high sulfur coal. For 1997 and 1998, however, the estimation results show that the permit price is in the range of 95% confidence interval for sulfur premium from 0 to 1 pound per mmbtu, suggesting that the permit price in the auction reflects the sulfur premium of coal for low sulfur coal. From these results, Arimura (2003) concludes that the market is becoming efficient in 1997 and 1998. Using an output distance function approach, Swinton (2002, 2004) calculates the shadow prices of emission reductions and finds that they diverge among some power plants, suggesting that these plants have not taken full advantage of the permit market during much of phase I. Burtraw et al. (2005) suggest that this divergence of marginal abatement costs among some plants is due to the effects of implementing electricity restructuring in some states which provided incentives to reduce costs. Keohane (2006) uses a unit –level econometric model of technique choice, based

on actual decision by nearly 1000 units from 1995 to 1999, to estimate what would have happened if prescriptive regulation had been employed in place of an emissions trading scheme. The results show that cost savings appear to have been lower than estimated by others, noting that under the most natural choices of counterfactual regulations, the cost savings from trading, relative to a uniform emissions standard, ranged from $148 to $268 million annually: a cost savings of 16% to 25%. Ellerman and Montero (2007) show that the aggregate behavior of the SO2 bank indicates that most participants have made reasonably efficient abatement decisions during the period 1995-2002. Helfand et al. (2007) discover that although the SO2 price path does not reflect the Hotteling rule, profit opportunities appear relatively small and quite risky. They suggest that the SO2 permit market appears to have been relatively efficient during the period 1994-2003.

Discussion

As evidenced by the extensive research complied by source[26] referenced above, the sulfur emissions trading scheme fulfilled its objective in a relatively efficient manner. Reference[26] goes on to propose that the SO_2 futures market adds significant inefficiency into the system because of inherent risk premiums, however this topic is beyond the scope of this paper. Figure 5.1 shows the actual versus projected cost of SO_2 prices through 2004.

Figure 5.1 Comparison of Projected and Actual SO_2 allowance prices[14]



The nature of the SO_2 scheme's success lies in its simplicity. Allowances were allocated using a baseline of 2.5 pounds SO2 per million Btu for phase 1 and 1.2 pounds of SO2/mmBtu for phase two. New entrants (after 1996) were required to purchase credits through auction, and energy efficient firms were allowed to phase-in to the program. Additional reserves were kept by the EPA to encourage development of 'green' technologies. Monitoring, reporting, and enforcement were robust and effective with EPA oversight. This effective design framework fulfilled the stated objectives of the CAAA in a cost-effective manner.

A key difference between the SO_2 market and the EU and Kyoto schemes is homogeneity. In the U.S. scheme, a sulfur allowance is a sulfur allowance is a sulfur allowance. There are no 'flexibility' mechanisms, or NAPs, or heterogenic allocation methodologies and benchmark metrics. It is simple, limited in scope, and effective. When designing a domestic cap

and trade scheme for carbon emissions, the Sulfur market should have significant weight in the design framework.

Recommendations

After reviewing and dissecting the design framework of the Kyoto Protocol, EU ETS, and the SOx market, we can now assess the relative effectiveness of the various control mechanisms implemented in each scheme. This assessment will be used to propose design framework suggestions for use in a domestic cap and trade scheme.

The Kyoto Protocol and the EU ETS were largely unsuccessful in fulfilling their stated objectives. Both the Kyoto Protocol and the EU ETS delegated allocative control and methodology to Member States. This was shown to introduce heterogeneity into the market, which served to destabilize the carbon 'currency,' creating a systemic problem in the entire market. In addition, both schemes allowed for the use of 'flexibility' provisions to reach the proposed cap on emissions. These provisions facilitated the 'outsourcing' of carbon reductions to Annex II countries. By providing a lower cost alternative to the carbon market, the JD and CDM mechanisms created a perverse incentive to delay 'green' technology R&D in favor of cheaper international projects. By flooding the market, they also served to further destabilize the already unbalanced international carbon price. The choice to allocate based on total emissions rather than output was another major flaw present in both schemes. Output based allocation was shown to reduce the exposure of the carbon market to macroeconomic risk variables. Data collection errors were common in both schemes in early stages, but for the most part have been resolved since inception. The cumulative result of these flaws was to render both schemes impotent.

The sulfur market in the U.S. fulfilled its objectives in a cost effective and timely manner. It worked because it was relatively simple: Allocation methodology was determined by a central authority; flexibility mechanisms were prohibited; allocation was output based; and allowance reserves were used to create incentives to develop 'green' technologies. This framework resulted in a reduction of SOx at costs much lower than projected.

When designing a domestic cap and trade program, regulators should employ the following control mechanisms:

- Output based allocation: output based allocation shields the carbon market from macroeconomic risk factors (i.e. rising gas prices or an economic downturn). It also serves as an effective universal baseline metric. In the absence of NE/C provisions, this was shown to result in the least market distortion in the UK.[25]
- Auctioning of Allowances: Referencing figure 4.3, auctioning was shown to result minimal market distortion.[25] This also eliminates the need for new entry/closure provisions, forcing all firms to compete in the open market for credits.
- Homogeneous allocation methodology, with the absence of 'flexibility' mechanisms.
- Use of allowance reserves to encourage green technology R&D. This should be modeled on the current SO_2 market.
- Stringent monitoring and reporting requirements, backed up with effective enforcement penalties and oversight.

In addition to the above recommendations, new legislation should sponsor the creation of a congressionally appointed committee to oversee the carbon allowances market in a theoretical U.S emissions trading scheme. Its objective will be to: (1) prevent dramatic short-term flux in allowance values; (2) provide politically shielded oversight capabilities; (3) assess the impact of

the domestic design framework; (4) update allowances when new information becomes available; (5) encourage 'green' technology implementation and R&D; (6) raise investor confidence in a cap and trade scheme. This concept was first introduced in bill S. 2191 by Lieberman and Warner.[14] This bill proposes to establish a 'Carbon Market Efficiency Board' to oversee GHG allowance markets; however, it fails to specify the mechanics of this board.

It is my belief that the committee should be congressionally appointed, with terms 10+ years. This will shield the members from political pressures. Appointment should be staggered to ensure continuity in board methodology. This firm would be responsible for creating an annual report on the policy impact of the domestic scheme (possibly partnering with DOE). It would be in charge of allocation methodology, oversight, monitoring, and reporting. Enforcement would be carried out by the EPA. The commission would be charged with developing and implementing proper control mechanisms to ensure that the scheme fulfilled its objective. By removing politics from this process, I believe this board will go a long way towards implementing a successful emissions quota in the U.S, and it is highly recommended for any cap and trade legislation.

Conclusion

This paper investigated the design framework of the SOx emission trading scheme in the US, the Kyoto Protocol, and the European Union Emissions Trading Scheme (ETS), while taking into account the political, social, and economic context surrounding the development of these schemes. It assessed the policy impact of each scheme in order to make informed recommendations for use in the development of a domestic emissions quota. By dissecting the design framework of the three 'cap and trade' programs investigated, this paper sought to

illustrate the flaws present in each scheme. Hopefully this information will be used to avoid past mistakes when drafting future legislation.

In a domestic ‘cap and trade’ program, the following control mechanisms are recommended by this report: output based allocation; auctioning; a uniform allocation methodology; stringent monitoring and reporting requirements (including data collection); the use of allowance reserves to foster development of ‘green’ technology; and the creation of a congressionally appointed committee to oversee, develop, and implement the emissions quota scheme. Future research topics include: a CBA of each of the above variables on a domestic scheme; and a stakeholder analysis of this project.

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