Combating Global Warming: Carbon emissions policies for the United States

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An honors thesis submitted in partial fulfillment
of the requirements for the degree of
Bachelor of Science
Undergraduate College
Leonard N. Stern School of Business
New York University
May 2009

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The future of our planet

In his inaugural speech in 2009, American President Barack Obama stated, "We will restore science to its rightful place...We will harness the sun and the winds and the soil to fuel our cars and run our factories…With old friends and former foes, we will work tirelessly to lessen the nuclear threat, and roll back the specter of a warming planet."[1] Given that the President entered his term in the midst of one the largest economic downturns of our times, wars on two fronts in the Middle East, and deteriorating healthcare and education systems, his commitment to curbing climate change speaks to the real and catastrophic consequences of inaction.

In the Fall of 2007, when Senators Joseph Lieberman (I-CT) and John Warner (R-VA) introduced their America's Climate Security Act (S. 2191), Senator Lieberman clearly laid out the dangers that face, not only America, but the entire world:

> With all the irrefutable evidence we now have corroborating that climate change is real, dangerous, and proceeding faster than many scientists predicted, this is the year for Congress to move this critical legislation. If we fail to start substantially reducing greenhouse gas emissions in the next couple of years, we risk bequeathing a diminished world to our grandchildren. Insect-borne diseases such as malaria will spike as tropical ecosystems expand; hotter air will exacerbate the pollution that sends children to the hospital with asthma attacks; food insecurity from shifting agricultural zones will spark border wars; and storms and coastal flooding from sea-level rise will cause mortality and dislocation.[2]

As Senator Lieberman points out, there are many devastating known side effects of global warming. Equally dangerous, are the consequences that we have not yet identified, which could be more destructive than the ones we already know about. Thus,

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[1] Presidential Inaugural Address, January 20, 2009

[2] "Lieberman and Warner Introduce Bipartisan Climate Legislation." October 18, 2007

the need for action is clear, and as the most powerful nation in the world today, America cannot afford to follow, but must lead in this endeavor.

Introduced August 2, 2007 by Senators Lieberman and Warner, this bill would set an emissions cap to begin in 2012, targeting the electric, transportation, and industrial sectors, which currently represent 80% of the US economy. Reduction targets would reduce greenhouse gas emissions to current levels by 2012, 10% below current levels by 2020, and 70% below current levels by 2050. With regard to the allocation of permits, the proposal would auction 24% of allowances in 2012, increasing to 52% by 2035. With regard to the usage of offsets, the bill allows up to 15% of allowances to be international offset credits.

In essence, the bill seeks to set a target for reducing carbon emissions in the US and to control compliance costs by allowing companies to trade, save, and borrow emission allowances, and by allowing them to generate credits when they induce non-covered businesses, farms, and others to reduce their greenhouse gas emissions or capture and store greenhouse gases. As we will see throughout this paper, these are the foundational characteristics of a cap-and-trade program.

For those who believe the grim scientific research about the potential effects of a warming planet, the need for climate policy to reduce pollution is obvious. Even for skeptics, however, there is motivation to act. A comparison can be made to the famous Pascal's Wager. In Pascal's Wager, he is contemplating whether one should believe in god given the possibilities that he does and does not exist. Pascal argues that, regardless of the probabilities, the scenario that god does exist, but you do not believe in him, will have an infinitely negative outcome (an eternal life in hell), thus making the probabilities meaningless (unless the probability of god's existence is zero), since the expected outcome for not believing in god includes the infinitely bad outcome of hell. Therefore, from a decision theory perspective, it makes sense to believe in god. Similarly, the outcome if climate change is real and we do not act is eternally negative, as life on our planet may cease to exist. Therefore, as long as there is a chance that climate change and its potential effects are real, it makes sense to err on the side of caution.[3]

For the most part, governments have used command and control policies to implement environmental standards. Command and control puts the responsibility on the government to micro-manage the emissions reductions policy, which usually means the government chooses certain technological standards and mandates that businesses use them. Such has been the case in the US with regards to ethanol subsidies, as well as various carbon-reducing requirements on factories. In addition to the fact that it is difficult for any government to identify which technologies are sustainable and effective in the long run, research is constantly changing and it is often unfeasible for government policy to change as the technologies do. This results in outdated policies that do not utilize their full abatement potential.

Economists have long argued that utilizing a market-based system would provide more efficiency to an emissions reductions policy, as it would allow market forces to dictate which technologies are utilized and what pollution gets reduced (the cheapest to reduce). A simple example can exhibit the power of market forces:

Imagine an economy with only two companies. Currently, each entity pollutes 20 tons of carbon dioxide, resulting in a total of 40 tons of pollution for the economy. In an attempt to cut emissions in half, a government can utilize a command and control policy, such as forcing each

[3] http://www.thesubjunctive.com/

entity to reduce its pollution to 10 tons instead of 20 tons. If the cost to reduce pollution is $5 for Entity 1 and $15 for Entity 2, it will cost them $50 and $150, respectively, and cost the entire economy $200. Utilizing market forces would allow the government to decide it wants to cut emissions in half, but allow the entities to reach this level however they wish. In this situation, Entity 1 would most likely reduce the entire 20 tons since it is cheaper for it to do it than Entity 2. This would lead to a reduction in the 20 tons for only $100 ($5 * 20 tons), as compared to $200. As part of the market system, Entity 1 would be compensated in some form by Entity 2 for taking on its emission reduction responsibilities (see Appendix I for a visual representation).

Market-based policies can generally take the form of either a carbon tax or cap-and-trade system. A carbon tax would mandate that all emissions would be taxed at a certain rate, thus giving businesses the incentive to reduce emissions. A cap-and-trade program sets a limit on the amount of pollution that each company, or entity, can emit through the issuance of allowances. These allowances can be traded on an exchange so that companies who have extra (because they have low abatement costs) can sell them to those who need (because they have high abatement costs). Both types of policies offer an efficient way for reducing emissions by setting a cost to polluting and allowing market forces to dictate how that cost is dealt with. For the rest of this paper, I will attempt to analyze whether a tax or cap-and-trade system would be more appropriate for the US to implement.

Long-term efficiency

In order to accurately identify the preferred framework for curbing carbon emissions, policy makers must attempt to understand the nature of the problem. More specifically, they must understand the risks associated with the threats that are to be avoided. Are the dangers immediate? Or are they more long term in nature? Will the dangers gradually occur over time? Or will there be some sort of inflection point--after which there is no resolving the situation? Although the scientific research is far from complete, it is generally believed that greenhouse gas emissions are a long-term problem. In other words, any action that we take today may not necessarily have a direct effect on the Earth in the immediate future, but will have a large and substantial effect on generations down the line.[4]

A problem as vital and long-term focused as global warming requires a solution that has breadth and sustainability that fit the situation. Additionally, because the issue at hand is so large and long-term, policy errors can have relatively large impacts down the line, due to the compounding of those errors. Therefore, as the goal is to reduce carbon emissions, the debate over which policy to adopt must incorporate a discussion regarding what policy will reduce emissions at the lowest possible cost to society—over the long-term. There are relatively few efficiency differences with regards to a carbon tax vs. a cap-and-trade system. The debate essentially revolves around the choice between a price instrument (tax) and a quantity instrument (cap).

If economists are certain regarding the shapes of the marginal cost and benefit curves of reducing pollution, a tax and cap should produce the same result since a price (tax) can be set to match a certain level of abatement (quantity), and vice versa. This is not true under conditions of uncertainty, however. In his 1974 seminal paper "Price vs. Quantities", Weitzman expounds that the optimal choice between a quantity-based and price-based emissions control framework should depend on the relative slopes of the marginal cost function and the absolute value of the

[4] This is in direct contrast to a situation like the current financial crisis. In that case, the government is acting, not merely because they are worried about the fortunes of Americans a few centuries from now, but rather, because

marginal benefit function.[5] Additionally, it is important to differentiate between the costs associated with pollution (global warming) and the costs associated with emissions abatement (higher costs for businesses, etc which is what he was referring to here).

Weitzman shows that when marginal benefits and costs of emissions control are linear, when authorities are uncertain about the intercepts of these functions, and when the benefits and costs of emissions control are uncorrelated, then a price-based regulation is more efficient than a quantity-based regulation, because the slope of the marginal cost curve is steeper than the marginal benefit curve. In other words, this would appear to indicate that at a certain level of abatement, the costs to abate one more ton of emissions may be greater than the benefit (and growing more rapidly). A price-based instrument is thus superior since it will cause less efficiency losses in the event of estimation errors, as compared to a quantity instrument (see Appendix II for a visual representation).

There has been debate over whether Weitzman's original assumptions on which his model was based are plausible ones. Nonetheless, Stranlund and Ben-Haim (2007) show that even if you relax some of Weitzman's assumptions, the general premise still holds. They explain that even under a scenario of greater uncertainty, when the errors in the estimates of the benefits and costs of emissions control are completely uncorrelated, the relative marginal slope test still holds; namely, the correct instrument choice can still be determined by comparing the relative slopes of the marginal cost and benefit curves.[6]

In agreement with Weitzman, most economists have long believed that global warming exhibited characteristics that would prefer a price instrument—that the marginal benefit of

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the government's actions will hopefully directly stave off danger today. Policy decisions should be tailored according to fit such goals.

