DOMESTIC POLICY OPTIONS FOR REDUCING CARBON DIOXIDE EMISSIONS:

A Comparison of Tradable Permits and Taxes

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EXECUTIVE SUMMARY

This paper examines two domestic policy options for reducing carbon dioxide emissions: tradable permits and taxes. In order to comply with the Kyoto Protocol, and to decrease the build-up of greenhouse gases in the atmosphere, the United States needs to reduce their greenhouse gas emissions.

Greenhouse gas emissions and atmospheric concentrations have been increasing since the industrial revolution. Atmospheric concentrations of carbon dioxide, the most important greenhouse gas, have risen 30 percent in the last 150 years. Scientists believe that this increase has already caused a slight warming of the Earth's climate and that future increases (under a business-as-usual scenario) will result in a more significant, and potentially catastrophic, warming.

The following criteria were used to analyze the policy options: the implementation, administration and monitoring burden; equity and fairness; efficiency and effectiveness; and political feasibility. Based on my analysis using these criteria, I believe that tradable permits are the best policy option for reducing carbon dioxide emissions. Tradable permits are the least regressive, more administrative and politically feasible, allow for greater flexibility, and guarantee a specific amount of emissions reductions.

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INTRODUCTION

This paper examines two policy options for reducing domestic carbon dioxide (CO_2) emissions: tradable carbon permits and carbon taxes.

Since the advent of the industrial revolution, humans have released various greenhouse gases (gases that absorb infrared radiation) into the atmosphere faster than they can be removed by natural processes. Greenhouse gasses (GHGs) are emitted primarily from deforestation and the burning of fossil fuels. GHGs include CO_2 (the most important GHG), methane, nitrous oxide, and various halons.

Anthropogenic sources release almost 30 billion tons of CO_2 into the atmosphere annually.[1] During the past 150 years we have seen a 30 percent rise in the concentration of CO_2 in the atmosphere, from 280 to 365 parts per million (ppm).[2] Scientists believe that this increase has already resulted in a slight warming of the Earth and that future increases will result in a more significant, and potentially catastrophic, warming. During the last century average global temperatures have already risen approximately one degree Fahrenheit (°F) and scientists predict that temperatures could rise by 2 to 6 °F by the end of next century if GHG emissions are not reduced.[3]

The United States is the largest emitter of CO_2. In 1997, recognizing that global climate change is a serious issue, the United States signed the Kyoto Protocol, which when ratified, will commit the United States to reducing their GHG emissions to 7 percent below 1990 levels by 2012. Two policy options for meeting this reduction requirement are tradable carbon permits and taxes.

Carbon permits can be applied either upstream (fossil-fuel processors) or downstream (fossil-fuel consumers). The upstream system discussed below encompasses approximately

2,000 entities and would provide near-total coverage of CO_2 emissions. A downstream system would have to encompass more than 300 million entities in order to provide near-total coverage. The burdens associated with developing and administering such a large program make the downstream option infeasible.

Carbon taxes could also be applied either upstream or downstream; however, the latter is more likely. This would affect hundreds of millions of entities but would not be too great of a burden because taxes are pervasive throughout our society – there are already many mechanisms for collecting them and many fossil fuels are already taxed.

The criteria that I used to analyze the options were:

- the burden of implementation, administration and monitoring on government and program participants;
- equity and fairness;
- the efficiency and effectiveness of the programs, including: emissions coverage and reduction, leakage, costs, flexibility, efficiency and the effect on behavior and technological change; and
- political feasibility.

Based upon my evaluation of permits and taxes, I recommend that the United States develop a tradable permit system involving the processors of fossil fuels. I also recommend that permits be auctioned and that the revenue generated from the auctions be used to offset the regressive nature of the price increases.

THE POLICY PROBLEM IN A BROADER CONTEXT

Carbon Emissions

Each year the burning of fossil fuels releases 24 billion tons of CO_2 into the atmosphere.[4] About half of these emissions are sequestered either by the ocean or by vegetation and forests,[5] the other half remains in the atmosphere. These additional emissions have increased the concentration of CO_2 in the atmosphere by approximately 30% over pre-industrial times.[6]

In spite of the US commitment in Rio to voluntarily reduce carbon emissions by 2000, US emissions have risen by ten percent in the last decade.[7] The United States is, by far, the largest source of CO_2 emissions in the world - contributing 22% of global CO_2 emissions. [8]

Global Climate Change Science

Most scientists believe that the increase in atmospheric CO_2 concentration under a business-as-usual scenario will lead to a warming of the Earth's atmosphere by an average of 2 to 6 °F over the next 100 years.[9] This rate of change would be faster than any experienced in the last 10,000 years and has the potential to dramatically alter the Earth's climate.[10]

The effects of global climate change will vary – some areas will benefit and some will be devastated. Generally, land masses are expected to warm more than the oceans, higher latitudes more than equatorial latitudes, and there will be less temperature variation between day and night. Climate change is expected to affect 5 main areas: sea level, water cycle, species and ecosystem distribution, agriculture, and health.

SEA LEVEL

Sea level will rise because of thermal expansion of the oceans and the melting of glaciers, inundating low-lying areas in the United States such as the Mississippi River Delta and Southern

Florida. Coastal and low-lying areas will also be more vulnerable to flooding. Scientists estimate that sea level will rise between 6 and 37 inches by 2100.[11] Half of the world's population lives in coastal areas, many of which have fertile soil and are used extensively for agriculture. For example, about 25% of Bangladesh's habitable land is less than 10 feet above sea level and is home to approximately 30 million people, most of whom are involved in agriculture.[12]

WATER CYCLE

Temperature increases will cause an intensification of the water cycle, producing more severe and more frequent storms and floods and increased evaporation. The availability and quality of water supplies will also be affected. In the United States, areas in Arkansas, Colorado, Missouri and Texas are particularly at risk.[13] Around the world, increasing water scarcity will further hinder development and exacerbate tensions between countries that share water sources.

SPECIES AND ECOSYSTEM DISTRIBUTION

Most ecosystems cannot respond (either through adaptation or migration) to rapid climate change. Each species has a niche, or a specific set of environmental conditions within which it can survive and reproduce. As climate change affects environmental conditions, within and around ecosystems, species may find themselves out of their niche. Forests are most likely to be affected because of their long lives and the amount of time it takes them to reproduce. For example, up to 65% of current boreal forests would be negatively effected if CO_2 concentrations were to double.[14]

AGRICULTURE

Temperature and water supply are the two key considerations when determining what to plant, and when and where to plant it. Changes in either of these factors can lead to dramatic changes in agricultural patterns and would therefore have a profound effect on the global food supply.

HEALTH

Human health is directly connected to environmental conditions. As temperatures increase, so does our risk of morbidity and mortality from heat stress – death rates during extreme heat events can be double or triple regular rates.[15] The distribution and spread of diseases are likely to increase due to the expansion of the ranges of vector organisms. Air pollution is likely to be exacerbated, water supplies polluted or threatened, and soil characteristics changed (leading to inadequate nutrition) – all of which affect human health.

Evidence of Global Warming

Whether this warming is in fact occurring is the source of considerable debate. There is evidence to support this conclusion: the ten hottest years on record have all occurred since 1980 and average global temperatures have increased by approximately 1 °F in the last century.[16] Global mean sea level has risen 4 to 10 inches.[17] Frozen areas (glaciers and permafrost soils) have begun to melt – it is estimated that 1 to 3 inches of the observed rise in sea level is from glacial melting.[18] Precipitation in the United States has increased by 6% and the frequency of heavy downpours has increased by 20%.[19] Vegetation is also being affected: in the northern high latitudes the length of the growing season increased by up to 12 days between 1981 and 1991.[20]

International Global Climate Change Regulations

In 1992 the Earth Summit convened in Rio de Janeiro where 160 countries, including the United States, signed the Framework Convention on Climate Change (FCCC). The objective of the FCCC is to stabilize atmospheric concentrations of GHGs at a level that would "prevent dangerous anthropogenic interference with the climate system." Developed countries volunteered to reduce their GHG emissions to 1990 levels by 2000, and governments agreed to submit progress reports and emissions projections at annual Conferences of the Parties (CoPs).

