TRADABLE POLLUTION PERMITS

By

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A Thesis Submitted to The Honors College

In Partial Fulfillment of the Bachelor's degree

With Honors in

Economics

THE UNIVERSITY OF ARIZONA

May 2008

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Introduction

Pollution is a growing problem in the world. In particular, air pollution causes health problems, acid rain, and reductions in crop yields. Most people now believe that air pollution also contributes to global warming, which could contribute to another, even wider range of environmental problems. Many people criticize the United States for being one the most polluting countries in the world and complain that the United States does not do enough to reduce air pollutants, especially since it declined to participate in the Kyoto Protocol, but are these valid complaints, and what would be the best way to combat pollution? Before answering these questions, we need to understand pollution and why this problem exists.

Pollution is a negative externality; meaning polluters do not directly experience the costs and damages caused by the pollution they create. Many people take offense at the idea of putting a price on the environment, considering it morally wrong. However, treating the environment as priceless, without price, without value, worthless, is what causes these excessive environmental problems. Firms are not charged for using or damaging the air, because it is undervalued, thus inflicting negative external costs on others by damaging the environment.[1] When firms in polluting industries do not consider the costs they impose on external parties, it creates inefficiency because they produce too much of a product to sell at a price that does not reflect all of the costs that went into making it. Also, governments without some sort of environmental policy have created a subsidy for all polluting firms because these firms can cheaply emit their pollutants into the air with others having to pay the costs. Subsidies occur when someone else helps incur the cost of something, but charging polluters for the damages they cause would end this subsidy.[2] Therefore, putting a price on the environment should offend no one; giving the

[1] (May 124)
[2] (May 125)

environment a value can lead to polluters paying for the damage they cause. However, realizing the environment should be given a value is one thing, but deciding on what this monetary value should be is another, much more difficult task to accomplish. A tradable pollution permit system is a solution to this difficult task because it creates a market that decides what this value will be, through supply and demand.

Air pollution causes billions of dollars in damages to heath, agriculture, and the environment. Sulfur dioxide (SO_2) causes acid rain, damaging ecosystems and potentially increasing aluminum and methyl-mercury amounts in lakes and fish, and, along with particulate matter (PM), is associated with human diseases and deaths.[3] Air pollution also attributes to chronic health problems, like asthma, and reduces crop yields. The benefits of air pollution are the products and services produced, such as electricity. It would be incredibly expensive to clean the air completely, since a first requirement would be for all production processes that pollute to stop. Still, pollution causes damages and needs to be controlled so these damages do not outweigh the benefits the polluting firms provide. However, pollution policy is difficult to implement partly because, while pollution has social costs, firms incur the mostly private abatement costs, and they fight hard politically to avoid these costs.

Often government involvement in the market can cause even more problems, so a common economic rule is that the government should only become involved in markets if some sort of market failure exists, such as public goods, monopolistic power, and externalities. Since air pollution is a negative externality and clean air is a public good, government involvement may be warranted to try to lessen the market failure, especially since basic social norms, property

[3] (Harrington 42)

rights, and law suits are not always effective in improving negative externalities.[4] The government can do this best by making the polluters internalize the externalities they cause.

Ways to Control Pollution and their Effectiveness

Several ways to control pollution from stationary sources exist, though some work better than others. Standards, a type of command and control (CAC) regulation, are the most commonly used, though least efficient, system to control pollution. This system usually consists of either telling firms exactly how to clean up, as with a technology standard, or creating a fixed legal emissions standard. Technology standards are not efficient because there may be other ways for firms to achieve even more reductions at lower costs, than the mandated technology. Also, fixed emissions standards are not efficient because it is easier for some firms to clean up than others. The firms for which it is expensive to reduce emissions may prefer to pay other firms to clean up for them, but are not allowed under this system.

Emissions taxes and fees are forms of market incentive regulation that can get closer to the efficient level of pollution. Theoretically, a price equal to the difference between the external marginal social costs, or marginal damages, and the firm's private costs could be placed on the polluting firm as a tax or fee to reduce production to efficient levels. However, these cost polluters more as they pay the costs of cleaning up, as well as the costs of the tax or fee. Also, difficulties arise in finding the exact values needed to determine the efficient tax or fee.

Tradable pollution permits, also known as transferable discharge or emissions quotas or allocations, are another form of market incentive regulation. This system works better than the others because only the firms need to know their costs. Also, the firms themselves have the flexibility to determine their own emission levels, by buying or selling permits, and to determine the best, most cost effective way to reduce emissions, encouraging innovation to find newer,

[4] (Sargent 500)

cleaner, and cheaper technologies.[5] Under this system, a firm would be allowed to pay another firm to clean up more by buying more permits or be able to make money by selling permits, if they can reduce emissions more cheaply than other firms, creating the same amount of reductions, only cheaper.[6] This creates large savings when compared to other methods.[7]

This system has gained more use and acceptance over the last few years, though it is not a new idea. The first to identify "that a system of exchangeable property rights yields an efficient outcome to an externality problem irrespective of who receives the rights," was Coase.[8] However, these concepts have only recently been accepted as a legitimate way to reduce pollution and, while Coase may argue that initial allocation of the property rights, the pollution permits in this case, does not matter economically, (if transaction costs are low) it matters a lot politically. The problem of deciding who gets the permits, and how many, causes much of the controversy over this system.