[5] Weitzman, 1974

abatement would be flatter compared to the costs. This was due to the fact that since carbon accumulates in the atmosphere, and builds on past carbon emitted, it would appear that the marginal benefits of abatement would decline as more and more abatement occurs (since less carbon is now left in the atmosphere). This is similar to attempting to save a sinking ship that is filled with water. The more water that one succeeds in removing, the less benefit there is from throwing a single, additional bucket overboard becomes.

Recent research, however, identifies that climate change is not characterized by smooth atmospheric changes, but rather by numerous tipping points.[7] With this in mind, it is possible that the marginal benefits of abatement will actually be steeper than the marginal costs, since one additional ton of carbon emitted may push the carbon content of the atmosphere past that critical point, thus making the marginal benefit of reducing that ton of gas enormous, regardless of the amount of carbon that has already been abated. [8] Additionally, if the costs are viewed from a global perspective, the cost curve will be flatter than the benefit curve. This is because countries with low costs of carbon abatement can be included in determining the cost.[9]

Lastly, prior research has generally failed to incorporate banking and borrowing into the equation. Banking and borrowing are mechanisms in a cap-and-trade program which allow emissions permits to be fungible across time. In banking credits, a company can decide that instead of selling the extra credits it has it would rather keep them for a later year when it might need them. The rationale behind keeping the permit, instead of selling it now and buying another permit later if it needs, would be that the company believes that the spot price of a permit will be significantly higher in the future when they need to buy it. Similarly, borrowing credits means

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[6] Stranlund and Ben-Haim, 2008
[7] Lockwood, 2001
[8] National Research Council, 2002

that a company can use today a credit that it is due to receive in a later year. A company might do this because they think the price of a permit will be lower in the future so they can buy the permit back at a lower price, or a company may have certain liquidity constraints in the near term so it would rather not outlay cash to purchase another permit today (see Appendix III for a visual representation).

Allowing banking and borrowing will reduce costs, or flatten, the marginal cost curve, because companies can utilize a period of particularly low abatement costs to cover required emissions reductions of past (borrowing) or future (banking) periods at lower costs.[10] When taken into account, these considerations would lead policy makers to choose a quantity-based instrument, such as cap-and-trade. Therefore, although past research has generally concluded that a price instrument is superior, recent research suggests that the comparative advantage of a tax is not as great as once believed.

Technological innovation

Because emissions policy should be long-term focused, it is important that businesses—the ultimate partners in reducing emissions—are able to adequately understand, and prepare for, the costs that they will be charged for polluting. Both a tax and cap would seem to provide this long-term visibility for companies. There are some differences, however, and these will be discussed in more detail in the section regarding political considerations.

Assigning a cost to pollution will motivate corporations to reduce the "low-hanging fruit" emissions, such as capturing easily catchable pollution. While this is a good place to start,

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[9] Rial et al, 2004
[10] Stavins, 2008

government policy should ultimately also attempt to spur innovation in new and sustainable clean technologies. Both a tax and a cap should spur technological innovation that otherwise might not occur. This is because both policies give companies the incentive to find ways to reduce emissions, even beyond what is required—both currently and in the future—to spare themselves from a tax or to sell extra permits after meeting the cap. From an economic perspective, these investments will be a direct consequence of firms assigning a cost to pollution, the ultimate goal of any policy (and in the case of a cap, companies can even assign revenue to abatement if they sell unused permits). Although it would appear that technological innovation is equally likely with a tax or cap, we will argue later that international considerations would seem to give a cap the edge.

The ultimate goal of climate policy is to reduce greenhouse gas emissions over the long-term, beginning with carbon. While both cap-and-trade and tax programs would accomplish this goal to certain degrees, actual emissions under a tax will depend on economic growth (large enough growth may make it worthwhile for companies to pollute more, even while incurring more taxes), the cost of abatement technology (if abatement is more expensive than the tax companies will choose to pollute and incur the tax), as well as such factors as climate policies in other counties. As a result, a tax may not achieve any particular level of cumulative emissions in advance. On the other hand, under a cap, total, long term emissions will be determined in advance.[11]

[11] Keohane, 2009

Political implications

Assessing the correct theoretical policy to attack climate change is a difficult and daunting task in and of itself. When coupled with practical considerations, such as political implications, the task gets that much more difficult. These considerations are paramount since more than ever before there is a supreme need for implementation, rather than merely theorizing. This next section will examine the political feasibility of a cap-and-trade and a tax system. This includes the ability to implement the program and the political consequences after implementation.

Before analyzing which policy makes more sense, it is important to clarify the different revenue-generating options the government has. A tax is the most straightforward and, as with any tax, the government will raise money through tax receipts. Under a cap-and-trade, the government has more flexibility as to how much money it would like to raise, thus balancing the need for government funding and the private sector's appetite (or ability) to provide that funding. On the two extremes, the government can choose to give away all of the permits for free (no revenue) or auction them all off (full revenue). Auctioning off too little will cause the government to miss out on a significant revenue generator and auctioning too many could cause a huge burden on businesses trying to cope with the new climate reality, posing barriers to implementation.[12] Therefore, the ideal balance probably lies somewhere in between.

From a political perspective, those generally reluctant to support any sort of "large government" initiatives would most likely also oppose climate change regulations, since either policy would lead to higher costs on businesses and extra revenues for the government. Which policy are these constituencies more likely to support if they had to choose?

There are three characteristics of a cap-and-trade system that would make it superior to a tax with regards to the political arena: its name, its revenue flexibility, and industry flexibility.

Aversion to "taxes"

Aside from its actual effects, a cap-and-trade program benefits from not having the word "tax" in its name. This may seem a bit superficial and unimportant, but one should not underestimate America's aversion to taxes. Additionally, the US already has extremely high corporate taxes in relation to the rest of the world. It is therefore safe to say that American companies would be vehemently opposed to any more taxes they might have to pay to the government. Additionally, by avoiding implementing an additional tax on the country, the government may leave itself room to implement other, necessary taxes, such as a gas tax.

Flexibility in revenue generation

Second, a cap-and-trade system offers the government increased flexibility in determining how much of the climate burden it wants to levy on businesses and what costs the government is willing to incur itself—without changing the fundamental goal of the program. This can be done by altering how many permits are given away for free and how many are auctioned to companies. Companies cannot be expected to transform into "green" businesses overnight, so the government can gradually adjust the amount of permits it "charges" companies

[12] Although and analysis of the EU's system later in this paper will show that not all companies will be over-burdened by auctioning, specifically those companies that can pass the costs along to consumers

so that the burden can slowly be transferred from the government to the private sector. More specifically, Robert Stavins of Harvard advocates initially allocating 50% of the permits for free to sectors which will have trouble passing along costs, phasing in complete auction over 25 years as businesses get acclimated, leading to an average free allocation of 15% over the period.[13] This is consistent with a study done by Bovenberg and Goulder, where they found that 13% free allocation would be sufficient for compensating those industries that are hurt the most by climate policy.[14] Stavins estimates that auctioning the permits could generate over $100 billion in government revenue.[15] This compares to roughly $300 billion of revenue the government generated from corporate incomes taxes in 2008.[16] Additionally, allowing some of the value to accrue to the private sector by giving away some permits will increase the probability that regulation will be accepted by participating firms.

Flexibility to help certain industries

If the implementation of climate policy affects certain industries in a disproportionate way, the government can choose to help them out by giving away more permits for free, thus lowering those companies' costs in adhering to the carbon cap. An example would be those companies which cannot pass along the higher costs to their consumers. Thus, by merely varying the amount of allowances given away, regulators can help certain industries, while keeping the reduction in pollution unchanged.[17] In other words, under a cap-and-trade system, the government has the power to alter the level which it absorbs the costs of abatement, in

[13] Stavins, 2008
[14] Bovenberg and Goulder, 2003
[15] Stavins, 2008
[16] A Citizen's Guide to the 2008 Financial Report of the U.S. Government
[17] Keohane, 2009

relation to businesses, while at the same time keeping the total level of abatement unchanged.

Varying government income and helping certain industries could be accomplished under a tax system as well, by the government lowering the tax rate or giving tax rebates to industries in need. However, both of these have drawbacks. In any tax program, the government should be very reluctant to change the tax rate over time. This is because the government will lose credibility in its ability to price carbon (if it keeps changing the price) and it will give businesses the incentive to lobby for tax rate changes (since they see rates can be changed), reducing the legitimacy of the whole program and distorting the long-term decisions of companies, as they question the stability of the tax.

Additionally, giving rebates to industries in need may have more adverse effects than merely allocating permits to them for free. This is because by providing a company with a carbon tax rebate, a government is essentially reducing the cost of polluting for a company, thus allowing more total pollution in the economy. This is in contrast to merely allocating permits to specific companies, which reduces costs for a company, while the cap on the whole country does not change. Overall pollution is not affected by this action, the overall goal of the policy. Thus, a cap-and-trade system gives the government more flexibility in responding to economic conditions and certain legitimate interest groups, without compromising the essence of the program.