The first CoP met in Berlin in 1995. The Parties to the FCCC agreed to a series of negotiating sessions in order to develop binding emission reduction commitments. The goal was to reach an agreement by the third CoP in 1997.

The second CoP was held in Geneva in July 1996. Most Parties signed the Geneva Declaration, which endorsed the IPCC's conclusions in their *Second Assessment Report* and the Panel's assertion that continued increases in atmospheric GHGs will negatively affect global climate. The Declaration also called for the Parties to increase their effort to develop binding targets and schedules in order to develop a protocol that could be signed at the next meeting.

The Kyoto Protocol was signed in December 1997 at the International Climate Summit in Kyoto, Japan. Annex I countries (industrialized countries) agreed to reduce their GHG emissions by an average of five percent below their 1990 emission levels beginning in 2008. Reduction requirements were not included for developing countries. The Protocol enters into force when it is ratified by 55 Parties representing at least 55% of the total CO_2 emissions of industrialized countries in 1990.[21]

Since the Kyoto Protocol the Parties have met twice – in Buenos Aires in 1998 and in Bonn in 1999. The Buenos Aires Plan of Action strengthened the technology transfer and assistance programs for developing countries that were part of the FCCC and it set a deadline in 2000 for completing unfinished business (such as flexibility mechanisms).[22] It was at this meeting that the U.S. signed the Kyoto Protocol and agreed to a 7% reduction below 1990 levels.

The main topic of discussion at the Bonn was potential flexibility mechanisms for Annex I countries to meet their targets.

US Climate Change Regulations – Presidential Actions

After the Framework Convention on Climate Change was signed the Bush, and later Clinton, administration adopted a "no regrets" policy for meeting U.S. obligations. Under this policy, measures to reduce greenhouse gases would be taken only if they made sense apart from climate change considerations. For example, improved energy efficiency can be cost effective, apart from any benefits related to mitigating climate change.

Bush's *National Action Plan for Global Climate Change* focused on voluntary pollution prevention and energy efficiency/conservation initiatives – most of which were in the works before the FCCC was signed. The Bush plan also established a baseline for future actions by estimating US emissions and cataloging the activities that affected them.

Clinton's *Climate Change Action Plan* set explicit reduction goals (1990 levels by 2000) and described 50 programs (enhancements of existing programs and new, voluntary measures) to help achieve those goals. Much of the Clinton Plan was based on Bush's earlier work, however, provisions for funding (including new incentives for business, industry and agriculture) and technical support were also included.

In 1997, President Clinton outlined several actions to reduce GHGs in his *Climate Change Proposal* including tax cuts, early reduction incentives, federal money for research and development, electricity restructuring and energy efficiency improvements.[23] President Clinton also expressed his commitment to both domestic and international trading systems.

Each year the Clinton Administration includes funding for climate change initiatives in the budget it presents to Congress. For the past two years (FY 2000 and FY 2001) the Clinton Administration has requested $4.1 billion for programs and research relating to climate change.[24] Each year Congress reduces the administration's budget requests.

US Climate Change Regulations – Congressional Legislation

Before the Kyoto negotiations, the U.S. Senate passed Senate Resolution 98 stating that the United States should not sign any agreement that did not include specific reduction schedules for developing countries or that would result in significant harm to the U.S. economy. The Resolution further required that any agreement sent to the Senate for ratification include a detailed analysis of implementation options and the costs associated with those options.

In spite of past funding for such programs, Congress continues to be concerned about recent attempts to establish programs and research activities that are viewed as ways to reduce greenhouse gas emissions. Congress fears that funding such initiatives will lead to "back door" implementation of the Protocol.[25] As a result of this concern, many appropriations bills contain language that prohibits the administration from funding programs, and in some cases research, that are seen as de facto implementation of the Protocol.[26] A Concurrent Resolution on the Budget for Fiscal Year 2000 was also passed in April 1999 firmly stating that funds will not be provided for programs that enact the Protocol before its ratification.

Numerous Congressional hearings have been held on the subject of climate change and on potentially awarding credits to companies that reduce emissions before the Protocol enters into force. Generally Congress is skeptical of climate change science and the risks associated with climate change, and is concerned about the costs of emission reductions. There is also concern about the transfer of wealth to developing countries that could potentially occur with an international emissions trading scheme.[27]

Acid Rain: A Model for Climate Change?

There are few examples of environmental initiatives that are suitable for comparison to the issue of GHG emissions and global climate change. One of the most successful of these is the U.S. sulfur dioxide (SO_2) emissions trading program set up by the Clean Air Act (CAA) Amendments of 1990. These Amendments set an annual limit on the amount of SO_2 that can be emitted by power plants and gives each plant a specific quantity of allowances based on their past emission rate. If a plant's emissions are less than their allowances in a given year, they may sell the excess. If their emissions are greater they must buy excess allowances from another plant or face stiff penalties. Allowances can also be saved to offset emissions in later years ("banking").

This program has resulted in emissions being reduced 35% more than the Amendments required.[28] The price of an allowance in the first year of trading averaged around $100 per ton, much lower than pre-implementation estimates of $300 to $700.[29] Overall costs of compliance during the first five years are estimated at one-fourth that of traditional regulatory approaches ($1 billion as opposed to $4.5 billion).[30] The program has also resulted in greater fuel switching (to low-sulfur coal and natural gas) and in significant advances in technology (especially in scrubbers).

There are several reasons for the success of the program that are applicable to GHG emissions.[31]

- Flexibility – emitters had to meet their emissions restrictions but could do so using the methods that were best for them (fuel switching, technological enhancements and changes, and/or purchasing allowances). This helped reduce costs of compliance.
- Banking and Trading – allowed emitters more flexibility in decision making. Government non-interference in trades also helped to reduce costs.
- Monitoring – effective monitoring of emission levels, and permit banking and trading helped ensure compliance.
- Tracking – a system for tracking allowances that was open to public scrutiny also helped to ensure compliance.
- Penalties – automatic, steep penalties that hold emitters accountable for their emissions and also helped to reduce compliance costs.

All of these aspects also helped to engender political and industrial support for the program – both of which were crucial to its success.

POLICY ANALYSIS

In order to meet the requirements of the Kyoto Protocol (7% below 1990 levels) the United States will have to reduce CO_2 emissions by 20 – 30% below predicted emission levels in 2010.[32] Two of the policy instruments that the United States can use to meet its domestic reduction targets are tradable emission allowances (permits) or taxes.

Both taxes and permits force entities to internalize the costs of the pollution that they generate. Under both systems, entities will reduce their emissions or potential emissions as long as the price of the permit or tax is greater than their marginal costs of reduction. If the permit or tax price is less than the marginal costs of reduction, entities will choose to either buy more permits or pay the tax.

Tradable permits can either be applied upstream (to producers) or downstream (to consumers). Under a tradable permit system, a cap would be set on total emissions with individual permits allocated to CO_2 emitters freely or through an auction. Each permit would be equivalent to one ton of potential or actual CO_2 emissions. If a company emits less than their number of permits they can sell the excess. If a company emits more than their number of permits they have to buy more permits to make up the difference. Companies would also be allowed to "bank" (save) their permits for later years.

Tradable permits guarantee a specific amount of reduction – the government only distributes as many permits as will meet its emission target. Because the quantity of permits is fixed, the price of permits fluctuates according to market supply and demand. This fluctuation can lead to significant costs.

Taxes fix the cost of reductions. Under a carbon tax system, the government would establish a tax that would be levied on fossil fuels according to their carbon content. Entities will reduce their actual/potential emissions as long as the cost of reduction is less than the level of the tax. If costs are greater, then entities will stop reducing and just pay the tax. Because of the fixed costs, there is no way to guarantee the level of reductions achieved with a tax. Taxes will likely need to be adjusted regularly to ensure that reduction targets are being achieved.