Another problem with initiating this system is the firms that will need to buy permits. Currently, they are paying nothing for their pollution and they may not understand that the tradable permit system would cost them less than any other set of regulations to reduce emissions. In contrast, the SO_2 trading system came after firms were already under SO_2 regulations, so this program looked more like a cost and flexibility improvement to the firms, than does a tradable system for greenhouse gas emissions, which are not yet regulated.[9]

History

Before examining specific environmental programs, here are some useful facts to keep in mind. A normal 500-megawatt coal-fired power station annually uses 1.5 million tons of coal to

[5] (Kosobud 15)
[6] (Albrecht 239)
[7] (May 137)
[8] (May 49-50)
[9] (Sargent 508)

create 3.5 billion kilowatt hours of electricity and one million tons of carbon, emitted as carbon dioxide.[10] In the United States, a lot of waste occurs at every level of production, imposing costs on the environment,[11] which means there is a lot of room for improvement. In fact, even the lowest estimate for the benefits of the Clean Air Act of 1970 and 1990 are five times greater than the costs it created.[12]

The Clean Air Act Amendments of 1990

One of the most famous environmental policy success stories in the United States is the program created in Title IV of the 1990 Clean Air Act Amendments, which regulates SO_2 emissions from power plants under an emissions trading program.[13] Each permit allowed one ton of SO_2 to be emitted. Creating a market for SO_2 permits after initial allocation represents a large change from traditional environmental regulation, mainly technology standards, providing the potential for the environmental goal to be achieved at the least cost.[14]

The environmental goal was created as an annual cap on the average total emissions from power plants and was set at 8.95 million tons.[15] This reduced emissions by 10 million tons, a significant 50% reduction from 1980 levels.[16] This program consisted of two phases. In 1995, Phase I began, affecting 174 voluntary generating units and 263 generating units in the 110 dirtiest coal and oil power plants, which were operated by 61 electric utilities, and, in 2000, Phase II began covering all power plants with a capacity of over 25 megawatts, as well as smaller ones with a 0.05% or more sulfur content in their fuel.[17] These firms are not the only participants in the emissions market, though. Anyone, including environmentalists, can purchase

[10] (Repetto 49)
[11] (Repetto 50)
[12] (Repetto 50)
[13] (Harrington 41)
[14] (Kosobud 152)
[15] (Harrington 44)
[16] (Stavins 53)
[17] (Harrington 44) and (Stavins 53)

permits to prevent these tons from ever being emitted into the atmosphere, if companies adhered to their permitted limits. Removing permits from the market causes the price to increase, since the overall quantity has decreased, making the relative price of cleaner technology appear lower; this could create incentives for more firms to volunteer to install cleaner technology.

A fixed number of total allowances are allocated to the industry each year by the Environmental Protection Agency (EPA)[18] "and firms are required to surrender one allowance for each ton of sulfur dioxide emitted by their plants."[19] Individual facilities are allocated allowances "in proportion to their fuel consumption during the 1985-1987 period multiplied by an emissions factor."[20] If a plant has more allowances than it needs then they could be transferred to another unit, sold, or banked for future use. If a plant is unable to reduce its emissions to or below its level of emissions allowances, "it must compensate another plant or firm to reduce emissions commensurately."[21] This gives the plants that can clean up the cheapest the incentive to do so, allowing the environmental goal to be achieved at the lowest cost. Firms for which it is costly to clean up can purchase SO_2 permits from other firms at a price that exceeds their marginal cost of emission reduction

Another feature of this program is that firms not originally regulated can volunteer to be regulated. Volunteering firms are given permits, increasing the total amount of permits in the market. These "volunteers received allowances to allocations equal to a forecast of their emissions for industrial facilities, or allowances similar to allocations for other utilities' Phase I units for electricity generators."[22] These companies had incentives to volunteer if they knew they had marginal abatement costs less than the price of the permits. Even worse, the program

[18] (Stavins 53)
[19] (Harrington 41)
[20] (Harrington 61)
[21] (Harrington 44)
[22] (Harrington 57)

rules were designed to guarantee this adverse selection since volunteers can "wait until the end of the year before declaring whether to participate, and by allowing them to determine their participation on a year-by-year basis."[23] The result is that the volunteers are the ones that would reduce their emissions anyway, causing a permanent decrease in total national SO_2 emissions without this program, but, since they were given permits, most of which will be sold, there is less of a reduction.

Part of this new system included the ability to bank allowances for future use, which became "crucial to the success of the program [because,] once firms had built up a bank of unused allowances, they had a vested interest in maintaining the value of those banked credits, and thus in furthering the program itself."[24] During the first two years of Phase II, banked permits were being used, causing emissions to be about 1 million tons over the annual emissions cap each year. While it is expected that emissions will remain above the cap for the rest of the decade, they should gradually decline to about 9 million tons per year.[25] While more is being emitted now, it is important to remember that less was polluted earlier, so the total amount emitted under this program over the years is still within limits, plus, without this program, many more tons of SO_2 would have been emitted.

Monitoring adherence under CAC policies requires evidence of excess emissions or the verification of mandated abatement technology. One disadvantage of economic incentive policies, in general, is that they require a different, more expensive monitoring system than command and control policies. Because incentive policies necessitate "credible and quantitative emissions estimates" the U.S. used continuous emissions monitors (CEMs) for the SO_2 program,

[23] (Harrington 57-58)
[24] (Harrington 46)
[25] (Harrington 46)

which, while expensive, were necessary for political consensus.[26] The cost of the CEMs was probably worth getting Congress to pass the SO_2 policy, since the benefits of the program greatly exceed the other costs. These CEMs caused the program to be "viewed as administratively transparent: penalties are certain and compliance has been virtually perfect."[27] Firms face a $2,000 fine for each ton over their allotment, which is about 10 times more than marginal abatement costs.[28] These monitoring systems are necessary to prevent illegal behavior, which would distort prices and the resulting levels of clean up. If cheating were to occur, firms would be acting as if they had more permits than they really did, which would effectively decrease demand for permits, thus, decreasing the price of the permits.