The third reason that a cap-and-trade system may be more desirable politically is that consumer price increases are less apparent under a cap. This is because the cost of carbon is more implicit in a cap system, hidden in the cost of abatement and auction costs, whereas the cost of carbon in a tax is visible by all (just look at the tax rate). Thus, increases in consumer prices are not as easily attributable to environmental policy under a cap. In such a situation, there will be less pressure on policy makers to redistribute the government's revenues and fewer lobbyists demanding such actions. This is in contrast to a tax, where powerful sectors will pressure the government for exemptions, causing the system to resemble command and control and its drawbacks.[18]

Rent Seeking

Another important political factor to consider is the potential for participants to employ rent seeking tactics, or seek to make money by manipulating the economic and/or legal environment. Under which policy is rent seeking more likely to exist and be successful?

Rent seeking under a tax would entail receiving some sort of tax exemption, allowing a firm to pollute without being adequately charged for it. This type of rent seeking is unlimited in its nature, because there is no limit to how much that company can pollute, without being charged. Rent seeking under a cap-and-trade, would entail a company receiving an over-allocation of free pollution permits. This type of rent seeking is limited, however. The company can exploit the over-allocation in one of two ways: either pollute more than they need to or sell the extra permits to generate revenue. Regardless of the course of action chosen, the gain is limited to the amount of over-allocation that the company was given. The overall cap on society will still hold, and there will be no unexpected, extra total pollution, as would be possible under a tax. Thus, a cap-and-trade system is superior with respect to rent seeking as well, and with regards to political considerations in general.

[18] Furman et al, 2007

International harmonization

One of the unique and most important characteristics of carbon emissions is that one ton of carbon emitted has the same affect on the climate, regardless of location and time. Therefore, in combating global warming, it is imperative that a policy be drafted that is both long-term in nature and international in scope.

The Hamilton Project adds three related reasons why a global response to climate change is necessary. First, the developing world will soon surpass the US in its contribution to emissions and will account for 75% of the growth in emissions over the next 25 years, with China accounting for 39%.[19] Second, involving the developing world will offer the greatest opportunity for low-cost emissions reductions, as rapid increases in demand for energy can be met at low cost by designing new power plants and technology to be more efficient in developing countries.[20] Third, if foreign countries have more lenient pollution standards, carbon leakage will occur, whereby local firms in developed countries will move abroad to lower their pollution costs.[21] Therefore, the policy must be powerful enough to cause meaningful change, while at the same time flexible enough to be tailored to individual country needs and appetites.

International drawbacks of a tax

There are two major drawbacks of a tax system with regards to international adoption. First, a tax system will only be effective if the carbon tax is the same across countries, otherwise carbon leakage will occur. This is unlikely to happen, as developing countries have no incentive

[19] International Energy Agency (IEA), World Energy Outlook, 2006
[20] Frankel, 1999
[21] Weyant and Hill, 1999

to charge as high of a tax on carbon emissions as a more developed country would, since they will be inhibiting the faster-paced growth that they would otherwise enjoy. Additionally, no country would like to have an outside, international authority setting tax rates for their domestic businesses, especially when countries differ in their appetite for taxes in general.

Second, the efficiency gains from the policy will be restricted to each individual country. In other words, the tax system will promote the lowest-cost abatement in that given country, but not necessarily across countries. This is inefficient from a global perspective because most developing countries have lower abatement costs, and should therefore be net pollution reducers (since they can reduce the cheapest), whereas developed countries would be net pollution users (because it is more expensive for them to abate). Such a gain from the trading of relative advantages will be lost since domestic taxes would not allow wealth to be transferred across borders, unless developed countries literally transfer tax receipts to developing countries, a reality that is very unlikely.

For a cap-and-trade program to work, countries would need to employ a logical cap on emissions, as a cap that is too high will reduce the effectiveness of the whole policy. Unlike under a tax, however, businesses in developing countries will have an incentive to join the global cap-and-trade system since they can achieve substantial revenues from selling extra permits to developed countries (since their cost to abate pollution is lower). Additionally, these developing countries will have an incentive to ***tighten*** their domestic caps so that permit supply will be lower and prices will be higher, leading to more revenue per permit. Having a lax and loose policy framework would not be in the interest of anyone involved, and thus incentives would be aligned across borders. Additionally, as the price of carbon permits becomes standardized across borders, companies in developed countries will not gain from re-locating to developing countries because their pollution costs will be the same.

Aligning incentives is particularly important in this instance because there has yet to emerge a global regulatory body that has the power to implement policy, and punish those who do not adhere. Not only that, but there has been a general hesitation by both the US and the developing world to move first on climate control, because both fear that whoever moves first will be at a competitive disadvantage economically, until the other implements policy as well. Therefore, a system that aligns the incentives of both sides is more likely to be implemented simultaneously by both. A cap-and-trade system—which aligns the incentives of all countries involved—would appear superior.

Stable, yet flexible

A cap-and-trade system would work particularly well on an international scale because it sets a globalized standard, but still allows individual countries room to tinker with the policy. For instance, individual governments can choose to auction off permits or give them away for free (or, more likely, somewhere in the middle). This will allow governments to generate the amount of revenue they desire, help certain industries, and alter allocation patterns ***without*** affecting the global cap on emissions. This would not be possible under a tax, as any adjustment to the policy would also alter the total amount of carbon emitted (as explained above).

"Fair" resolution to the legacy argument

With regards to climate policy, developing countries have often argued that developed nations should bear the larger cost for reducing pollution since it is the pollution of those countries that has filled the atmosphere until now. While their argument may have merit, it is difficult to imagine the powerful, developed countries agreeing to a policy that hurts them in favor of rapidly growing, developing countries. In this manner, a cap-and-trade system would be beneficial to both parties. Under a cap-and-trade system, developing countries would not be given preferential treatment (this would satisfy developed countries), but as a natural consequence of the system wealth will most likely flow from the developed to the developing world. This is because developed countries will undoubtedly be net purchasers of permits (from developing countries) and developing countries will be net sellers of permits (to developed countries), since developing countries generally have lower abatement costs. Developing countries will benefit from the inflows of capital and developed countries will benefit from access to low-cost abatement. This wealth transfer (from wealthier countries to poorer countries) is good for society as a whole, is done in a fair and economically efficient manner, and will leave all parties better off. This would not be possible under a tax since wealth transfers stay domestic.

Since international harmonization is so integral to the climate change issue, the differences between a tax and cap-and-trade program are therefore magnified. More specifically, since developing countries will have an incentive to tighten their caps, will receive substantial wealth inflows, and have the ability to tailor the program to country-specific issues, a cap-and-trade program has a substantial advantage over a tax in international implementation.

Short-term volatility

The first phase (Phase 1) of the European Emissions Trading Scheme (EU ETS), which lasted from 2005 to 2007, had both successes and failures. One of its greatest failures was the sudden fall in the price of carbon from over 15 Euros per ton of CO_2 in October 2006 to close to 0 Euros only seven months later. The price fall was primarily caused by the emergence of data in 2006 showing that there had been a significant over-allocation of permits to companies in Phase 1, leading to much more supply than demand, and thus a recalibration of the equilibrium carbon price, down to almost nothing.

This abrupt reduction in pollution costs decreased the perceived legitimacy of the EU ETS system in the eyes of European corporations, since they no longer had confidence in the price of carbon that they had been factoring into their long-term decisions, specifically regarding investments in emissions abatement technologies and green products. As the goal of the cap-and-trade system is to assign a cost to polluting, thus making companies less likely to pollute and more likely to invest in green technologies, excessive short-run volatility can potentially derail the whole purpose of the program.[22]

The EU experience in no way indicates that a cap-and-trade system cannot work, but rather, it offers a clear cut and timely lesson that policy-makers should pay close attention to going forward. In the case of the EU, the price of carbon was affected by poor information available in the market, which was magnified by the release of 2005 emissions data which showed a 4% surplus of permits above actual emissions.[23] Prices eventually stabilized once the EU Commission gave a stricter review of allowances and decided to reduce EU emissions to 20% below 1990 levels by 2020. Although there is no way to prevent new information from hitting the market, there are certain mechanisms that a cap-and-trade system can employ to *limit*

[22] It should be noted that price volatility should not affect abatement investment decisions any more than the volatility in the cost of abatement technologies, which can occur under both a tax and cap (Cap and Trade, Rehabilitated: Using Tradable Permits to Control U.S. Greenhouse Gases Nathaniel O. Keohane).

price volatility.

Information transparency

In relatively efficient markets, the equilibrium price will generally be based on a balance between supply and demand expectations. As long as these expectations do not deviate too much, the price will remain relatively stable. Therefore, it is imperative that any climate control regulatory system enables market participants to have accurate expectations, to the extent possible. In this case, expectations relate to how many permits will be available (supply) relative to how much carbon is emitted, and thus how many permits are needed (demand). In order for a cap-and-trade system to work effectively, regulators much be careful to a) use their best effort in setting a reasonable cap to avoid over- or under-allocation, and b) avoid situations where sudden news can have a meaningful impact on the knowledge available to the public. One way to accomplish this may be to have more frequent studies/assessments of whether predictions are holding true.