Evaluation Criteria

Both policy options will be evaluated according to the following criteria:

- ***IMPLEMENTATION AND ADMINISTRATION*** – How difficult will it be to establish and administer a program? How much of a burden will monitoring be and who will bear the costs? Administration should be feasible – i.e. governmental burden, reporting requirements and the number of regulated entities should all be minimized. Also, the program must be applied at a point where accurate estimates of carbon content/emissions can be obtained without too great of a reporting burden.
- ***EQUITY AND FAIRNESS*** – Is the program regressive? Who are the winners and losers? What are the effects on consumers and industry and will the program support tax shifts to ease the costs of compliance?
- ***EFFICIENCY AND EFFECTIVENESS*** – This criteria has many facets:
    - **Emissions Coverage and Reductions** – How many emissions sources will be captured in the system, what percentage of total emissions do these sources represent, and by how much will emissions be reduced? The program should capture the greatest percentage of emissions possible and take into account non-fuel uses, exports and imports. The program should also ensure that the appropriate amount of reduction is occurring.

    - **Leakage** - There should be no “loopholes” that encourage producers and consumers to find ways around the program (leakage). For example, regulating entities of a certain size would encourage larger entities to break their operation into smaller pieces that are below the regulation threshold.
    - **Costs** – What are the transaction costs and the overall costs? The program should minimize costs.
    - **Flexibility** - Programs should allow entities the freedom to choose their methods of compliance and allow for new emissions sources to enter the program without too great of an economic burden. Also, other GHGs should be able to be included in the program at a later date.
    - **Efficiency and Deadweight Loss** – How efficient is the program and will it result in deadweight loss? The program should maximize efficiency and minimize deadweight loss.
    - **Effects on Behavior and Technological Change** – What, if any, effects will the program have on consumer and industry behavior? The program should strive to change consumer and industry preferences (e.g. increase demand for efficiency improvements and reduce consumption) and to spur technological advances (e.g. efficiency improvements, emission mitigation, and new sequestration methods).
- ***POLITICAL FEASIBILITY*** – Is there public, political and industry support for each option? What are the chances that a program can be implemented?

Tradable Permits

There are two ways to implement a tradable permit program: by applying the permits "upstream" (fossil-fuel producers and distributors) or by applying the permits "downstream" (fossil-fuel consumers). Permits can measure either the amount of carbon in fuels ("inputs") or the amount of CO_2 emitted ("outputs"). Each method has its advantages and disadvantages.

UPSTREAM VS. DOWNSTREAM

Under an upstream emissions permit system, regulated entities would be required to hold permits for the potential CO_2 emissions of their fuels. Each permit would allow the company to produce or sell one ton of future CO_2 emissions. Companies that deal with carbon-rich fossil fuels (coal and oil companies) would need to hold more allowances per unit of energy than companies that deal with less carbon-intensive fuels (natural gas). With a downstream approach, regulated entities would be required to hold permits for the amount of CO_2 emitted. Each permit would allow the entity to emit one ton of CO_2. Entities that emit more would need to hold more permits than those that emit less.

In order to achieve near-total emissions coverage, an upstream permit system would, depending on where the permits were applied, encompass between 2,000 (processors) and 1 million (extractors) entities. A trading system at the processor level is the most feasible and is discussed in greater detail in the next section.

A downstream permit system would encompass more than 300 million entities. Table 1 shows the number of downstream entities by sector and their percentage of total U. S. emissions.

TABLE 1: Downstream Sectors and Their Percentage of U.S. Carbon Dioxide Emissions

Sector	Units	Share of US Total*
Residential	~ 100 million	7%
Commercial	~ 4.5 million	4%
Industry – Large	~3,000	12%
Industry – Small	~ 365,000	13%
Transportation	> 200 million	28%
Electricity Generators	~3,000	36%

Source: Center for Clean Air Policy. "US Carbon Emissions Trading: Some Options that Include Downstream Sources." Washington, D.C.: Center for Clean Air Policy, 1998, 11.

*Share of total is net of electricity emissions.

The number of downstream sources makes it administratively infeasible to incorporate them all into a cap-and-trade system. It would be possible to restrict regulation to the largest emitters (electricity generators and certain industrial sectors), however, this would capture approximately only 50 percent of emissions and would still include more than 100,000 entities. This would be unfair for those regulated because they would be bearing the full burden of reduction. Incomplete coverage would also increase the potential for leakage – regulated entities would have an incentive to break up their companies to avoid regulation or to switch their production to unregulated sources of fossil fuels.

Monitoring and compliance would also be very difficult with a downstream system. Estimating the carbon content in the thousands of fossil fuel products that consumers use would be extremely difficult to do in any cost-effective manor. Estimating actual emissions from the use of those products would be impossible.

The rest of this paper will focus on upstream tradable permits and comparing them with carbon taxes.

UPSTREAM SYSTEM

The design of an upstream permit system will have to address the following:

- which entities to regulate;

- where and how to measure the carbon content of fuels;
- how to deal with imports and exports; and
- how to initially allocate permits.

Who to Regulate

An upstream system could be applied to three different stages in the production process: extraction (the individual mine or well), processing (refineries, treatment plants or preparation plants) or transportation and distribution (pipelines, rail shipments, and others). Table 2 shows the number of entities in each option.

TABLE 2: Upstream Entities and Their Percentage of Total Production

	Coal		**Natural Gas and Natural Gas Liquids**		**Petroleum**	
	Number	*Percent of Production*	*Number*	*Percent of Production*	*Number*	*Percent of Production*
Wells or Mines	2100	100%	300,000	100%	600,000	100%
Extraction Entities	3402				8,000	100%
Refiners/Processors	550	~90%	725	~80%	175	~100%
Pipelines			150	~100%		
Local Distributors			1,300		14,127	
Importers		< 1%		~ 10%	200	~ 60%

Source: Center for Clean Air Policy. "US Carbon Emissions Trading: Description of an Upstream Approach." Washington, D.C.: Center for Clean Air Policy, 1998, 7.

As you can see from the above data, if permits were required at the extraction or local distribution levels the number of regulated entities would range from 11,000 to over 1,000,000. Such a large number of entities would make administration and compliance monitoring very costly and time consuming. Smaller companies would be the hardest hit by the reporting requirements and by competition for permits, however, excluding them would eliminate 20% of the nation's fossil fuels from the program.[33] If only the largest extraction companies (around 200) were regulated, anywhere from one-third to one-half of the nation's fossil fuels would be unregulated.[34] Excluding smaller entities also creates and incentive to subdivide operations in order to bypass regulation – a phenomenon that would increase the amount of unregulated emissions over time.

Regulating the pipelines and the processors of fossil fuels would capture almost all of future carbon emissions, with the exception of some imports and those quantities that bypass the intermediate stages. Below is a discussion of both of these omissions and ways to include them in the program.

Imports

Any upstream permit system needs to include emissions from imported fossil fuels. The U.S. imports approximately 6 percent of its refined petroleum, approximately 13 percent of its natural gas and less than one percent of its coal.[35] Petroleum imports can be captured by requiring importers of refined products to hold allowances based on the carbon content of the fuel. Natural gas imports can be captured by requiring allowances at the pipeline. Coal imports can be captured at either the port of entry (for processed coal) or at the processing plants.

Fuels that Bypass Intermediaries

Not all fossil fuels go through a processing plant. Approximately 20 percent of natural gas goes directly to the pipeline, bypassing the processing plant[36] and approximately 20 percent of petroleum products (in the form of natural gas liquids (NGLs)) go through gas refineries but not through the pipeline.[37] This situation can be remedied with a hybrid approach to natural gas: require pipelines to carry permits for the gas they transport and require refineries to carry permits for the NGLs they process. Approximately 10 percent of coal is shipped directly to end users from the mines.[38] These emissions can be captured by requiring mines that ship directly to end users (less than 100) to hold allowances for those shipments. Refiners process nearly all of the crude oil imported or produced in the United States, so there is little that will not be captured by an upstream program.

Measuring Carbon Content

The best way to estimate future emissions is to measure the amount of carbon present in the fuel. The government could estimate the carbon content of various fuels or it could require regulated entities to perform these measurements. Below is a discussion of the options for each industry.

Petroleum

Because refineries do not currently track the carbon content of their inputs or their outputs, requiring them to measure carbon content will increase the administrative burden on individual entities. However, due to the small number of refineries, the overall administrative burden would be less than if extraction entities were required to determine carbon content.