Some feared that trading SO_2 permits would cause problems known as 'hot spots.' This could happen if more SO_2 were emitted closer to a city, causing an increase in health problems, or nearer to an environmentally sensitive area, causing it to be damaged more than it would otherwise have been. This problem would cause an increase in damages, even though total emissions would have decreased. To limit this problem, the original plan for the SO_2 trading program was for there to be an East and a West market. In the end, though, "the two-region model was abandoned and replaced by a single national SO_2 market with a single national cap, largely because the single-market approach was expected to result in greater cost savings from allowance trading."[29] Fortunately, "despite its lack of geographic resolution, trading under the program has not affected sensitive ecosystems and human health; in fact, it may have benefited them,"[30] because of the overall reductions. This program did not create a hot spot problem, so

[26] (Harrington 258-259)
[27] (Harrington 58-59)
[28] (Stavins 54)
[29] (Harrington 47)
[30] (Harrington 59)

creating a single national SO_2 permit market was the right choice, providing the opportunity for more trades and savings.

SO_2 permit prices have fluctuated between $70 and $210 over the years, averaging $170 per ton during Phase II.[31] Even though the costs of the permits were free for the initial allocation, firms still incurred costs when they had to buy more permits or become cleaner to avoid needing more permits. It is estimated that this SO_2 program saved, when compared to the costs firms would have incurred in a uniform emissions rates scenario, $250 million during Phase I and $784 million per year during Phase II. The cost savings are estimated at $1.6 billion per year, in comparison with the costs that firms would have faced under a scrubber technology standard,[32] although savings could have been even greater if some local environmental regulations had not prevented the buying of some allowances.[33] Instituting a tradable permit system created large amounts of savings for the firms, providing evidence that this type of policy is better for the firms than taxes and technology standards.

Since the Clean Air Act's tradable emissions permits system was so successful with SO_2, it has been applied to other areas and pollutants, such as mercury and carbon dioxide (CO_2). CO_2 is a greenhouse gas believed to be the major culprit behind climate change, due to the burning of fossil fuels creating an imbalance with more CO_2 being emitted than being removed, either by solution in the oceans, microorganisms in the ocean, or photosynthesis by plants.[34] However, because the Bush administration's Clear Skies Initiative did not include mandatory

[31] (Harrington 48)
[32] (Harrington 49-50)
[33] (Stavins 55)
[34] (Chichilnisky 36)

CO_2 emissions reductions, and CO_2 is not considered a toxin, but rather a natural part of the atmosphere, permit trading for this substance is controversial.[35]

Kyoto

The Kyoto Protocol has created an international tradable CO_2 permit market, which the United States declined to participate in for political reasons, mainly that developing countries, including China, were not included and that the program will be practically impossible to enforce. If the United States had remained under the Kyoto Protocol, it would be "committed to reducing greenhouse gas emissions to 7 percent below 1990 levels in the period 2008 to 2012."[36] Reducing CO_2 emissions only 7 percent below 1990 levels does not seem like a lot since the United States was able to reduce SO_2 emissions to over 50 percent below 1980 levels in the electricity generating industry and in the firms that volunteered.

RECLAIM

There are over 13 million residents in the South Coast Air Basin. On January 1, 1994, The South Coast Air Quality Management District (AQMD) initiated the Regional Clean Air Initiative Market (RECLAIM), which is a program using an Electronic Bulletin Board trading institution where firms publicly post terms of trade, which occur after bilateral negotiation, to help reduce NO_x and SO_x emissions.[37] To avoid a hot spot problem, the area was divided into two regions, an upwind Coastal area and a downwind Inland area. The Coastal zone could not buy Inland permits, but could sell its permits to firms in either region. The Inland area could not sell to the Coastal zone, but could buy from either region.[38] RECLAIM includes all facilities annually emitting 4 tons or more of NO_x or SO_x from permitted equipment in the South Coast

[35] (Harrington 59)
[36] (Energy Information Administration 19)
[37] (Cason 55)
[38] (Cason 56)

Air Basin. The NO_x market has 390 facilities and the SO_x market has 41 facilities, representing about 65% and 85%, respectively, of reported emissions from permitted stationary sources in the Basin.[39] Each facility gets a certain number of RECLAIM Trading Credits (RTCs) based on peak levels of activity between 1989 and 1992, receiving a linearly decreasing amount yearly between 1994 and 2000, with even more reductions in allocation levels between 2001 and 2003, and with amounts equaling 2003 allocation levels, unless AQMD decides on even more reductions, between 2004 and 2010.[40]

RGGI

In December 2005, Maine, New Hampshire, Vermont, Connecticut, New Jersey, New York, and Delaware adopted a plan for RGGI (Regional Greenhouse Gas Initiative); Maryland, Massachusetts, and California have also joined, or announced that they would join, soon.[41] The RGGI program applies to all fossil fuel power plants with a capacity of at least 25 megawatts, has a cap at about the 2006 levels, and at least 25% of the permits must be sold or auctioned by each state.[42] Evidence from the European system, and other studies, suggest that giving away permits results in higher generator profits and less incentive to reduce emissions, since firms decide to reduce emissions or buy permits based on the permit price.[43]