Banking and borrowing[24]

Banking and borrowing will decrease price volatility because it allows some flexibility in the supply of credits in a given year, allowing it to adjust to new information and scientific changes. These mechanisms also uphold the integrity of the program because carbon that accumulates in the atmosphere stays there for a long time (over 100 years), so year to year deviations in the overall amount of emissions is not too damaging as long as the long-term,

[23] Convery et al, 2008

[24] Please see earlier section which explains what banking and borrowing mechanisms are.

cumulative cap on the economy remains intact. Additionally, entire banks could be created for the sole purpose of managing a company's future permits, generating revenue by charging interest on the borrowed credit and the like. Phase I of the EU ETS did not allow banking or borrowing, and we will return to this subject later.

CDM & JI projects

The Clean Development Mechanism (CDM) and Joint Implementation (JI) are arrangements under the Kyoto Protocol in which companies in industrialized countries can invest in emissions-reducing projects, which will then create extra emissions permits for that company in its domestic country. In the same way that banking and borrowing made permits fungible across time, CDM and JI projects make emissions reductions, and the permits they can create, fungible across borders. Additionally, capital has been raised by investment funds looking to invest in these projects, in the hopes of selling the permits for greater than their cost to abate.[25]

The main difference between the two arrangements is that CDM refers to projects in developing countries, whereas JI projects are located in other developed countries. The purpose of the programs is to allow companies in developed countries access to low-cost abatement, even if the project host countries are not covered by an emissions scheme. JI projects are much less common since low-cost abatement opportunities are predominantly in the developing world, and will thus not be analyzed any further in this paper. Additionally, companies in developed countries may have expertise in a certain type of abatement that companies in developing countries may not have, and thus society as a whole will benefit from the additional abatement in the developing country.

These abatement mechanisms will help stabilize carbon prices because, as with banking and borrowing, there will be added flexibility to the supply of permits. Therefore, if unexpected news emerges which alters the expected demand of permits, the supply side may adjust as well in order to keep the equilibrium price from changing too much. A limited amount of CDM projects were allowed during Phase I of the EU's trading scheme.

Allowing CDM- and JI-created credits to be used in developed countries can create complications and over-sight issues. The two criteria that a CDM project must meet are: a) they must provide real, measurable, and long-term benefits related to the mitigation of climate change, and b) they need to achieve reductions beyond what would occur anyway (known as "additionality"). There have been cases reported where a company from a developed country ("Company A") would tell a certain company in a developing country ("Company B") to increase its pollution for a short period of time so that when Company A cleaned up the pollution back to its original levels, it would look, in comparison, like they reduced emissions by a large amount. This would give Company A a certain amount of emissions credits when it really did not do much in the way of reducing overall emissions. In a cap-and-trade system, such an exploitation of the system can ruin the integrity of the scheme itself, as credits will be created without a counteracting reduction in emissions, which will cause the overall emissions cap to be breached in the aggregate. These issues will be dealt with in more depth later with regards to the EU's system.

These complications can be managed, however. Better oversight of CDM and JI projects is a good start, although this can be difficult since the cooperation of the developing country's government would be necessary. Additionally, regulators should calculate the emissions

[25] For a few examples of both project developers and projects themselves please visit

reduced, not based on a comparison to recent emissions, but rather a comparison to the emissions over some past period of time. This would help to avoid the gaming mentioned earlier.

CDM and JI projects may have positive, auxiliary effects as well. Carbon emissions policy is only a slice of the greenhouse gas emissions problem. Project-based mechanisms may give governments the ability to reduce other greenhouse gases, in conjunction with the carbon policy. For instance, a project to reduce SO_2 emissions will count as a CDM project, thus generating an extra carbon permit by reducing another harmful gas. This will increase the incentive for companies to reduce greenhouse gases, other than carbon—a nice secondary benefit of a cap-and-trade system that employs CDM and JI projects.

International trading

The larger the traded market for carbon credits is, the more efficient it will be, leading to more accurate prices for carbon and less volatility in those prices. Having an international market for these credits has many benefits for the emissions reductions program, which are discussed throughout this paper. One such benefit is that it will increase the size of the market considerably, allowing for a wider spread of sources for both supply and demand, leading to smaller and more rare, short-term price swings. Implementation of such an exchange, or market, is beyond the scope of this paper.

Tight cap

As was mentioned earlier and will be looked at again later, the main reason for the huge volatility in carbon prices during Phase I of the EU's system was the over-allocation of permits

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http://www.climatefocus.com/focusareas/cdmji.html to polluting entities. It is understandable why regulators erred on the side of generosity when allocating permits, since they did not want to over-burden businesses in the first phase of a long-term program. Nonetheless, the danger in being too generous in allocating permits is now apparent and regulators should take notice. Anyway, regulators have other tools at their disposal in a cap-and-trade system in order to appease businesses, such as allocating more permits for free as opposed to an auction. Such a tool would only affect government revenues (decrease them), which is much preferred as opposed to an over-allocation of permits, which defeats the whole purpose of a cap.

In deciding what entities to allocate to, regulators should consider whether to update the baseline emissions levels. In other words, in Year X of the scheme, should regulators base their allocation decisions on actual emissions during Year X-1, or should they keep the initial baseline data from the inception of the program. Both approaches would appear to have drawbacks.

The situation of certain entities—such as their use of clean technologies—may have changed considerably from the time the scheme was implemented, and therefore Year 0 baseline data would seem irrelevant when deciding on a Year X allowance level. On the other hand, if allocation is continuously updated—that is, if the baseline year is always the year prior—it can cause perverse incentives for corporations. If a company expects the price of carbon to increase over time (which would seem logical since the cap is steadily declining over time) it may decide to pollute more today so that they will be offered more permits tomorrow.

For this reason, it makes the most sense for regulators to use some sort of trailing average emissions level that incorporates both emissions in the recent past as well as from earlier on. This average could also be weighted more heavily towards the recent emissions data if there was a significant change in emissions levels at a particular entity due to a material shift in either the entities business operations or technological advancements.

Hedging

Even if all the aforementioned methods do not result in a large reduction in price volatility, firms will still have the ability to manage the price of the permits through financial hedging instruments. For instance, a company can become carbon price neutral by both purchasing and selling short a derivative instrument that has a value derived from the price of carbon. In this manner, the company will not have to worry about fluctuations in the price of carbon and accurately make long-term decisions. Although these instruments are still nascent, they stand to grow more numerous, efficient, and liquid as the carbon industry gets bigger. We will address the financial market component of a cap-and-trade program later with regards to the EU.

Effective abatement and flexibility

Until this point, assessing the effectiveness of a carbon tax vs. a cap-and-trade program involved comparing long-term cost efficiency, political feasibility, international harmonization, and short-term price volatility. The over-riding purpose of any climate change program, however, is the effective abatement of harmful greenhouse gases, and the policies must be compared on their ability to achieve this goal as well. As a cap-and-trade program sets the overall emissions target, and the carbon price is a function of this cap, it would seem to be superior on the basis of attempting to reach a certain level of total emissions. This is in contrast to a tax, where the carbon price is set, and total emissions are a function of this price.

Nonetheless, in theory, there is no need for there to be any difference in abatement between a carbon tax and a cap-and-trade program, if the appropriate tax rate and cap are chosen, respectively. Essentially, a certain desired price of carbon (as set by a certain tax rate in the tax program) can be reached under a cap system by setting the appropriate cap. Additionally, a desired emissions level (as set by a cap in the cap-and-trade program) can be reached by setting an appropriate carbon tax rate. As the goal of the program is to reach a certain emissions level, and not necessarily any specific price, it would follow that if a tax is chosen as the policy instrument, the tax rate, or carbon price, should be tailored in such a way as to reflect this desired emissions level. Although theoretically possible, new data that will surely arise over time regarding climate change will make it necessary for the chosen policy to exhibit flexibility with regards to total emissions.

Flexibility

As mentioned above, both a carbon tax and cap-and-trade program have the flexibility to alter the desired total emissions—in a direct way under a cap and an indirect way under a tax (by changing the tax rate). In practice, however, it may be much more difficult to continuously change a tax rate over time as opposed to merely altering the total cap on emissions. This is because changing tax rates will explicitly change the cost of carbon to individual companies, making them more likely to oppose such a move (if the tax rate is being increased) and also more inclined to lobby for changes in the tax rate if they feel it is flexible and ever-changing. Altering the cap to respond to scientific breakthroughs, on the other hand, will also change the price of carbon to companies but in a much more implicit way, making them less likely be as outspoken about the increased costs (if the cap is lowered). Additionally, it may be an easier argument for a scientist to make to say that the maximum amount of emissions in the atmosphere must be X, rather than saying the minimum tax must be X. Carbon and the atmosphere are the scientist's expertise, not taxes. Thus, it appears that a cap-and-trade system will allow for much more flexibility in responding to changes in our scientific understanding of the damage that carbon in the atmosphere causes.