Refineries can either determine carbon content at the input level or the output level. Measuring carbon content at the input level would capture emissions from fuel used in the refining process (approximately 6 percent of the oil they receive[39]), measuring output products would not. Measuring at the input level would also reduce the administrative burden – a refinery inputs only crude oil but outputs hundreds of products. Measuring at the output level would require the government or refiners to develop an emissions list for the hundreds of products that refineries produce, some of which are sold only in very small quantities.

According to the IPCC, the nearly complete combustion of carbon in crude oil (99%) makes crude oil carbon content a good measure of CO_2 emissions.[40] Measuring carbon in crude oil can be accomplished in three ways: set one average measure for all crude oil, set different measures for different grades of crude oil, or determine the carbon content for each batch that the refinery receives. The first option, one standard measurement, is the most easily implemented, however, it may cause some unfairness in permit allocation because of variations in the carbon content (2 – 3 percent).[41] With one standard measurement some refiners would overpay while others underpaid. The second option (set measures for each grade of crude) provides a more accurate and fair measurement of potential emissions, however it would require a greater reporting burden. The latter option would be the most accurate and fair assessment of potential emissions, however, it would also be the most burdensome. Developing set measures for each grade of crude would provide the best balance between accuracy and reporting burdens.

Natural Gas

Unlike the petroleum industry, natural gas inputs are more different than outputs. There are a large number of inputs into a natural gas processing plant and only a small number of outputs. Measuring the outputs, each with well-known carbon characteristics, would be the least burdensome. The carbon content of gas that goes directly to the pipeline (bypassing processing) could be calculated based on the energy content of the gas (something pipelines already measure), which is strongly correlated with the amount of carbon.[42]

Coal

The carbon content of coal varies widely with the rank of the coal and the location of the mine. Coal preparation plants typically perform analysis on the raw coal coming into their plants and on the processed coal leaving the plants. The incoming tests are very basic and cannot measure carbon content (although such measurements could be required). Outgoing tests are more thorough and can, in the case of chemical analysis, quantify carbon content. There are three ways to measure carbon content in coal: develop predetermined measurements for different types of coal based on rank and geography, develop a formula that relates carbon content to other, known characteristics, or require a detailed chemical analysis for all coal.[43]

The first option (predetermined levels) would be the easiest to implement and it provides a reasonably accurate estimate of emissions potential. It would require a lot of analysis up front (probably by the government), however, once the analysis was complete and the emissions factors were determined, implementation would be simple. The second option (relating carbon to other characteristics) would require a detailed analysis by the federal government of the chemical composition and carbon content of different types of coal. The government would then develop formulas that companies would apply to the types of coal that they sell to determine potential emissions. This method would be a more accurate measurement of potential emissions but would also impose a greater burden on government and industry. The final option (performing a detailed analysis on all coal) would precisely measure the carbon content of coal, however, it would be very costly and time consuming for companies to implement.

The first option will be the easiest to implement and will provide an accurate measure of carbon emissions. This option is the least-cost option for both governments and preparation plants.

Table 3 provides a summary of where permits should be held, the point at which carbon content should be measured and the basis for that measurement.

TABLE 3: Where and How to Measure Carbon Content and Require Permits

	Permit Point	Measurement Point	Basis for Measurement
Petroleum	Refineries	Inputs	Grade of crude oil
Natural Gas	Processing plants	Outputs	Chemical composition
	Pipelines	Inputs	Energy content
Coal	Preparation plants	Outputs	Rank and geography

Other Concerns

The other concerns surrounding an upstream system are: double-counting, and the handling of non-fuel uses and exports.

Double-Counting

There are several points in the upstream system where double counting might occur. Some petroleum refinery products are sold to other refineries as unfinished goods and are used as inputs into other products. In order to avoid double-counting, an upstream permit system should require permits only for inputs purchased from extraction entities, not for inputs purchased from other refineries. Refineries already track their trades with each other so this solution would not require any additional reporting burdens.

Double-counting is also a concern for natural gas pipelines, since gas often travels through multiple pipelines before reaching the end-user. Requiring permits only at the point of entry into the pipeline system (i.e. for gas received from extraction or processing entities but not from other pipelines) would reduce this concern. Pipeline companies already track the sources of the gas so this solution would also not require any additional reporting burdens.

To avoid double counting with coal, mines would only be required to hold allowances for the coal that is not shipped to preparation plants (these plants have to hold allowances for all the coal they receive). The number of mines needing to hold allowances would most likely be less than 100 and the information should be easy to track using existing accounting records.[44]

Non-Fuel Uses

Approximately six percent of fossil fuels are used in non-combustible products.[45] Oil refineries make a number of materials that are used to make non-combustion products such as asphalt, plastics, and lubricants; almost 11% of crude oil goes for such non-fuel uses.[46] The same situation would apply to natural gas processing plants that also produce products that are used for non-combustible purposes. Very little coal goes toward non-fuel uses so this will not be a problem for coal processing plants. Ideally, allowances should not need to be held for such products because they provide long-term sequestration of carbon and because of the administrative burden of tracking the amount of carbon sequestered. This issue may be able to be resolved through a rebate system for the non-combustible products, however, this option

needs more looking into. The administrative feasibility of setting up a rebate program may end up being a nightmare and eventually, the carbon is released from these products. Since the long-term stabilization of GHG concentrations is the goal it may not be wise to discount the eventual emissions from these products.

Exports

The United States is not a major exporter of fossil fuels of fossil fuel products. Only 9 percent of coal, 1.5 percent of crude oil, 5 percent of finished petroleum products and 1 percent of natural gas is exported.[47] Entities that export fossil fuels or fossil fuel products would not have to hold permits for the exports.

INITIAL ALLOCATION OF PERMITS

A key issue in the design of a permit trading system is how to allocate the permits. Permits can either be given away freely or auctioned off - both options have benefits and drawbacks. Regardless of which option is chosen, consumers will still pay higher energy prices.

Gratis Allocation

Gratis allocation may be the easiest method for distributing permits, but it is by no means the best or most equitable method. By giving away permits, the government transfers scarcity rents (potentially billions of dollars) to those companies that receive permits. This option would result in furious lobbying by industries to receive the maximum number of permits. Utilities and fossil fuel companies favor gratis allocation over auctioning.

There are a number of ways that permits can be given away freely. Two common options are to base allocation on historical levels (of either fuel sales or emissions) or to base allocation on the entity's share of market output. The latter option may create an incentive avoid reductions in output now (either through technological advances, fuel switching, or direct cuts in production) in order to increase the amount of permits received later.

Gratis allocation may reduce technological innovation and technology sharing – businesses would have incentives to reduce their own emissions but would not have incentive to share their innovations with the rest of the industry. Industry-wide technological improvements would reduce the price of the permits and thus the value of the firm's asset. Under gratis allocation the parties that face the greatest costs of the program may not be the ones who benefit from free permits. For example, an efficient firm receives few permits and is then faced with the choice of further reducing their emissions or buying more permits (potentially at great expense). Meanwhile, an inefficient firm receives numerous permits, subsequently achieves relatively inexpensive reductions and is able to sell their permits at a profit.

Also, there is no chance to reduce the costs of control through revenue recycling, as there would be with auctioned permits.

Auctioning

With auctioning, parties bid on emissions permits. Two type of auctions frequently discussed are a sealed-bid, uniform-price auction and an ascending auction. Under a sealed-bid, uniform-price auction, buyers submit their bids (for number of permits and price they are willing to pay) and the auctioneer determines the bid price that will clear the market. All bids below the clearing price are rejected, those above get filled and those at that price get rationed. In an ascending auction, buyers keep improving their bids until demand equals supply – in other words, those that are willing to pay the most receive the permits.

The government stands to gain significant revenue if it auctions carbon permits instead of giving them away. For example, in order to meet targets under the Kyoto Protocol, the United States will need to restrict carbon emissions to approximately 1.3 billion tons per year. If permit prices equal $50 per ton of carbon emissions, the government would raise $65 billion per year in an auction.

The revenue generated by permit auctions could be used to offset some of the costs of GHG reductions ("revenue recycling"). For instance, a reduction in the payroll tax or an increase in transfer payments for lower income families could offset the added costs of electricity and fuel. Revenues could also be applied to research and development on energy efficient technologies or other advances. If the revenues are applied wisely to specific sectors of the economy, they could significantly reduce the economic burden of GHG reductions.