This program creates an offset and an allowance market. Offsets allow the power plant to emit more CO_2 with fewer permits. Two types of offsets are the planting of trees and the capturing and burning of methane, another greenhouse gas, emitted from landfills and agriculture as an energy source, releasing CO_2, which is less damaging than methane.[44] This system also

[39] (Cason 57)
[40] (Cason 57)
[41] (Bogdonoff 10)
[42] (Bogdonoff 11 and 14)
[43] (Bogdonoff 14)
[44] (Bogdonoff 12)

has safety-valves, which increase the percentage of offset permits allowed to be used from 3.3% to 5% of their emission allowances, if the price per permit exceeds $7 per ton of CO_2, and to 10%, if the price exceeds $10.[45] Maine has been allocated 5.95 million permits and each is expected to sell for about $5.[46]

In 2005, California created targets to reduce its greenhouse gas emissions to 2000 levels by 2010, 1990 levels by 2020, and 80% below 1990 levels by 2050. California plans to do this in part with a low carbon fuel standard which requires fuel sold for passenger vehicles to produce 10% fewer greenhouse gas emissions by 2020. California, Oregon, Arizona, and New Mexico are in the process of creating programs to reduce greenhouse gas emissions, too.[47]

Mercury

The Bush administration created a mercury pollution cap and trade program for coal-fired power plants to take effect in 2010.[48] This program has been under a lot of criticism because mercury is an extremely hazardous air pollutant, making hot spots an even bigger concern. Also, a study found that "70 percent of the mercury that rain or snow washed out of the skies...came from local or regional sources."[49] With trading, several areas could gain higher concentrations of mercury, resulting in adverse health effects. This program had planed to reduce emissions from coal-fired power plants by 70% cost-effectively with trading, however, despite the programs potential, a federal appeals court ruled that the EPA could not allow firms that failed to meet emissions targets to buy credits from other firms.[50] Some also claim that a 70% reduction in mercury emissions is not enough and that a 90% reduction through "a more direct manner" was

[45] (Bogdonoff 12)
[46] (Bogdonoff 14)
[47] (Bogdonoff 16)
[48] (Shogren)
[49] (Spotts)
[50] (Shogren)

better.[51] While this may seem excellent to environmentalists, no federal reductions are occurring while the dispute continues and reducing emissions down this far may create costs that far exceed benefits. Also, 'the more direct manner' implies a technology standard, which would probably not be as cost-effective as a tradable permit system. The mercury program example shows that there is still much distrust and confusion over market incentive approaches.

Problems and Solutions

This SO_2 program resulted in total net benefits, including better human health and less acid rain, that were greater than expected and much greater than total costs. However, while this is great news, it shows a limitation of this program, which is that only an act of Congress can change the cap, making it unable to adapt to new scientific and economic information.[52] This suggests that too many permits exist and that their price is too low, since, theoretically, marginal benefits should equal marginal costs to be efficient. This essentially means that the benefits of this program are cheap, so more benefits should be bought, which could be done by the government decreasing the number of permits; basically buying permits before allocating them. Unfortunately, despite this information, the cap cannot be reduced easily.

However, while an adjustable cap, which could be relaxed if permit prices hit a specified upper limit and lowered if they fall below a certain lower limit, may sound good, it may only create more problems.[53] This could cause more disputes in Congress as they try to agree on the price ceilings and floors. It could also cause firms to misrepresent their information, potentially manipulating the system, since, if the firms costs appear higher, there would be more permits in the market, though this would reduce the true price of the ones they already have, so some would not want to do that. Also, if environmentalists buy permits in an effort to permanently reduce

[51] (Spotts)
[52] (Harrington 59)
[53] (Harrington 59)

emissions, the government could thwart their attempts by increasing the amount of permits in response to the resulting increase in price.

The RGGI program is a good start, but it also needs improvement. One concern is that, since not all states are regulated, some carbon generation could be exported, with losses in efficiency due to transportation.[54] The program has the states taking the initiative to not let things get worse, but their goal is to reduce greenhouse gas emissions to only 10% of 2009 levels by 2019, and, with the projected price per permit only between $1 and $10, marginal benefits most likely exceed these marginal costs, so the program is not economically efficient.[55] The safety-valve feature also prevents the market from automatically creating efficiency. In 2005, the United States emitted 6 billion tons of CO_2 and there are many environmental groups who would be willing to purchase permits to help the environment. The safety-valve system would undermine their efforts of causing the price to increase so power plants would have a greater incentive to emit less, since its purpose is to protect the polluters from having too large an economic burden, giving them less of an incentive to become cleaner.

The largest problem a tradable pollution permit system faces is implementation. Before congress can decide to implement a system like this, initial allocation needs to be determined. One of the most remarkable, and somewhat ironic, characteristics of a tradable emissions permit system is that, while initial allocation does not affect economic efficiency at all, if transaction costs do not exist, it matters a lot politically. Initial allocation would only matter economically indirectly, since the economy is hurt when politics prevent improvements from being made, and, if the best allocation method is not chosen, then it may not pass into law, and things will not improve. Without transaction costs, the initial allocation does not change total net benefits for

[54] (Bogdonoff 13)
[55] (Bogdonoff 10 and 13)

the economy, since the ones who value them the most should theoretically be able to purchase them from those who have them.