In addition to being flexible with regards to changes in scientific findings, a climate change policy must also be flexible enough to work with existing or potential future government policies. For instance, both a carbon tax and cap-and-trade program may not directly impose a cost on oil, which, aside from the various environmental concerns, poses serious threats to the US's national security concerns. It has long been argued that a higher tax would be most effective in combating the country's reliance on oil.[26] As such, it may not be feasible for the government to attempt to implement two separate tax programs in the near future—one for carbon and one for oil. Political appetite for an oil tax may be enhanced if climate policy emerges in the form of a cap, avoiding making companies feel like they are being taxed twice. Additionally, there are a number of taxes that are present in our current government system and very few cap programs (the largest being the SO_2 cap-and-trade program), another reason why Americans may not want another tax.

While domestic political considerations must be accounted for, flexibility from an international perspective must be addressed as well. Since the most efficient program will be one that crosses borders, a general policy framework must be designed that can also transcend national borders. It has already been mentioned above that a cap has two distinct advantages with regards to international considerations: the need for an equal tax rate, which is unlikely, and the ability for wealth to be transferred across borders with a cap system. A third advantage lies

[26] As recent as December 2008 by economist Thomas Cooley in a Forbe's column "Raise The Gas Tax Now."

in the political flexibilities mentioned above. Countries and their citizens have differing appetites for taxes, and a global climate policy should not force a country to diverge from its norm. Additionally, a cap-and-trade system will allow foreign governments to be flexible with their other domestic policies, and not overburden their citizens with too many taxes, especially one where the rate is set by foreign entities.

From theory to reality

Until now, we have touched on the theoretical considerations that must be taken into account when designing a successful cap-and-trade program. These included long-term efficiency, politically viability, international harmonization, short-term volatility, effective abatement, and the overall flexibility of the program. Nonetheless, to quote Steinbeck, "The best-laid plans of mice and men/often go awry", so it would be beneficial to take a look at how a cap-and-trade system looks when actually implemented, as it was in the European Union in 2005.[27]

EU ETS

In the 1990's, the European Commission attempted to implement a carbon tax across the EU in order to combat the growing global concerns regarding climate change. That attempt failed as some member states viewed a tax as a blow to their own sovereignty that would undoubtedly be followed by more Europe-wide taxes. Additionally, many major industry

[27] Steinbeck, 1993

lobbyists opposed the tax, and even a few favored a cap-and-trade system instead. The tax never did take hold in Europe, but the EU nonetheless got its chance to lead in the effort to reduce greenhouse gas emissions in the decade that followed.[28]

The Kyoto Protocol, the ground-breaking international environmental agreement that over 180 countries have ratified (notably excluding the US), requires that industrialized countries achieve certain binding targets by 2008 and 2012. Based on this requirement, the EU government established the EU Emissions Trading Scheme (EU ETS), a market-based emissions trading program through which member states would reduce their CO_2 emissions by 8% between 2008 and 2012, while attempting to minimize the negative effects on economic development and employment.[29] The EU structured the program in three phases: 1) Phase 1, from 2005-2007, was intended to be used to gain experience with emissions trading before the Protocol's 2008 to 2012 commitment period, 2) From 2008-2012 to coincide with the first commitment period of the Protocol, and 3) post-2012, whereby an expansive, effective, and sustainable policy will be alive and kicking.

Phase I included 11,000 electric power and industrial installations in 25 member states, which accounted for about 45% of the EU's carbon dioxide emissions. Additionally, according to the World Bank, the financial value of the carbon credits in the EU ETS amounted to $63 billion in 2007. $50 billion of these were EU allowances (EUAs) and $13 billion consisted of credits from Clean Development Mechanism projects (CERs).[30] This has made the EU ETS the largest, multi-national emissions trading scheme in the world, and therefore provides an excellent example from which the US can learn from before enacting its own climate change policies.

[28] Convery et al, 2008
[29] European Commission, 2004
[30] World Bank, 2008

In assessing the effectiveness and lessons of Phase I of the EU ETS, it makes sense to identify different features that the program had and whether these features helped in achieving long-term efficiency, politically viability, international harmonization, a limit to short-term volatility, and effective abatement while at the same time was still flexible to allow changes in policy.

Determination of the caps

In an emissions trading scheme, the supply and demand in the market are directly affected by government decisions. The number of permits allocated will determine scarcity levels and thus the effectiveness and efficiency of the program.[31] Therefore, the initial decisions regarding how much and to whom permits are allocated to, are important ones.

In the case of the EU, countries tried to put a larger burden on the power sector, by allocating to it fewer permits. This was done because the power sector is relatively location-oriented and does not face much international competition. The EU was nervous about over-burdening internationally competitive industries because they did not want to put their domestic companies at a competitive disadvantage now that they had higher operational costs. Additionally, the power sector has relatively low abatement costs, as they can easily take meaningful measures, such as switching from coal to natural gas, which has less pollution.[32]

One startling fact about the EU ETS is the relatively little amount of time countries were given in order to determine the caps for their jurisdictions. In only half a year, member states were required to identify which companies to include in the cap, establish a baseline level of pollution for those entities, determine an overall country cap, and decide how to allocate those

[31] Betz and Sato 2006

caps. To make matters worse, although there was relatively reliable information available for total country emissions, data for individual entities was difficult to obtain in only six months. Therefore, member states relied on recent emissions data as well as voluntary data submitted by the companies themselves. This created perverse incentives for companies to both increase their emissions now (to set a higher baseline which would allow them to receive more allowances) and fudge the voluntary numbers that they submitted. Additionally, in projecting future emissions, countries used relatively optimistic assumptions with regards to economic growth, which made the projected emissions higher.[33] As would be expected, and especially because this was the "test" phase, countries erred on the side of over-allocation, so as not to create an unnecessary burden for corporations.

The speed with which the caps were created and the ambiguity regarding the actual data was magnified by the fact that emission reduction targets were relatively modest for this test phase. Therefore, any slight over-allocation of allowances would mean that many companies would not need to reduce their emissions very much at all, if any. In hindsight, it is not such a surprise that in the spring of 2006, verified 2005 data showed that allowances were over-allocated and that there were more allowances than actual emissions. Therefore, the need to reduce pollution was negated and the allowances made worthless. This had numerous negative effects on the overall policy. It created a huge amount of short-term volatility in the price of a EUA as it fell from over $37 to under $10. Not only did this anger companies which had purchased permits, it also caused large losses to financial speculators, who are integral to providing liquidity and price discovery in the system.

The sharp decline in price also removed the cost of pollution in the decision-making

[32] Convery et al, 2008

calculations of polluting companies. When deciding whether to continue with business as usual or whether to invest in cleaner operations, companies no longer had the incentive to invest. Additionally, it caused corporations to doubt the integrity of the system as a whole, as they could not trust that the price of carbon would remain steady. Therefore, it is of utmost importance that the US learns from the mistakes of the EU in this regard and tries to avoid repeating them.

There are a few ways in which the US can try to avoid a repetition of what happened in the EU. First, the US has successfully established a cap-and-trade program for sulfur dioxide, in which allowances were not over-allocated. The program used average emissions from 1985 to 1987 as the baseline for necessary reductions in 1995. Using a historical average, as opposed to a recent year's emissions as the EU did, was superior for two reasons. First, the baseline years happened far enough in the past that companies could not alter their emissions to manipulate the allowances they would get, since the data was taken from a time when companies did not even know the program was going to be implemented. Additionally, the SO_2 program used an average of 3 years to determine the baseline data, which further eliminated any one-year extraordinary emissions or reductions that could have misrepresented a company's actual emissions habits.

Another way that the US can enhance the reliability of its data would be to incorporate benchmarking into the equation. Benchmarking distributes allowances based on both a standard emissions rate (i.e. best available technology), and an economic indicator (i.e. historical production levels for the covered entity).[34] In this manner, companies will be allocated allowances based on how much they should be expected to emit, calculated from normal production outputs, and how easy it will be for them to reduce emissions, based on the

[33] GAO-09-151, 2008

technology available. This would decrease the incentive for companies to inflate emissions during the "base" year, as allocations will not be based just on their emissions for that year. The EU has decided to incorporate more benchmarking in Phase II.

Additionally, the US could attempt to approach the data-gathering process in a more centralized way. In the EU, member states researched their own data and relied on individual entities to provide them with data. Granted, the member states were under time constraints, and the US could benefit greatly from having a more centralized organization doing all of the data collecting. In the spring of 2009, the Environmental Protection Agency released a draft rule entitled "Mandatory Reporting of Greenhouse Gases", which sets out a framework through which over 13,000 facilities in the US would be required to report greenhouse gas emissions data annually.