Carbon Taxes

Unlike permits, which restrict emissions to a predetermined level, taxes restrict reduction costs to a predetermined level. Like permits, carbon taxes could either be levied according to the carbon content of fuel or according to actual emissions, however, as with permits, it would be easier to do the former. Under this system coal would be taxed the highest, then petroleum, then natural gas. Taxes could be levied either as a specific amount (such as price per ton of carbon emissions) or as a rate (similar to a sales tax, such as 5% on every $1.00 of gasoline or electricity purchased).

Designing a taxing policy faces many of the same issues as permits regarding: who to regulate, how to measure carbon content, and how to handle imports and exports.

WHO TO REGULATE

Carbon taxes could be applied either upstream (to producers, processors and distributors) or downstream (to consumers/emitters). In an upstream system, applying the tax to processors and pipelines would capture almost all of the potential carbon emissions and would also pass part of the cost onto consumers in the form of higher prices. The tax could be applied at the same points as an upstream permit system (see earlier discussion).

In a downstream system, taxes could more easily be levied on end-users than permits. Most discussion about carbon taxes centers around downstream taxes. The tax could be applied to fuel purchases such as natural gas, gasoline, and aviation fuel. The tax could also be applied to electricity use. Most of these are already taxed in some form and adding an extra tax would do little to increase the administrative burden. However, downstream taxes will not capture the emissions that occur during the transport, processing or refining of fossil fuels, or fuels used as inputs for other products. Emissions from fossil fuel processing and refining can be captured by tracking the amount of fuel used during those activities and having companies pay taxes on the amount of fuel used. Companies that use fuels as inputs for other products could be accommodated by a rebate system.

HOW TO MEASURE CARBON CONTENT

Measuring the carbon content in an upstream tax system would be much easier than measuring carbon content in a downstream system. Some sectors in an upstream system already track carbon content – this data could be used to determine their tax burden. For a more complete discussion of the options refer to the discussion above within the upstream permit option.

In a downstream system, electricity generators and industry already track (somewhat) their actual emissions or the emissions potential of the fuel they use. This data could also be used to determine their tax burden. Emissions from other sectors (transportation, residential and commercial) would be administratively infeasible to track. Information on the carbon content of the fuels will have to come from upstream sources (such as refineries, processing plants and pipelines) and will have to be used to calculate the appropriate tax for each fuel type used.

IMPORTS AND EXPORTS

Imports and exports of an upstream tax system can be handled similarly to those in an upstream permit system (see the above discussion). Imports and exports in a downstream tax system would not need to be specially taxed because they are taxed once they enter the market and are purchased by consumers. As with permits, exports would not need to be taxed.

Analysis By Criteria

In order to determine the best policy option for reducing carbon dioxide emissions, each option will be evaluated according to the following criteria:

- implementation, administration and compliance burdens;
- equity and fairness;
- efficiency and effectiveness; and
- political feasibility.

IMPLEMENTATION, ADMINISTRATION AND COMPLIANCE

Whichever carbon reduction program is chosen should provide relative ease of implementation, be feasible administratively, and must ensure compliance. The easiest way to accomplish these tasks is to limit the number of entities that are regulated.

No matter which system is chosen, compliance can be assured through the use of substantial penalties. As long as the penalties for non-compliance are significantly greater than the cost of the permit or tax, and there is a high probability that they will be levied when there is non-compliance, regulated entities will have an incentive to comply. If penalties are not high enough, or if they are not applied swiftly and consistently, then regulated entities will do little to ensure their compliance.

Upstream Permit System

The experience that governments and some industries have with permit trading systems can help to lessen the costs of implementation and administration.

An upstream permit system, as described earlier in this paper, includes fewer regulated entities and fewer types of industries than a tax. This will make the administration and monitoring of the upstream system less burdensome and will facilitate trading. The administrative burden on individual companies can also be reduced by:

- Setting pre-determined measurements for the amount of carbon in different grades of crude oil (when it reaches the refinery). This will increase the government's burden initially (during the measurement setting phase);
- Using the already known carbon characteristics of products leaving natural gas processing plants and calculating carbon based on the already tracked energy content of gas entering the pipeline. This will not increase the government's burden; and

- Setting pre-determined measurement for the amount of carbon in different types of coal based on rank and geography and apply it to coal leaving the refinery. This will increase the government's burden initially (during the measurement setting phase).

Permit Allocation

The distribution of permits entails a significant role by government. If permits are allocated freely – either by historical or projected emissions – the amount given to each entity will need to be calculated. Affected industries will also expend a significant amount of time and money lobbying for a greater share of the permits. If permits are auctioned, the government will have to run the auction and companies will have to invest time and money determining how many permits to bid for and at what price.

A uniform price auction (1 round) will have less of a burden on companies and the government than an ascending clock auction (multiple rounds). Any type of auction will add to the governments burden initially because the government will have to decide what to do with the revenues an auction generates. These administrative burdens will recur each time permits are distributed.

With free allocation, government spends a significant amount of time and money each year determining who gets how much and negotiating with recipients regarding their share. Also, each year recipients will spend a significant amount of time and money lobbying for more permits. Permit auctions would eliminate both of these activities and therefore lower the overall costs of a permit program.

Carbon Taxes

Governments have had extensive experience with taxes and many of the potentially regulated activities are already taxed (for example: gasoline, electricity, natural gas and heating oil). Applying the taxes based on inputs (i.e. the carbon content of fuel) rather than outputs (the actual amount of CO_2 emissions) would reduce the monitoring and compliance burdens. In the beginning, the government burden may be large because the emissions factors and correct tax levels have to be determined. There are too many downstream sources to monitor emissions, so carbon factors will need to be determined for each of the fossil-fuel products used. This will increase the administrative burden of taxes.

Taxes will have an added burden because of their need for regular adjustment in order to account for inflation, increasing or decreasing costs of reduction and other market, policy or information changes. Without adjustments significant distortions may occur, resulting in an ineffectual tax level.

EQUITY AND FAIRNESS

Permit Allocation

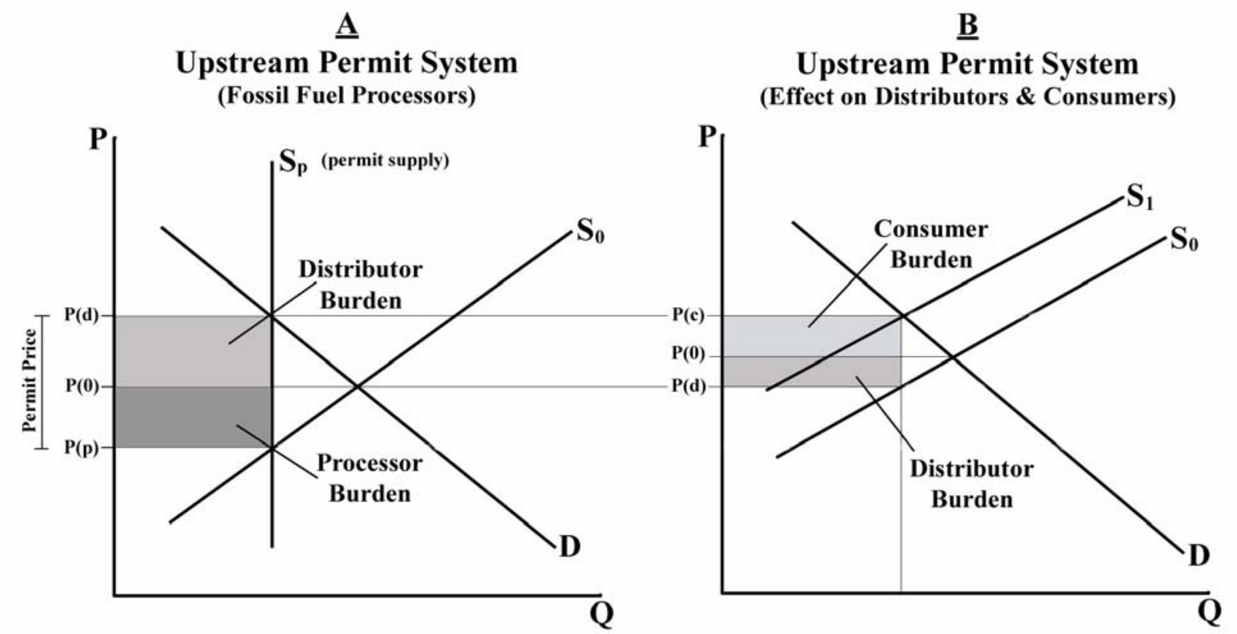
As discussed earlier, giving away carbon permits will transfer large amounts of scarcity rents to certain companies. These rents may not be going to the companies that are most affected by the trading program and may unfairly burden those companies with some of the costs of reduction. Auctioning permits would allow the government to capture these scarcity rents and apply that revenue towards offsetting some of the more harmful effects of reductions.