Giving away the permits is viewed as better by some because firms are more likely to want to comply, as opposed to permit auctions, in which they are paying for both the amount they clean up and the permits for the amount they still emit.[56] This decision, not only can determine the willingness of the firms to accept the system, but could also affect the prices the consumers will see later. If the firms are given the permits freely, their costs increase less, so their prices will not increase as much as they might in an auction situation.[57] However, deciding to give the permits away presents the problem of how to allocate them. Though economically it does not matter, large polluters getting more permits seems to reward the polluters, while those who pollute less receiving fewer allocations seems to penalize them. This does not seem efficient, let alone fair, and would most likely be opposed by many. If a free allocations system were to be handled well, it would probably be best to distribute them based on the capacity, or output of the goods, like electricity, of each firm, as opposed to allocating them based on emissions; environmentalists could always purchase them later.

A solid permit auction system open to everyone would not have this allocation problem since the market would decide who gets the permits, with power plants, as well as environmentalists, having the ability to purchase the amounts of permits they need. However this could raise prices, making international competition more difficult if the foreign producers have no regulations. The only way to level the international playing field is to have everyone playing by the same rules; maybe even have an international emissions permit system,[58] though this idea has large enforcement problems.

[56] (Sargent 506)
[57] (Sargent 506)
[58] (Sargent 508-509)

Tradable System Better

Despite potential hot spot problems and determining the initial allocation of the permits, a tradable discharge permits system is the most cost effective. "One traditional measure of whether a policy change is 'better' is whether the new policy is Pareto superior to the old policy. It is a rather remarkable characteristic of this transferable discharge permit system that it provides an opportunity to implement a Pareto superior policy change."[59] A Pareto superior change is the economic term for a change in which everyone wins. Everyone wins with this type of system, since the firms can potentially profit by polluting less and selling their excess permits or by cleaning less and buying permits, thereby incurring a savings. Also, with this system, everyone gets to enjoy a cleaner environment, at the least cost.

Previous Experiments and their Results on Specific Traits of a Tradable Permit System

Transaction Costs Experiment

Timothy N. Cason conducted an experiment and later wrote an article about it called "Transactions Costs in Tradable Permit Markets: An Experimental Study of Pollution Market Designs." This article describes an experiment on the role of transaction costs in a tradable emissions permit market. If there are no transaction costs then initial allocation does not matter economically, only politically, which may be why economists pay less attention to this part of the issue.[60] However, if transaction costs exist, then initial allocation could affect economic efficiency. If there are transaction costs, it could decrease the number of trades, even though both parties would otherwise benefit from the trade. Trading makes this type of system the most cost-effective, but transaction costs can lower the cost-effectiveness of the program.[61]

[59] (Tietenberg 79-80)
[60] (Cason 163)
[61] (Cason 146)

The transaction costs potentially faced with this system include learning the new rules, determining the new optimal production plan, and deciding whether to buy or sell permits. Also, transaction costs could include contract enforcement, making sure the trade is completed.[62] Having several trading zones and rules for trade also adds to transaction costs.[63] The results from this experiment show that regulators should consider how market rules will affect transaction costs when implementing this type of program.[64]

The experiment used a computerized double auction system with fees to represent transaction costs. Buyers put in how much they were willing to pay and sellers put in how much they were willing to sell and a uniform price was found and used for all transactions. The experiment looked at situations where transaction costs, or the fees representing them, were non-existent, constant, and declining. This experiment also had two scenarios for initial allocation, one with 20% of the cost-effective allocation, meaning only 20% of the permits were given to the firms that should have them in the efficient allocation, and the other with 60% of the cost-effective allocation, meaning only 60% of the permits were given to the firms that should have them in the efficient allocation.[65] So, 100% cost-effective allocation would be a situation needing no trades.

The experimenters found that transaction costs raise the price at which the permits trade.[66] However, with decreasing transaction costs, the price was lower and more trades occurred, both being closer to where they would be with no transaction costs, and final cost-effectiveness was greater, when initial allocation was at 20% rather than at 60%.[67] They also

[62] (Cason 146)
[63] (Cason 147)
[64] (Cason 164)
[65] (Cason 152)
[66] (Cason 154)
[67] (Cason 154, 159, and 161)

found that with constant transaction costs, initial allocation does not affect the price, the number of trades, or final cost-effectiveness, though fewer trades occur and the price was higher than would otherwise be without transaction costs. [68]

An Electronic Bulletin Board System Experiment

Lata Gangadharan and Timothy N. Cason conducted an experiment and later wrote an article about it called "An Experimental Study of Electronic Bulletin Board Trading for Emission Permits." They conducted this experiment to see how the electronic bulletin board system (BBS), used in the RECLAIM program, compared to the continuous double auction (CDA) system, shown in previous research to be better than other trading systems,[69] and to see if dividing the market into trade regions made a difference in the price, since, in equilibrium, both prices should be equal. If Coastal permits are cheaper, then the price will be the same because Inland companies will buy coastal permits, raising the price in the Coastal region and lowering the price in the Inland region until prices are equal. However, if Coastal permits are more expensive, then there will be two different prices for Coastal and Inland permits.[70]

This experiment had three BBS sessions, which ran at the same time over 6 weeks, with each trading period lasting one week. Subjects posted offers to buy or sell permits on a website, negotiated by email or phone, and completed transactions when both emailed identical terms to the experiment administrator.[71] The experiment also had three CDA sessions, which each lasted two hours and were conducted on different days, with each trading period lasting 5 minutes. Sellers posted offers to sell, competing to have the lowest ask, while buyers posted offers to buy,

[68] (Cason 156, 159, and 162)
[69] (Cason and Gangadharan 56)
[70] (Cason and Gangadharan 56)
[71] (Cason and Gangadharan 62)

competing to have the highest bid,[72] transactions occurring as soon as an offer was accepted.[73]