The EU monitored "downstream" entities, or direct and indirect emitters, as opposed to "upstream" entities, or those sources that represent when CO_2 initially enters the economy. Upstream entities are easier to monitor, because they are less numerous, but require a larger amount of cooperation across the program. The EPA's proposed rule would seek to monitor both types of facilities. This is in contrast to the program proposed in the Lieberman-Warner Climate Security Act of 2008, which advocates monitoring only upstream sources.[35] The types of facilities which are required to report emissions data include: a) the majority of suppliers of fossil fuels or industrial greenhouse gases and engine/vehicle manufacturers, b) pollution-heavy industries such as electrical generation and manufacturing of electronics, chemicals, cement, and aluminum, and c) facilities that emit above a certain threshold annually (25 thousand tons of

[34] ibid

[35] GovTrack.us. S. 3036--110th Congress, 2008

carbon dioxide equivalent).[36]

The creation of such a rule by the EPA is a clear sign that the US is preparing to implement an emissions reductions policy and attempt to avoid the monitoring errors that befell the EU in Phase I of its program. The EPA says so itself in the preamble to the rule:

> 1. Identifying the Goals of the GHG Reporting System
> The mandatory reporting program would provide comprehensive and accurate data which would inform future climate change policies. Potential future climate policies include research and development initiatives, economic incentives, new or expanded voluntary programs, adaptation strategies, emission standards, a carbon tax, or a cap-and-trade program. Because we do not know at this time the specific policies that may be adopted, the data reported through the mandatory reporting system should be of sufficient quality to support a range of approaches.[37]

The EPA estimates that the cost for corporations to comply with this new rule will be about $160 million total in the first year and $127 million annually thereafter.[38] In a future cap-and-trade program, the government can use permit auction revenue to offset the reduced income tax revenue that this added expense will lead to. The gases that are covered by this rule include carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, as well as others. This would appear to indicate that reducing CO2 emissions is only the beginning of how far climate change policy may go.

Allocation: free or auction?

As was touched upon earlier, the decision to allocate the permits for free or to auction them off (or a combination) may have a significant impact on the distributional consequences of

[36] A carbon dioxide equivalent is a measurement that represents a quantity of CO_2 that has the same polluting effects as the given gas. For example, if gas X has half the polluting effects as carbon dioxide, the CO_2 equivalent of 10 tons of gas X would be 5 tons.
[37] Environmental Protection Agency, 2009
[38] Schwartz et al, 2009

the trading scheme.[39] In essence, the government has to weigh the positive impacts of generating substantial amounts of revenue versus the burden it wants to place on companies, and perhaps even consumers. As Phase I was only a test-run, the EU decided to lean heavily towards giving away the permits for free, so as not to overburden the companies who were involved in the program. In Phase I, the allocation was handled by each member state individually and the EU allowed each country to auction off up to 10% of the permits. Only four of the EU countries auctioned any permits at all, and the rest gave them away for free. Aside from lightening the burden of corporations, the hope was that allocating permits for free would also help consumers as companies would not need to increase their prices to offset the auction prices. This was not the case, however, as companies used the marginal cost of carbon in their pricing decisions, which was unaffected by the fact that the permits were given away for free. Therefore, since companies anticipated that their costs would increase in the future due to the price of carbon, they passed those costs along to the customer. An important lesson to take away from this is that allocating the permits for free will only help the entities that are receiving the permits, not necessarily the end purchaser of products.

Since most companies ended up passing the cost of carbon onto the consumer anyway, the only entities that were actually helped by the free allocation where those companies that did not have the pricing power to be able to pass along added costs. Therefore, the US should be mindful that if it chooses to offer a larger amount of permits for free earlier on and gradually move towards full auctioning (as was proposed earlier in this paper), it should only give away permits to those companies who do not have pricing power. Additionally, since we saw from Phase I that consumers were forced to fund much of the carbon costs, revenue generated from

[39] Betz and Sato, 2006

auctioning permits could be used to reduce certain other taxes that are currently levied on the average consumer.

Banking and borrowing

The EU ETS did not allow banking and borrowing in Phase I and this may have contributed to the price volatility, particularly because the credits would still have had value, despite the Phase I over-allocation, if banking had been allowed. This is particularly evident from the fact that forward prices (to be delivered in Phase II) did not fall as much as spot prices (Phase I) when the over-allocation was announced (see Appendix IV). Seemingly acknowledging this logic, the EU ETS has decided to incorporate banking into the scheme going forward. Given that carbon prices will most likely be expected to rise over time, the ability to bank permits will give corporations a big incentive to reduce emissions even more today, so they don't have to use a permit now which will have a greater value in the future. The EU's decision not to allow borrowing may stem from the fact that it does not want companies to build up carbon debt to an unsafe point, as the consequences of not paying back that debt involve the future of our planet.

CDM

Clean Development Mechanisms, which were discussed earlier in this paper, were allowed during Phase I and accounted for about 20% of the value of the permits as a whole. Although developed countries outside of the EU also participated in creating abatement projects (Canada, New Zealand, Switzerland, Japan), the majority of the demand for CDM projects came from the EU. As of September 2008, over 3,800 different projects were seeking credits through the CDM, and this probably underestimates the actual quantity.[40] Additionally, aside from reducing global emissions, the CDM program created a demand to reduce emissions from gases other than CO_2, since reduction of these other gases count towards CER credits (the CDM equivalent of an EU Allowance). Therefore, it is clear that the mechanism succeeded in involving developing countries, particularly China and India, as well as other gases besides carbon dioxide into the EU's scheme. At the same time, there were many operational challenges that occurred and must be addressed going forward.

The two criteria that a CDM project must meet are: a) they must provide real, measurable, and long-term benefits related to the mitigation of climate change, and b) they need to achieve reductions beyond what would occur anyway (known as "additionality"). With regards to the first criteria, situations occurred when projects were avoided, even though they would have reduced a large amount of emissions, because the project did not provide any indication that future emissions would be reduced. For example, a large pollution clean-up effort would succeed in reducing current emissions, but not protect against future ones and would therefore not be counted as a CDM project.

The additionality requirement is essential, although difficult to implement. It is essential, because if a project does not really reduce emissions that wouldn't have otherwise been reduced, and a carbon credit is generated because of it, the integrity of the total cap in the EU would be compromised. Additionality is difficult to implement because it requires estimating what may have happened in the future if no action were taken. Such estimates are inherently speculative. Additionally, the CDM program's integrity is subject to the reliability of the host country's verification schemes. Since the countries involved are developing, they usually have nascent

[40] GAO-09-151, 2008.

regulatory frameworks and thus such reliability is questionable. For this reason, the application process for projects was very lengthy and time consuming in Phase I, which caused many projects to be abandoned.

It thus appears that the US should take a long look at the CDM program to make sure that the integrity of its own program isn't jeopardized. Additionally, the US should keep in mind that once developing countries implement an emissions program of their own, such projects will be unnecessary. Therefore, CDM programs should be utilized as a transitional, short-term tool, rather than a permanent fixture in the climate change policy.

New entrants and closures

A significant issue that the EU ETS came across in Phase I was how to handle entities leaving and entering the system. In Phase I, an entity that was leaving (a factory or company ceasing to exist) had to return its permits to the EU and new entrants coming online would receive permits for free. This caused perverse incentives as a dying company had little reason to abate pollution since it would have to give the permits to the EU anyway when it shut its doors.

Additionally, the fact that new entrants weren't charged at all does not make much sense. The main purpose for giving away any free allowances in the first place was due to the fact that many companies have older, legacy factories already in place, so the government would help them along in the earlier years to cover abatement costs. If a new entrant is coming online, the government should probably expect, and demand, that its factories have more up-to-date technologies, and thus can handle the burden of having to purchase its own allowances. In this manner, the EU should have learned from the sulfur dioxide cap-and-trade scheme in the US, where new entrants must purchase their allowances, and closed facilities still get to keep their permits and can sell them on the open market, or back to the government at market prices.[41]

The market

While carbon emissions are often traded over-the-counter, many are now being traded on regulated exchanges. Emissions are traded on the European Energy Exchange (EEX) the Nordic Power Exchange (Nord Pool), and others, however the European Climate Exchange (ECX) is the main marketplace for trading carbon dioxide allowances in the EU and internationally, accounting for almost 75% of trading.[42] The exchange currently supports two types of allowances, EUAs and CERs. EU Allowances (EUA) are permits that stem from the EU's climate change program, the EU ETS. Certified Emission Reductions (CER) are generated through carbon-reducing projects (usually CDMs) in non-covered countries. Trading of the allowances commenced in April 2005 and options followed, which began trading in October 2006, although only for EUAs. Futures and options contracts for CERs were introduced in 2008.

The ECX's carbon contracts are listed for trading on the Intercontinental Exchange (ICE) Futures Europe, an exchange which recently reached over 800,000 contracts traded daily. Therefore, all contracts are cleared by ICE Clear Europe, enjoy standardized terms and are regulated by the UK's Financial Services Authority (FSA). Almost 100 leading global businesses have signed up for membership to trade ECX emissions products.[43] In addition, several thousand traders around the world have access to the ECX emissions market on ICE via banks and brokers.

[41] Convery et al, 2008
[42] Ellerman and Joskow, 2008
[43] http://www.ecx.eu/

During Phase I of the EU ETS, the ECX was still relatively immature, which caused more than ideal short-term price volatility. This was mainly because there were only a small number of market participants, made up of professional traders and some larger corporations. As more participants enter the market, price stability should increase. Additionally, currently, each market participant has the incentive to keep prices high. Traders make a higher commission on higher valued trades and thus would rather the price be high. Corporations do not want regulators to tighten the cap because of low carbon prices, and thus also want to keep the price slightly inflated. Additionally, if allowances are given away for free, companies would also want their value to be higher, whether to pass along the "costs" to consumers or to sell the permits. This may be one of the reasons why the permits were trading at such a high value before they collapsed in 2006. As more participants enter the market, such as short-sellers, these incentive issues should go away.