Regressivity

Carbon taxes are regressive – low-income households generally spend a larger percentage of their income on electricity, heating and gasoline and are therefore more affected by price increases. Permits are also regressive, although not as much of the burden is passed on to consumers.

In Figure 1, we see that an upstream auctioned permit trading system (applied to processors of fossil fuels) shifts the supply curve from S_0 to S_p. The price fossil fuel distributors (the consumers of the processed fuel) pay rises from P(0) to P(d) and the price that processors receive declines from P(0) to P(p). The difference between P(d) and P(p) is equal to the permit price. Processors and distributors share the burden of paying for the permits.

FIGURE 1: Consumer and Distributor Burdens in an Upstream Permit System.

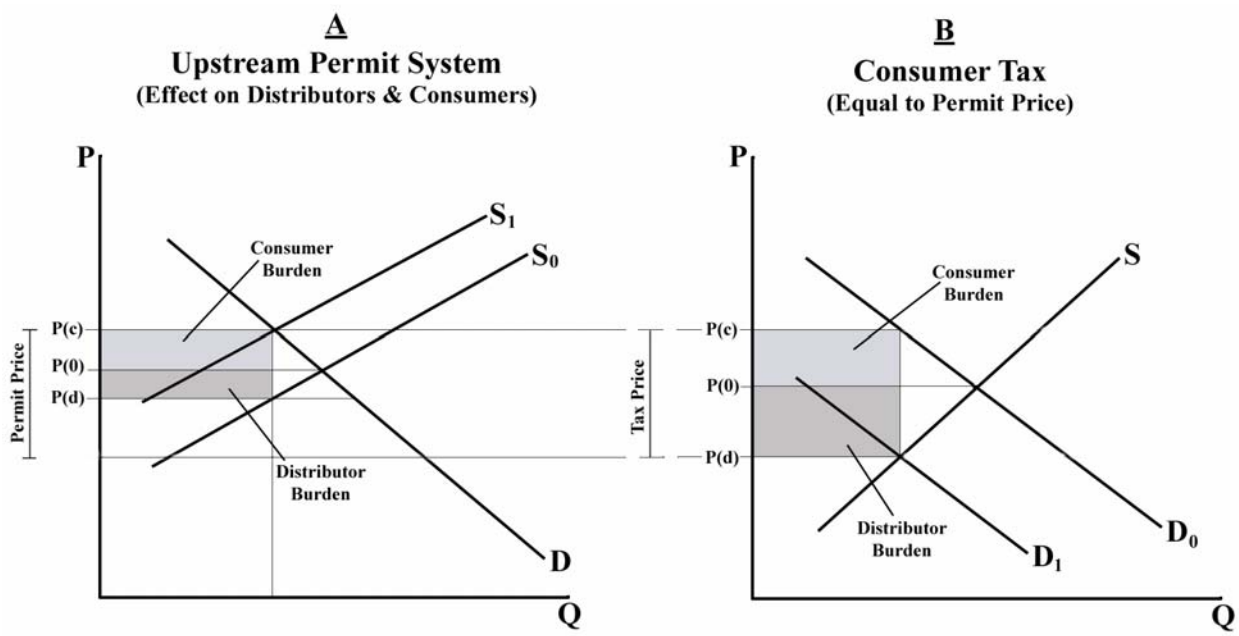


Fossil fuel distributors respond to their higher prices by shifting their supply curve from S_0 to S_1 (shown in Panel B). Consumers then pay a higher price, P(c) and distributors receive a lower price P(d). Only part of the distributor's burden is passed along to consumers. An upstream tax system would have a similar effect.

A downstream tax system would have a much greater effect on consumers than an upstream permit system. Figure 2 presents a comparison of the effect on consumers of an upstream permit system (Panel A) and a consumer tax with the tax equal to the permit price (Panel B).

In Panel B, Consumers respond to the tax by shifting their demand curve from D_0 to D_1. The price they pay increased from P(0) to P(c). Distributors receive P(d) for the fossil fuel they sell and they sell less. With a downstream tax both consumers and distributors bear a larger burden than with an upstream permit. Taxes would be more regressive than permits, however, as discussed above, recycling revenue generated from taxes or permit auctions can help offset this regressivity.

FIGURE 2: Consumer and Distributor Burdens of a Permit System vs. a Tax



EFFICIENCY AND EFFECTIVENESS

A variety of factors affect the efficiency and effectiveness of policy options: emissions coverage and reductions, leakage, transaction and other costs, flexibility and deadweight loss, and effects on behavior and technological change.

Emissions Coverage And Reductions

A program designed to reduce emissions should include the largest portion of total emissions and ensure that reduction targets are met. When sectors are not included in the requirements, opportunities for low-cost reductions in those sectors are lost and the burden of reductions falls more heavily on the regulated sectors. For example, if only 50% of emitters are regulated, they will have to reduce their emissions by twice as much as if all entities were included. Both upstream permits and downstream taxes cover nearly 100 percent of emissions.

Tradable permit systems limit the amount of emissions to a predetermined level (the number of permits issued). Taxes do not limit the amount of emissions, instead they limit the cost of emissions reductions – the amount of emissions reduced depends on the price of the tax and the costs of abatement. Regulated entities will reduce emissions (or potential emissions) up to the point at which the cost per unit is equal to the tax per unit. If abatement costs are higher than the tax, regulated entities will pay the tax. Also, depending on where the tax is applied, there could be significant portions of the economy that are not taxed, further limiting the amount of reductions that will take place. One benefit of a tax is that it can be directly applied to all consumers of fossil fuels and it will send price signals directly to those whose actions will affect emissions.

In order to guarantee a specific amount of emission reductions (such as the 7% reduction below 1990 levels that is required by the Kyoto Protocol) a permit system should be used. An upstream permit trading system, as described above, would capture nearly all potential carbon emissions.

Leakage

Leakage occurs when the design of an emissions reduction program encourages producers and consumers to find ways around the program without reducing their emissions or when a program encourages fuel-switching to a more carbon-intensive fuel. Examples include companies downsizing their operations to avoid regulations that apply to companies of a certain size or companies switching from taxed fossil-fuel sources to untaxed fossil-fuel sources. Reduction policies should reduce the amount of leakage.

There is little opportunity for leakage in the upstream permit system described in this paper because of the comprehensive coverage.

With taxes, if all fossil fuels are not taxed, or are taxed incorrectly, consumers (both individuals and companies) may switch to avoid the tax. One analysis found that in the industrial sector, a carbon tax may actually increase the price of natural gas relative to that of oil, thus causing a switch from natural gas to oil.[48] Taxes would have to be very carefully designed to avoid these potential adverse incentives.

Transaction Costs

Tradable permit systems can have significant transaction costs from the discovery of and negotiation with trading partners and from constraints placed on transactions. In order to reduce transaction costs, entities must be allowed to trade freely and quickly. Transaction costs will be low in an upstream system because of a higher degree of familiarity between sub-sectors (e.g. refineries, pipelines, and processing plants). The greater the degree of familiarity and ease of discovery of new trading partners, the lower the transaction costs will be.

Taxes have minimal transaction costs associated with them.

Overall Costs

As discussed above, permits fix the amount of emissions reduction, not the cost and taxes fix the cost of the reductions, not the amount. Under a permit system the cost of reduction could potentially be very large. Most studies estimate the cost to be between $30 and $100 per ton of CO_2 ($100 per ton is the most widely used estimate).[49]

Revenue generated from auctioned permits or taxes could be recycled back into the economy to help reduce the costs of the program by mitigating the effects on low- and middle-income families and small businesses, and by providing financial assistance for research and development of new technologies.