Table 1[74]	Zone Trading Restrictions	
Trading Institution:	Inter-Zone Trading Permitted	Autarky (No Inter-Zone Trading Permitted)
Bulletin Board System	2 Sessions	1 Session
Continuous Double Auction	2 Sessions	1 Session

In all session, sellers had either Coastal or Inland permits and some buyers could only buy Coastal permits, representing inter-zone trading. In one treatment, the other buyers could only buy Inland permits, representing a no inter-zone trading policy choice. The experiment was simplified by giving standard values to the permits to create trade incentives and was made so Coastal permits would have lower prices and flow inland.[75]

The experimenters found that prices were lower than when there is no trade between regions allowed[76] and that prices were about equal in both inter-zone trading CDA sessions and one of the two inter-zone trading BBS sessions.[77] They also found that Inland prices are greater than Coastal prices when no inter-zone trading is allowed and that price deviations from the competitive equilibrium are not too different between the two trading systems.[78]

Compliance Behavior Experiment

James J. Murphy and John K. Stranlund conducted an experiment and later wrote an article about it called "A laboratory investigation of compliance behavior under tradable emissions rights: Implications for targeted enforcement." The purpose was to see if regulators could target enforcement efforts based on firms' characteristics. They wanted to see if risk

[72] (Cason and Gangadharan 60)
[73] (Cason and Gangadharan 63)
[74] (Cason and Gangadharan 62)
[75] (Cason and Gangadharan 61)
[76] (Cason and Gangadharan 64)
[77] (Cason and Gangadharan 68)
[78] (Cason and Gangadharan 70)

neutral firms' emissions benefits and initial permit allocations determine the violation levels and the marginal productivity of increased enforcement on the violation levels, under a trading program.[79] They found that both the firms' benefits and initial allocation do not affect the marginal productivity of enforcement and that violation levels also do not depend on differences in the firms' benefits, though they do depend on how initial allocation determines permit buyers and sellers, with buyers tending to have higher violation levels.[80] The experimenters also wanted to see if, under fixed emissions standards, risk neutral firms with higher marginal emissions benefits had higher violation levels and a higher marginal productivity of increased enforcement on violation levels,[81] finding that these firms were more responsive to enforcement changes.[82] This information would justify targeting firms for noncompliance under emissions standards, but not under a trading program.[83]

The experiment was designed with emissions based on production, no banking of permits, and completely random audits with a known and constant probability.[84] It had 12 market treatments and 8 standards treatments, each repeated 3 times, combining four marginal expected penalties with three allocations types in the market experiments and two in the standards experiments.[85] Each experiment had eight subjects, four with a high marginal benefit (MB) function and a production capacity of 17 and four with a low MB function and a production capacity of 8. Permits were seen as a license to produce,[86] though noncompliance was possible, with audits and penalties occurring at the end of each period.

[79] (Murphy 199)
[80] (Murphy 206)
[81] (Murphy 200)
[82] (Murphy 210)
[83] (Murphy 198)
[84] (Murphy 198)
[85] (Murphy 201)
[86] (Murphy 200)

With uniform initial allocation, Low MBs were the sellers, but with non-uniform initial allocation they were the buyers.[87] The high marginal expected penalty treatment had a high audit probability, a high marginal penalty function, and was designed to induce perfect compliance. The other three levels were designed to induce noncompliance by risk neutral subjects. The medium high treatment had a higher audit probability and a lower marginal penalty function than the medium low treatment, though both had the same marginal expected penalties. The low treatment had a low audit probability and a low marginal penalty function.[88] The permit price was higher and fewer trades occurred than expected in a perfectly competitive market, in these sessions.

Table 2[89]

High MB= 18-q and production capacity =17 and Low MB=18-2q and production capacity of 8

Expected Penalties	Audit Probability	Marginal Penalty Function	Allocation Type	Permits for			Experiment Used In	
				Total	HighMB	LowMB	Market	Standard
high	High	High	Uniform Low Standard	28	3	4	Yes	Yes
medium high	Higher	Lower	Uniform High Standard	56	7	7	Yes	Yes
medium low	Lower	Higher	Non-uniform High Standard	56	13	1	Yes	No
low	Low	Low						

The experiment used a continuous double auction and had 12 identical periods, each lasting 5 minutes, with production being completed in the first 4, leaving the last for any final permit holding adjustments. The standards experiments were the same, except trading was not allowed so the permits became the standard.[90] Noncompliance was not allowed in the perfect compliance experiments, and prices and quantities converged to the competitive equilibrium, in both the Uniform High and Low Standards.[91]

[87] (Murphy 201)
[88] (Murphy 201-202)
[89] (Murphy 201-202)
[90] (Murphy 202)
[91] (Murphy 203)

The experimenters also noticed that increased enforcement directly causes noncompliance to decrease, but indirectly causes the equilibrium price to increase. Higher prices suggest higher non-compliance levels; however, the direct effect dominates the indirect effect, so an increase in monitoring or penalties does lead to fewer violations.[92]

My Experiment - Initial Allocation

My proposed experiment design would investigate whether or not initial allocation matters economically. In my experiment there would be four types of firms, combinations of low and high production capacities and low and high amounts of clean technology. We will call firms with low amounts of clean technology 'Bad' and firms with high amounts of clean technology 'Good.' Bad firms would have an average cost of zero (BadAC = 0), while 'Good' firms would have positive average costs (GoodMC > 0).