Average monthly trading volume grew steadily from a monthly average of 10 million EUAs in the first quarter of 2005 to 100 million in the first quarter of 2007 and onwards (European Union's Emissions Trading Scheme in Perspective, 16). The main instruments traded are forward and futures contracts, with delivery dates in December of a given year. The reason why delivery dates are in December is because covered entities must present their allowances to the European Commission in April in the year after the applicable emissions period. Therefore, the settlement date has to be before April of the following year.

In Phase I, these contracts were purchased to be used for polluting, as hedges against price movements, and as speculative investments by traders taking the other side of such hedging. Additionally, what became clear from trading in Phase I was that, although the European Commission over-allocated permits on the aggregate, the power and heat sectors were net purchasers of permits, meaning allowances were under-allocated to these industries. This is because these sectors generally lack international competition and have pricing power so as to be able to pass along such costs. The market is expected to continue to grow as the program expands and other countries implement similar schemes.

Abatement?

Directive 2003/87/EC, which was written by the European Commission states, "This Directive establishes a scheme for greenhouse gas emission allowance trading within the Community...in order to promote reductions of greenhouse gas emissions in a cost-effective and economically efficient manner".[44] Although Phase I was only a trial phase, did any abatement occur?

Kemfert et al. (2006) estimate significant efficiency gains from trading permits in Phase I, as opposed to not having a trading scheme at all. Trading appeared to occur for the most part between different industry sectors, rather than across country borders. This is most likely attributable to the fact that since there was an over-allocation of permits, firms did not have to look far to find another firm that had extra.[45]

Convery et al. (2008) state that modest abatement occurred during Phase I. Additionally, anecdotal evidence indicates that companies took the price of carbon into account, especially in the power sector. Phase I occurred during a period of relatively robust economic growth, meaning that an increase in emissions would normally have been expected. In actuality, verified emissions in 2005 and 2006 were lower than emissions in 2002, 2003, and 2004. The paper concludes that emissions reductions due to the trading scheme were between 2.5% and 5% of what actual emissions would have been without the program, and that most of these reductions came from sources that had not been anticipated.[46]

Despite the deficiencies of the scheme during Phase I, the EU ETS succeeded in the aggregate. For starters, carbon now has a real price that firms must take into account when making investment decisions. The carbon price has induced at least some level of emissions abatement in a very short period of time. Fears that the carbon price would affect industrial competitiveness were assuaged, and should only lessen as more countries implement climate change policies. Despite their regulatory issues, project-based mechanisms (mainly CDMs) have successfully reduced pollution and increased wealth/technology transfer to developing countries, allowing the positive impact of the EU ETS to cross borders. Lastly, and most importantly for the US, lessons from the EU ETS can be applied to future climate negotiations.

The US Acid Rain Program

In 1995, the US Environmental Protection Agency (EPA) introduced a national SO_2 emissions trading program to reduce acid rain. The SO_2 scheme has been a major success, with emissions being reduced by about 45% from a peak of 18.25 million tons of sulfur dioxide in 1975 to 10.10 million tons in 2002, a reduction of almost 50%. Even more impressive is the fact that since the year of peak emissions, 1977, fossil-fuel-fired generation has increased at an average annual rate of 2% while SO_2 emissions from these sources have decreased at an annual rate of 2.4%. This implies an annual reduction rate of aggregate SO_2 intensity for fossil-fuel-

[44] European Commission, 2004
[45] Kemfert et al, 2006

fired generation of 4.3%, from 23 pounds of SO_2 per megawatt-hour in 1977 to 7.76 pounds in 2002.[47]

The program applies only to power generators and utilizes a cap-and-trade program. Sulfur emissions are similar to carbon emissions, in the sense that the cost of reducing emissions varies significantly among sources. Such a reality increases the potential efficiency gains from a cap-and-trade program, primarily through trading. One important difference, however, is that when the policies for sulfur were implemented, technologies already existed to reduce such emissions, making it easier to abate. This is in contrast to carbon emissions, as technologies are relatively nascent, making policy comparisons more difficult. Additionally, sulfur emissions tend to cluster and stay close to their original source, a characteristic that carbon does not have. Because of these differences, this paper will only take a very superficial look at the SO_2 scheme in the US and the lessons to be learned.

The biggest lessons that can be taken away from the SO_2 scheme are those of determining a cap and banking and borrowing. As was mentioned earlier, the program used average emissions from 1985 to 1987 as the baseline for necessary reductions in 1995. This process was superior because, first, the baseline years happened far enough in the past that companies could not alter their emissions to manipulate the allowances they would get. Additionally, the SO_2 program used an average of 3 years to determine the baseline data, which further eliminated any one-year extraordinary emissions or reductions that could have misrepresented a company's actual emissions habits. US regulators may not be able to apply the same process to CO_2 due to constraints on the data available, but should at least take to heart that having reliable, non-manipulated data is of upmost importance when designing the cap.

[46] Convery et al, 2008

Convery et al. (2008) claim that the US Acid Rain Program achieved significant abatement rather quickly due to the ability to bank allowances, thus allowing companies to factor emissions into their long-term decisions.[48] This shows the importance of allowing banking in the scheme, and the mistake the EU made in omitting it. Nonetheless, the effect of banking should not be overstated, as much of the abatement undoubtedly occurred because technologies were already available which allowed companies to abate significant amounts by retro-fitting their factories with clean technologies. Nonetheless, it is clear that the US Acid Rain Program succeeded extremely well in reducing emissions, and was even a motivation for the implementation of a cap-and-trade scheme in the EU.

Conclusion

The debate between the relative merits of a carbon tax and cap-and-trade scheme is fierce and both sides are backed by respected environmentalists and economists. Too often, however, the issue is looked at from a very narrow point of view. For example, one can find countless academic papers and media articles about the efficiency differences between a tax and cap. Additionally, one can read just as many publications about the political implications of the two schemes or their international harmonization potential. Rarely will a single publication look at all of the important factors at once, however. In this paper, I have attempted to approach the tax vs. cap question from a number of different angles, including long-term efficiency, political implications, international harmonization, price volatility, and abatement potential and flexibility.

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[47] Ellerman and Dubroeucq, 2004
[48] Convery et al, 2008

A price mechanism (a tax) has long been supported by economists as the more efficient policy instrument under conditions of uncertainty. Recent research has suggested, however, that this may not be the case and thus, from an efficiency standpoint, it is unclear which policy is superior. Therefore, from an efficiency standpoint a tax and cap may not be very different.

A cap-and-trade program benefits from a political perspective in two ways. First, as with a tax, it is able to raise substantial amounts of government revenue, but—unlike a tax—without using the word “tax”. Additionally, a cap scheme allows the government to help certain interest groups *without* jeopardizing the legitimacy of the overall cap on emissions. Tax rebates, on the other hand, will affect the overall cap since companies that receive the rebate will pollute more, since their costs to do so have been lowered. Therefore, from a political perspective, a cap-and-trade program is superior.

Given that a ton of carbon emitted anywhere affects the whole world’s atmosphere, international harmonization of any policy is crucial. In this regard a cap-and-trade program is superior to a tax. First, countries will probably be unwilling to accept a specific tax rate imposed on them from an outside body. Second, governments will not be able to tailor the program to their local needs without compromising the global cap. Third, there will be no wealth transfer to developing countries as financial flows will remain between companies and their governments.

A cap-and-trade program, on the other hand, will not impose a particular rate on any country, but will rather impose the requirement to set a strict cap. This is attainable since developing countries, net sellers of permits, will want the market to value these permits at a high price in order to maximize their revenue from selling them. This will incentivize these countries to set a tight cap to limit the supply. Additionally, governments will be able to tailor the program to their needs by allocating some permits for free, which will not affect the overall cap. Lastly, large amounts of wealth should transfer to the developing world, which should help motivate these countries to join the scheme. Therefore, from an international harmonization perspective, a cap-and-trade program is superior.

Short-term price volatility is only an issue with regards to a cap-and-trade scheme and almost derailed the EU's program. There are ways to limit this volatility, however, by ensuring information transparency, allowing banking and borrowing, utilizing project-based mechanisms (CDM & JI), creating a market for hedging instruments, and encompassing an international scope to the program. Therefore, price volatility is a real concern, but manageable at the same time.

Both a tax and cap-and-trade scheme will cause a significant amount of emissions abatement, although the exact amount would be more easily managed through a cap system, as the level of emissions would be explicitly set. Additionally, scientific research will most likely result in findings regarding maximum carbon levels that the atmosphere can handle, information more easily utilized in a cap system by altering the exact cap. This is in contrast to a tax system where such information would require the regulators to alter the price on carbon (tax rate) in hopes of reaching a certain level of abatement. Thus, on this measure as well, a cap-and-trade scheme may be superior.