The actual costs of reductions may be different from the estimates, as was the case with the Acid Rain Program. Once SO_2 trading was underway, the price of permits proved to be far less than original estimates and more reductions took place than were required. The total cost of the first stage of the Acid Rain Program was approximately $1 billion.[50] A carbon trading program will be more expensive than the Acid Rain Program because of the larger number of entities and the larger amount of emissions reductions.

The initial distribution of permits and the temporal flexibility of permits can reduce the costs of compliance. It is estimated that permit auctions, with revenues used to finance other tax cuts, could reduce the costs of compliance by 75 percent.[51] The Acid Rain Program proved that they ability of an entity to bank permits will also reduce costs.[52] If costs are expected to increase over time, as will most likely be the case, entities have more of an incentive to reduce now and save their permits for later.

Flexibility

An emissions reduction program should be adaptable to changes in technology, costs of reductions or other price changes without sacrificing the goals of the program. It should offer flexibility in compliance methods, and allow new sources to join easily.

Both taxes and permits allow flexibility in the technology used to achieve emissions reductions. Neither is overly restrictive to new sources of CO_2 emissions – although a gratis allocation permit program may provide some barriers to market entry.

Only permits allow for flexibility across companies and over time. Permit systems reduce the overall costs of compliance by allowing abatement to occur wherever (and to a limited extent, whenever) it can be done in the least expensive manner. Temporal flexibility of permits (in terms of banking or borrowing) allow companies to plan for equipment replacement and production retooling. One of the reasons for the success of the acid rain program was the temporal flexibility of the permits.

Technological improvement will reduce compliance costs in a tradable permit system and will increase the amount of emissions reduced in a tax system. Unexpected increases in compliance costs will not reduce the amount of emissions reductions in a permit system, however, they can have a dramatic effect on the amount of reductions in a tax system.

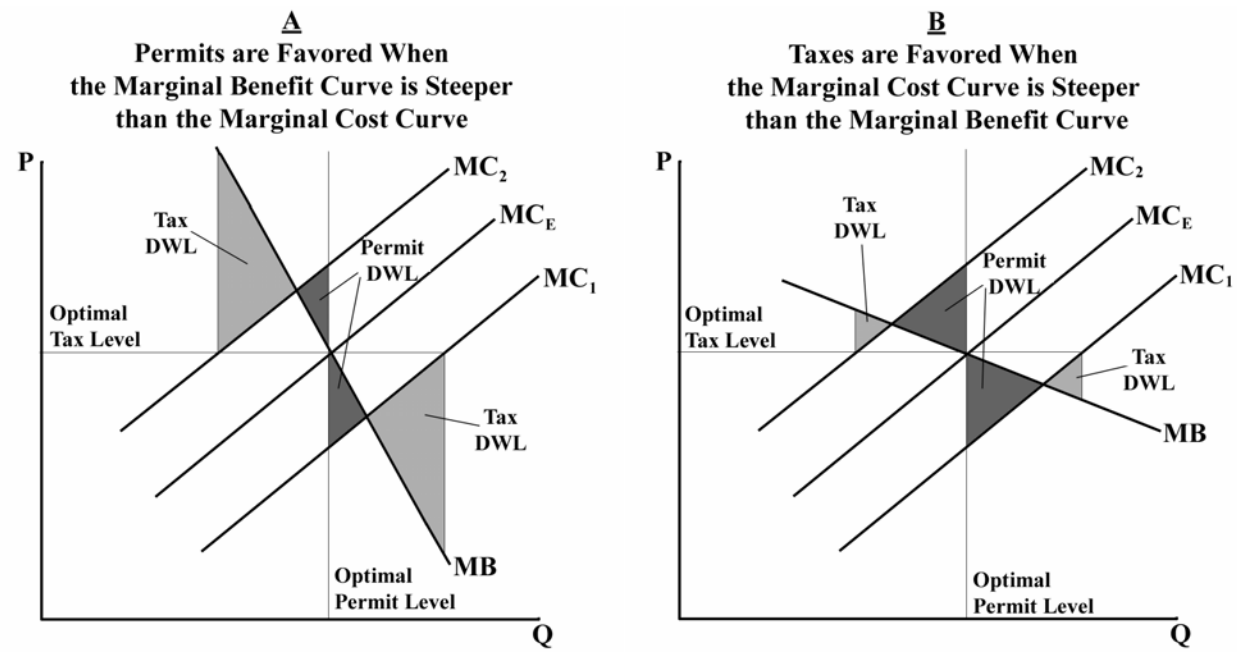
Permits are also able to adjust to price shocks and inflation – the price of the permit changes along with market conditions. Taxes are not flexible in these circumstances. The only way to deal with these events is to design mechanisms into the taxing structure that automatically kick in or to have policy makers reevaluate the level of the tax – a process that could take weeks or months to complete.

Efficiency and Deadweight Loss

The efficiency of taxes and permits can also be measured by deadweight loss (DWL). Deadweight loss is the pure waste induced by an increase in price above the efficient level (or by the decrease in quantity below the efficient level). For every level of reduction there is a marginal cost and vice versa. In order to maximize public welfare, an efficient tax/permit system should set the tax or permit level where the marginal cost of reduction equals the marginal benefit of that reduction. However, due to the time scale of global climate change and the uncertainty as to what the future will hold in terms of amount of emissions and technological advances, it is very difficult at this point to determine either of these. The goal of governments should be to set the permit/tax level at a point closest to what it would be if there were no uncertainties regarding costs or benefits. If marginal costs are estimated incorrectly the result is deadweight loss.

When the marginal cost curve of emissions reductions is steeper than the marginal benefit curve, taxes will produce a more efficient outcome – i.e. there will be less deadweight loss in the event that marginal costs differ from the expected. When the marginal benefit curve is steeper than the marginal cost curve, permits will produce a more efficient outcome. This is shown graphically in Figure 3, panels A and B.[53]

FIGURE 3: Tax and Permit Deadweight Loss



Since the effects of global climate change at any given time are correlated with the concentration of GHGs in the atmosphere and not the amount being emitted, one would expect that in the short run, the marginal benefit of reducing one more ton of CO_2 emissions would be very small. Thus in the short run, the marginal benefit curve would be shallow. However, assuming that reducing one ton now means that each year that ton will not be emitted and consequently GHG concentrations in the long run will be reduced, the marginal benefits of reducing that ton in the long run may be greater and the marginal benefit curve would be steeper. Under this latter scenario, permits may be more efficient in terms of reducing deadweight loss in the long run.

There is also a significant amount of uncertainly regarding marginal costs. Marginal costs could end up being greater than or less than anticipated. If marginal costs are greater than anticipated (marginal cost curve is steep) they could overwhelm marginal benefits. If marginal costs are less than anticipated (marginal cost curve is shallow) they could be overwhelmed by marginal benefits. Taxes would be preferred in the former scenario and permits in the latter.

Given the experience with the costs of Acid Rain Program, there is reason to be optimistic that the marginal benefit curve could be steeper than the marginal cost curve.

Effects on Behavior, Technology and Fuel-Switching

Behavior

An upstream permit approach will have more of a direct effect on fossil fuel processors than on consumers. Processors will prefer less carbon rich fuels, however, the extent to which they can switch to lower carbon fuels is very limited[54] - they will have to simply reduce their sales of fossil fuels in order to meet their targets.

Figures 1 and 2 showed that an upstream trading or tax program would not send as clear a price signal to consumers as a downstream system would. As a result, there will be less of an incentive for increasing downstream efficiency or fuel switching in an upstream system. This could affect the costs of compliance. Downstream systems send a clearer price signal to consumers, however, there are a variety of factors that influence consumer decisions.

In the short run, demand for fossil fuels is less elastic than in the long run, as a result they may not respond as aggressively to price signals as policy makers would like. In the short run, individuals and industry face a variety of constraints. Individual consumers are limited by their ability to purchase a car with greater fuel efficiency, utilize public transportation, reduce vehicle miles traveled, and reduce electricity and/or natural gas usage. Industry is limited by their ability to switch their production practices. In the long run, industry can budget for and purchase more energy efficient equipment or they can switch their manufacturing processes into something that does not emit as much. Consumers can, in the long run, relocate closer to their places of employment, purchase a more efficient car or appliances, and have modifications made to their homes (such as solar panels and insulation).