Table 3	Clean Technology Total Emissions per Firm	
Production Capacity	Low (Bad) (2.8 emissions per unit)	High (Good) (0.8 emissions per unit)
Low (10)	28	8
High (30)	81	24

In the beginning, aggregate production capacity for this industry is 80 (10+30+10+30) and total emissions are 141 [2.8(40) + 0.8(40)] units. Average emissions per unit of production without regulation are 1.76. The experimenter assures perfect compliance by preventing firms from producing if they do not have a permit. In the experimental world, the government has decided to reduce emissions to 75% of what they were, using a tradable emissions permit system, and no environmentalists exist. The trading system used would be a continuous double auction. This experiment would have three treatments or potential policy options.

[92] (Murphy 200)

In the first treatment, firms are each allocated permits for 75% of their *total emissions*. Firms can then choose to buy or sell permits. One permit equals one unit of emissions. The total amount of allowed emissions under this treatment is 105.75. Under this policy, firms with higher emissions receive more permits, in effect, rewarding firms for not investing in cleaner technology earlier.

In the second treatment, firms are each allocated permits for 75% of *average emissions*. So, 75% of total emissions divided by total production capacity gives an average of 1.32 units of emissions per unit of production (141/80 x .75 = 1.32). Under this policy, firms with higher production capacities receive more permits, though the total is still 105.75.

In the third treatment, the government auctions off all 105.75 permits. Under this policy the government would have taken over the property rights to the air. The firms would no longer have any rights to pollute the air unless they buy a permit from the government or from someone who has already bought one. Without a permit, firms would not be able to produce at all.

Table 4

Treatments 1 and 2	Number of Permits Allotted to Each Firm			
	Bad		Good	
	Treatment 1	Treatment 2	Treatment 1	Treatment 2
Low	21	13.219	6	13.219
High	60.75	39.656	18	39.656

The experimenters would observe three things: the price at which the permits trade, the number of trades, and the amount of permits used. If initial allocation does not matter economically, the price and the amount of permits used should not be different in the three treatments.

Given the small variations in the markets designed by other experimenters, many observations would be needed to show any significant differences. I expect to observe less than a 10% difference in any of the observable variables with a 95% power of significance, so the

experiment would have to generate at least 1076 independent observations for each treatment.[93] Therefore, there would need to be at least 108 participants and each treatment would need to be repeated at least ten times. Each time the treatment is repeated would be a new start and past earnings would not carry over into each of the 10 sessions. The entire experiment would consist of 30 sessions and would generate 1080 independent observations for each treatment.

Another set of experiments that could be of interest would be to combine the three initial allocations from my experiment with the compliance experiment conducted by James J. Murphy and John K. Stranlund (pages 19-22). If all permits were auctioned off at the beginning as the way of initial allocation in the compliance experiment, it would help determine if initial allocation would matter in the case where compliance is not perfect. So, to modify Table 2 on page 21, this particular part of the experiment would look like this, having 8 treatments.

Table 5

HighMB = 18-q and production capacity =17 and LowMB=18-2q and production capacity of 8

Expected Penalties	Audit Probability	Marginal Penalty Function	Allocation Type	Total Amount of Permits
high	high	high	Uniform Low Standard Auction	28
medium high	higher	lower	Uniform High Standard Auction	56
medium low	lower	higher		
low	low	low		

Predicted Overall Results

The tradable emissions permit system would be best without transaction costs and with high compliance levels. If these two things hold true, then initial allocation does not matter economically, only politically. However, with high transaction costs and low compliance, initial allocation matters both politically and economically. High compliance levels can be obtained by having high penalties and good surveillance technology. Low transaction costs can be obtained by designing a specific system that is not too complicated.

[93] (Kraemer 105)

Political Implications

Complications in Estimating Carbon Abatement Costs

There is wide variety in the estimates of the costs of reducing carbon emissions that were made for the Kyoto Protocol. These estimates are important because policy makers usually do not want to implement major programs without knowing their true costs.[94] While it is good to have an initial estimate, in a tradable permit system, costs will automatically be made known in the market as the prevailing permit price. If the total amount of allocations can easily be adjusted if the price is greatly different than expected, then having an accurate estimate is not vital to the success of the program, though adjustable caps may not be a good solution for the other reasons mentioned earlier.

The differences in the estimates occur because of the huge number of variables. There are different amounts of abatement required by law, more abatement generating a higher estimate of costs, and different policy regimes have different levels of flexibility. Also, structural differences in the economic models used to make the estimates exist, with different amounts of many different details being used. Another reason for the differences in estimates is the different amounts of consideration of the social benefits of carbon abatement, determining the benefits to be great or small in relation to the estimated costs, used in the estimates.[95]

There are also differences in the potential price for carbon emission permits depending on the amount of nations participating in the market. This carbon price is also important to policy makers, not just for the international Kyoto participants, but also for the environmental policies of other countries which declined to participate in the Kyoto agreement, like the United States.