The EU ETS and the US Acid Rain program are two examples of cap-and-trade schemes, with different results. The EU ETS encountered many difficulties in Phase I, particularly in regards to its allocation practices, which led to an over-allocation of permits and unacceptable price volatility. On the other hand, the US Acid Rain program achieved significant success, particularly because permits were allocated in a more intelligent manner. Therefore, when designing a scheme in the US, regulators must heed the warnings of the EU ETS and make sure to allocate permits in a logical way. Additionally, US policy should utilize measures to control price volatility, such as those mentioned above.

Above all else, it is imperative that any policy sets a reasonable cost to polluting—one that represents the social cost of global warming. Setting such a cost will force companies to incorporate pollution into their investment decisions and will result in a reduction of greenhouse gases at the least cost to society. Such utilization of market forces must also be complemented by smart government policies to plug in the holes where the market fails. For example, companies cannot incorporate clean technologies that do not yet exist into their decisions, so the government should step in and use revenue raised from the program towards research and development of new, groundbreaking technologies, which may not occur otherwise.

Appendices

Appendix I

Emissions Reductions – The efficiency gains of utilizing market forces

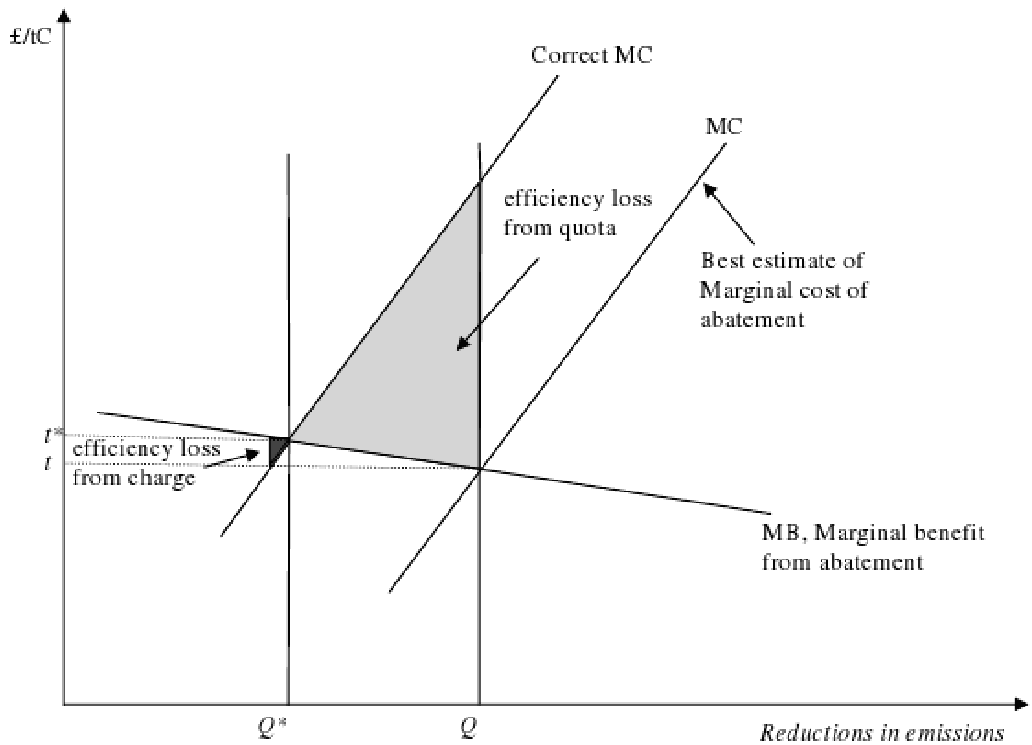
Command and Control Policies	Entity 1	Entity 2	Total Economy
Current Emissions (tons of CO_2)	20	20	40
Target Emissions	10	10	20
Actual abatement	10	10	20
Cost of abatement/ton	$ 5	$ 15	$ 10
Total cost to abate	$ 50	$ 150	**$ 200**

Private Sector Chooses Who Abates	Entity 1	Entity 2	Total Economy
Current Emissions (tons of CO_2)	20	20	40
Target Emissions	-	-	20
Actual abatement	20	0	
Cost of abatement/ton	$ 5	$ 15	$ 10
Total cost to abate	$ 100	$ -	**$ 100**

In the Command and Control example, the government dictates that each entity must reduce 10 tons of carbon emissions (without the ability to trade), resulting in a $200 total cost to the economy to reduce 20 tons. In the second example, however, the government does not dictate how the abatement should occur, but rather just mandates that the whole economy has to reduce emissions 20 tons. In this manner, Entity 1 can reduce all the pollution in the economy since it has the lowest abatement costs, resulting in a total cost of $100 to the economy. In such a market system, mechanisms will be in place to compensate Entity 1 for reducing more than its share (through monetary payments from Entity 2 to Entity 1 in a cap-and-trade system and through reduced taxes in a tax program).

Appendix II

Efficiency losses of utilizing price and quantity instruments under conditions of uncertainty



Weitzman argued that the efficiency loss using a price instrument (black area) would appear to be significantly less than using a quantity instrument (gray area), since the slope of the cost curve is steeper than that of the benefit curve. The related equation is:

Comparative advantage of price over quantity instrument =
½ variance of MC * (**slope of MC – slope of MB**)/(Slope of MC)^2

Source: Pricing Carbon for Electricity Generation: National and International Dimensions; Michael Grubb and David Newbery, October 2007

Appendix III

Example of Banking

Period 1 $15/ton —— Bank ——→ **Period 2** $20/ton

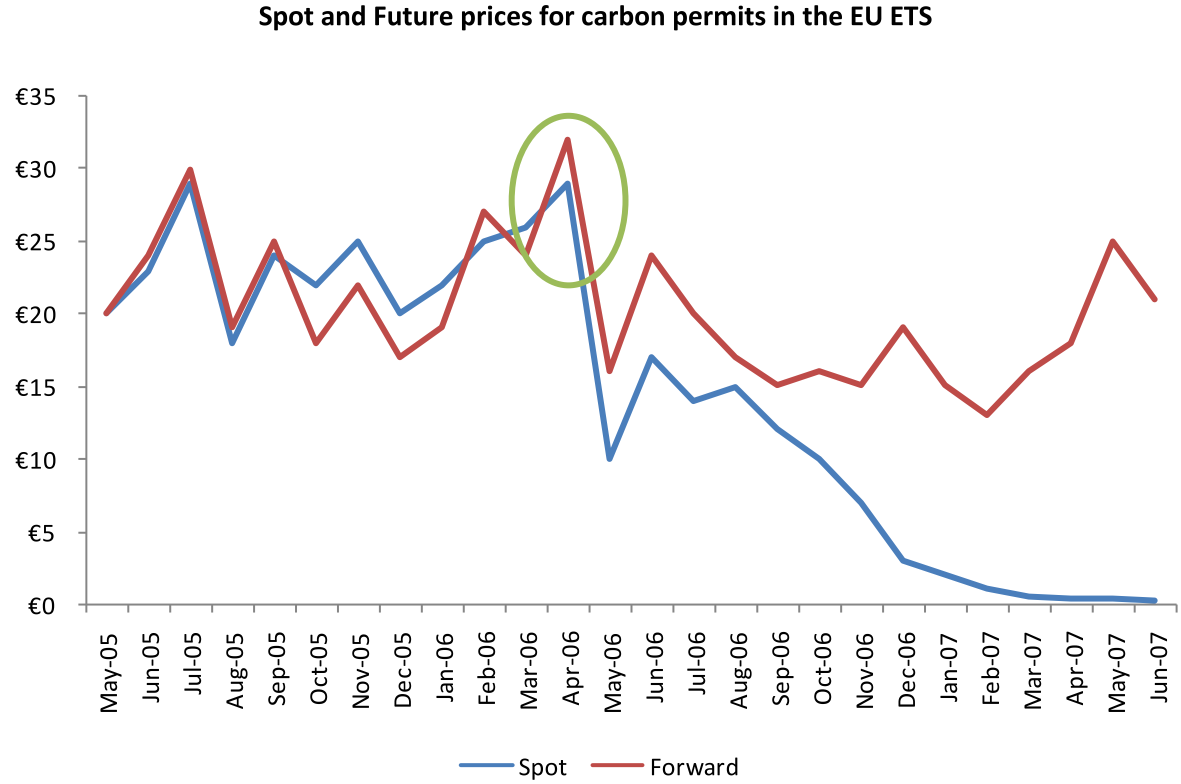
If future permit prices are expected to be ***higher*** than current prices, a company will choose to reduce emissions more than they are required to and save the permit so they can sell it for a higher value later. A company will choose this practice as long as its cost to abate is less than the expected cost in a later period.

Example of Borrowing

Period 1 $20/ton ←—— Borrow —— **Period 2** $15/ton

If future permit prices are expected to be ***lower*** than current prices, a company will choose to use an extra permit from a future period to pollute more today, so they can repurchase that permit for cheaper at a later date. A company will choose this practice as long as its cost to abate is more than the expected permit cost in a later period.

Appendix IV



Prices plummeted in the spring of 2006 as data emerged that there was an over-allocation of permits in Phase I.

Source: Bloomberg

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