Even without constraints, not all consumers respond to price signals - as is evidenced by the fact that many do not purchase energy efficient appliances that will save more money in the long run than the extra amount that is initially spent to purchase the appliance. Depending on how much or how little individual consumers respond to the price signals, a significant amount of emissions reductions may not be realized.

Taxes send a stronger signal to industry and/or consumers to reduce emissions. The effectiveness of these signals depends on the level of the tax and of the ability of consumers to respond. If the tax is set too low, people will pay the tax and not reduce. If it is set too high – people will incur enormous costs.

One of the advantages of a permit system is that as permits become scarce, the cost goes up and stronger signals are sent to the market.

Technology

In an upstream permit system, fuel produces would be required to hold allowances for the emissions potential of the fuel, not for actual emissions. This gives little incentive to find ways of reducing emissions, as utilities did with SO_2. This will not be a problem for the immediate future because there is currently no cost-effective way to scrub CO_2 emissions, however, if such technology does become feasible in the future, this issue will need to be addressed. There will be an incentive to increase energy efficiency downstream but it will not be as strong as with a tax.

A carbon tax would provide a stronger incentive for the development of energy efficient technologies (assuming it is set at the correct level).

Fuel-Switching

In order to reduce the amount of carbon emission potential, producers will have to either reduce the amount of fuels they use or produce or they will have to use lower-carbon blends. This will encourage switching to lower-carbon fuels up to a point, however, the extent to which this option is viable is unknown.[55]

POLITICAL FEASIBILITY

Permits

Permits are likely to be more politically feasible than taxes. The Clinton Administration has expressed its support for a tradable permit system.[56] If Gore is elected he will likely support permits. If Bush is elected he will likely not support any climate initiative. If Congress were to ever support a climate change program, they would likely prefer permits (see discussion below).

Industry, while opposing a climate change initiative, generally agrees that if reductions are required permits are preferred (because of the potential for profit through selling of excess permits).[57] Industry also favors gratis allocation of permits instead of auctioning. The potential does exist for this view to change – as it did in the recent auction for telecommunications spectrum rights. The exception to industry support is if the costs of reductions are estimated to be large – if that is the case it is likely that industry will prefer either taxes or permits with a price cap.

Most environmental organizations that favor permits favor auctioning and revenue recycling. It is unknown how consumers would feel about a permit program since they would not be directly participating in it.

An upstream permit system may also be more feasible politically because of the smaller number of groups to negotiate with and the fewer number of special provisions that will inevitably be requested.

Carbon Taxes

Taxes, appropriately or not, bear a certain stigma. Politicians seem very reluctant to impose a new tax – especially for environmental issues – and all too eager to repeal existing environmental taxes. Two excellent examples of this are the current debate over what to do with the government surplus (the Republican Congress wants to cut taxes) and the recent debate over temporarily repealing the gas tax to ease the burden of high gas prices on consumers. It is likely that Congress, if they were to agree to a climate change program, would prefer permits over taxes.

Consumers dislike taxes and would likely be very reluctant to have a new one imposed on them. Some of this reluctance may be overcome by using revenues for tax reductions elsewhere.

CONCLUSIONS AND RECOMMENDATIONS

This paper has explored the increase in greenhouse gas emissions since the advent of the industrial revolution and the effect that this increase has had and will continue to have on the global climate. In order to avoid catastrophic climate change, GHG emissions and atmospheric concentrations must be reduced. The United States made a step toward this end when it signed the Kyoto Protocol, an international agreement that will require participating countries to reduce their emissions by a specific percentage below 1990 levels. The United States will, upon ratification of the Protocol and its entry into force, have to reduce GHG emissions by 7 percent.

This paper examined two of the domestic policy options for reducing CO_2 emissions: tradable permits and taxes. The question of which policy to pursue comes down to a choice between price and quantity – between fixing the cost of reduction or the amount of reduction. In order to ensure the continued health of the Earth's climate, GHG emissions will need to be drastically reduced. The only way to ensure the amount of reductions is through a permit system. I believe that an upstream tradable emissions permit system is the best option for meeting the Kyoto Protocol requirements because it is:

- more flexible;
- more feasible administratively;
- less regressive;
- politically feasible; and
- it guarantees specific emission reductions.

Flexibility

Tradable emissions permits allow entities to determine how, where and when they want to achieve emissions reductions. This flexibility significantly reduces the cost of compliance and will help to garner industry support. Temporal flexibility is especially important when marginal costs are expected to rise over time (as they are with CO_2 reductions) because it allows companies to achieve lower cost reductions now and to save permits for later when costs are greater. Temporal flexibility was one of the reasons for the success of the Acid Rain Program.

Administrative Feasibility

An upstream permit system includes fewer entities and types of entities than carbon taxes. Emissions measurements (of potential carbon emissions) and compliance checks will be easier with the limited number of upstream entities. Processors already conduct some analysis of the fossil fuels they refine – these measurements can be used to determine the carbon content of the fuels that are being processed and transported. Measuring the potential carbon emissions of a few fossil fuels and fossil fuel products upstream would be much less burdensome than measuring the actual or potential emissions of thousands of fossil fuel products downstream. The limited number of entities to administer and monitor also helps to reduce the cost of the program.

Overall, permits are likely to be more administratively feasible than taxes.

Regressivity

Low- and middle-income households spend a larger percentage of their income on necessities such as electricity, gasoline and heating oil. When fossil fuel prices increase, the burden is greatest on those households. Those households are also generally less able to change their situation (through efficiency improvements, fuel switching, relocation or other means) to compensate for price changes. The above analysis showed that upstream permits pass less of the costs of reduction onto consumers than downstream taxes and therefore would have less of a detrimental effect on low- and middle-income households.

Permit auctions can also help to reduce the regressive nature of price increases. By recycling the revenue generated from permit auctions back into the economy through tax breaks and increases in transfer payments for low- and middle-income households, some of the negative effects of the increases can be mitigated. Revenue recycling also helps to reduce the overall cost of the permit program.

Political Feasibility

Permits would likely be supported by the Gore Administration and by Congress (once it accepted a climate change initiative). Environmental organizations support permits because of the guaranteed emissions reductions and flexibility. Industry supports permits because of their flexibility and potential for revenue generation (through the sale of permits), however their support for permits may falter if permits are auctioned off or if reduction costs are found to be large.

Industry's objection to auctioned permits may be mitigated by initially distributing a percentage of permits for free (to give them time to plan for future reductions) and auctioning the rest off. Reduction costs can be capped by having a threshold limit for permit price above which more permits are available. Both of these options have drawbacks – the former will reduce the fairness of the program and the latter may reduce the amount of emissions reductions achieved.

In spite of the potential for industry disagreement, permits are more likely to succeed politically than taxes.

Guaranteed Reductions

Permits guarantee the amount of emissions reductions – taxes do not. In order to meet the requirements of the Kyoto Protocol the United States will have to reduce its GHG emissions. The only way to guarantee that the reduction target is met is through permits.

Other Benefits

An upstream permit system can also be expanded to include other GHGs. Each GHG has a global warming potential (GWP) – a ratio of the warming potential of that gas to carbon dioxide. Permits could be distributed for other GHGs based on their GWP. The permits would be interchangeable since they are all based on CO_2.

Where Do We Go From Here

If the Kyoto Protocol is ratified by the United States and other countries and enters into force, the first reduction period will begin in 2008. The United States should start designing the upstream permit system now to ensure that it will be ready by the first reduction period. Starting the process early will allow for a significant amount of participation in the design process by affected parties and will give negotiators time to develop a comprehensive system that addresses the majority of concerns.

The United States does not need to (and should not) wait until 2008 to start developing a market for tradable permits. Establishing a market early, by auctioning permits before 2008 and allowing trading to begin, will give regulated entities a chance to plan for their future needs. Starting early will also allow a market to develop before entities are in a position of having to trade – this will significantly facilitate trading and reduce the costs.

An upstream permit trading system will allow the United States to meet its Kyoto targets and can easily be adapted to other GHGs and to future emissions restrictions.

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