[94] (Fischer 73)
[95] (Fischer 74)

In a tradable permit system, having multiple estimates on abatement costs is only a problem because politicians give it too much importance. Even though there is a wide range in the estimates, no mater what the costs, high, low, or in between, a tradable emissions system is the most efficient policy, meaning it would hurt companies' profits the least. Also a tradable permit system is preferable when there is uncertainty about the marginal costs and benefits of reducing pollution, since it lets the market find the efficient price and emissions level.[96]

Linkage to Economic Growth

Part of the CO_2 controversy is that economic growth is believed to be linked with CO_2 emissions. If CO_2 emissions are reduced, many fear that the economy will stop growing. However, over the 1990s, the United States' "economy grew almost three times faster than energy-related carbon dioxide emissions; in both 1998 and 1999, the US economy grew by more than 4 percent each year, while CO_2 emissions grew by less than 1 percent."[97] This trend has "broken a cycle dating back to the Industrial Revolution, a cycle in which economic growth inevitably leads to more pollution. And our new, cleaner model for growth holds out the hope for a better quality of life for all people in the decades ahead."[98] So, while economic growth and CO_2 emissions seem to be linked, reducing CO_2 emissions probably would not damage the economy. Actually, creating a market for CO_2 emissions permits may encourage economic growth. "Most companies now understand that improvements in energy efficiency not only reduce greenhouse gas emissions, but they can translate into substantial budget savings that enhance corporate profitability."[99] This shows that helping the environment can help firms as

[96] (Stavins 55)
[97] (Albrecht 22)
[98] (Albrecht 22)
[99] (Albrecht 19-20)

well as the economy. With better knowledge and technology, the United States is in a better position to reduce air pollution than ever before.

The reason it appears environmental laws imposed on businesses cause a decrease in productivity is that productivity growth is measured in a way that does not take into account the costs of pollution, which are reduced with environmental policy. What is measured is the companies' increase in costs, which do not create increases in output, suggesting a decrease in productivity.[100] However, some individual businesses actually experienced productivity growth by becoming more environmentally friendly, though if this were normal, all businesses would change without the need for environmental regulation.[101] The conventional way of measuring productivity growth is distorted. Using a different method of measuring productivity growth shows that there has been an increase in kilowatt-hours per ton of emissions, which is a better way to show that there really has been productivity growth, despite the environmental regulations. Other industries also show productivity growth when measured this way.[102] If the environment had an actual monetary value, it would be easier to take it into account when trying to determine if there is economic or productivity growth in an area. A transferable permit system not only would give the environment a monetary value, but would also allow polluters to become cleaner in the cheapest ways, making the increase in their costs lower than it could have been under other policies, and making the apparent decrease in productivity growth less.

Learning from the Past for CO_2

Creating an environmental policy to reduce CO_2 emissions in the United States would have to "have several attractive features. Given the potentially immense sums that may have to

[100] (Repetto 52-53)
[101] (Repetto 47-48)
[102] (Repetto 53)

be spent on abatement, it is important that the policy be cost-effective"[103] The most cost-effective way to achieve any environmental goal is with a tradable permit system. Also, while the SO_2 emissions trading system was a success, it was not perfect, so a new policy for CO_2 should try to fix the inefficiencies encountered earlier. A CO_2 emissions permit market should include as many emitters as possible, though it would be extremely politically unpopular and difficult to try to spread this market to include vehicles. The major complaints about reducing emissions are that it is too expensive, so there should be fewer complaints if the reductions are occurring as cheaply as possible. Also, it may be beneficial if a CO_2 emissions trading market had the flexibility to respond to prices. If costs are significantly lower than expected, fewer permits would be allocated, and if the abatement costs are much more expensive, then more permits could be allocated, though this could undermine environmentalists' efforts to reduce emissions even further.

Obstacles to Climate Policy

In the 2005/2006 year, Paul Higgins, a scientist who specializes in climate change, was assigned to be on the team of an Ohio congressman by the American Meteorological Society (AMS) and the University Corporation for Atmospheric Research (UCAR).[104] He recognized three large obstacles to climate policy and their solutions. The first is the understanding and knowledge gap between the research community and the policy makers, which could be fixed if scientists shared their research with the public in a way they could easily understand. The second is that a small powerful interest group would incur the costs of climate policy, while the many unorganized individuals in society would benefit. This problem could be reduced if some permits were freely given to the polluters who would be hurt the most. The third obstacle is the

[103] (May 49)
[104] (Higgins 1181)

concern for the economic consequences of only the U.S. taking action to decrease emissions and the need for international cooperation. Higgins suggests the U.S. effort level be partly responsive to other countries' cooperation and/or trade penalties be imposed, such as taxes, on the countries that do not have regulations, thus still subsidizing their polluters.[105] However, while it would be nice if all countries participated, it would be difficult to make sure countries do not cheat, and the only country the United States can legally control is the United States.

Conclusion

Many people all over the world, including several in the United States, have complaints about air pollution and the United States' actions concerning environmental problems. These people fail to see how much worse things could be without any regulations at all. The United States has reduced and kept SO_2 emissions to below half of 1980 levels, on average, very cost-effectively. The price the permits are trading at is not greater than the price at which one ton of SO_2 can be cleaned up. Unfortunately, because of a design flaw, more can not be easily abated, since Congress would need to agree to reduce the number of total allocations and lower the cap.

The United States is also taking steps to reduce mercury emissions, and, while the Bush Administration is being criticized for only trying to reduce mercury emissions, using a tradable permit system, by 70 percent instead of 90, one should keep in mind that 70 percent is a large reduction and is a lot better than nothing. The United States has also been criticized for backing out of the Kyoto Protocol. However, the United States can do much better than this on its own. The United States is in the process of reducing mercury emissions by 70 to 90 percent and has reduced SO_2 emissions by over 50 percent of 1980 levels, so only reducing CO_2 emissions by 7 percent below 1990 levels would not be a problem.

[105] (Higgins 1182-1185)

Having a national CO_2 emissions trading program is relatively easily enforceable, compared to the international Kyoto program, and will not have a hot spot problem since CO_2 is not toxic. Regulatory policies are necessary to help reduce the amount of air pollution. The United States has reduced pollution substantially over the years and has discovered along the way that tradable permit systems usually work the best to solve environmental problems.

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