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Reducing Global Carbon: Creating an American Policy

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Abstract

The United Nations Intergovernmental Panel on Climate Change's (IPCC) first assessment report, released in 1990, calculated that carbon dioxide (CO2) emissions had been responsible for more than half of the greenhouse gas effect. As of 2006, the United States, China, and European Union (EU) consume 56% of global CO2 emissions (Brinkley & Less, 2010). Figure 1, below, shows that CO2 levels have continued to rise at basically the same rate since before the 1960s (Tans & Keeling). 23 years later, on September 27, 2013, the IPCC released its fifth assessment report, concluding that climate change is the result of human activity with 95% – 100% certainty (Intergovernmental Panel on Climate Change, 2013). The report claims that an immediate response to this information is necessary to combat the negative effects of climate change, such as extreme weather events, ocean acidification, and other adverse phenomena. Despite knowing of the massive consequences if CO2 emissions cannot be reduced and controlled, the United States has yet to formulate a serious policy aimed at reducing carbon emissions due to a multitude of factors. However, the United States is coming around and the question is no longer if carbon policies need to be created, but how they should be created. To answer the question of how an effective carbon policy must be structured, this paper first examines where policies went wrong to learn from past mistakes, then gathers advice from several policy suggestions. By synthesizing the missteps and successes, an adjustment to a previous model is made to estimate the optimal carbon tax policy. The final section of this paper determines the feasibility of such a policy being enacted in the United States and provides suggestions for further research.

Keywords: carbon, tax, border, policy, united states

Reducing Global Carbon: Creating an American Policy

Introduction

The United Nations Intergovernmental Panel on Climate Change's (IPCC) first assessment report, released in 1990, calculated that carbon dioxide (CO_2) emissions had been responsible for more than half of the greenhouse gas effect. As of 2006, the United States, China, and European Union (EU) consume 56% of global CO_2 emissions (Brinkley & Less, 2010). Figure 1, below, shows that CO_2 levels have continued to rise at basically the same rate since before the 1960s (Tans & Keeling).

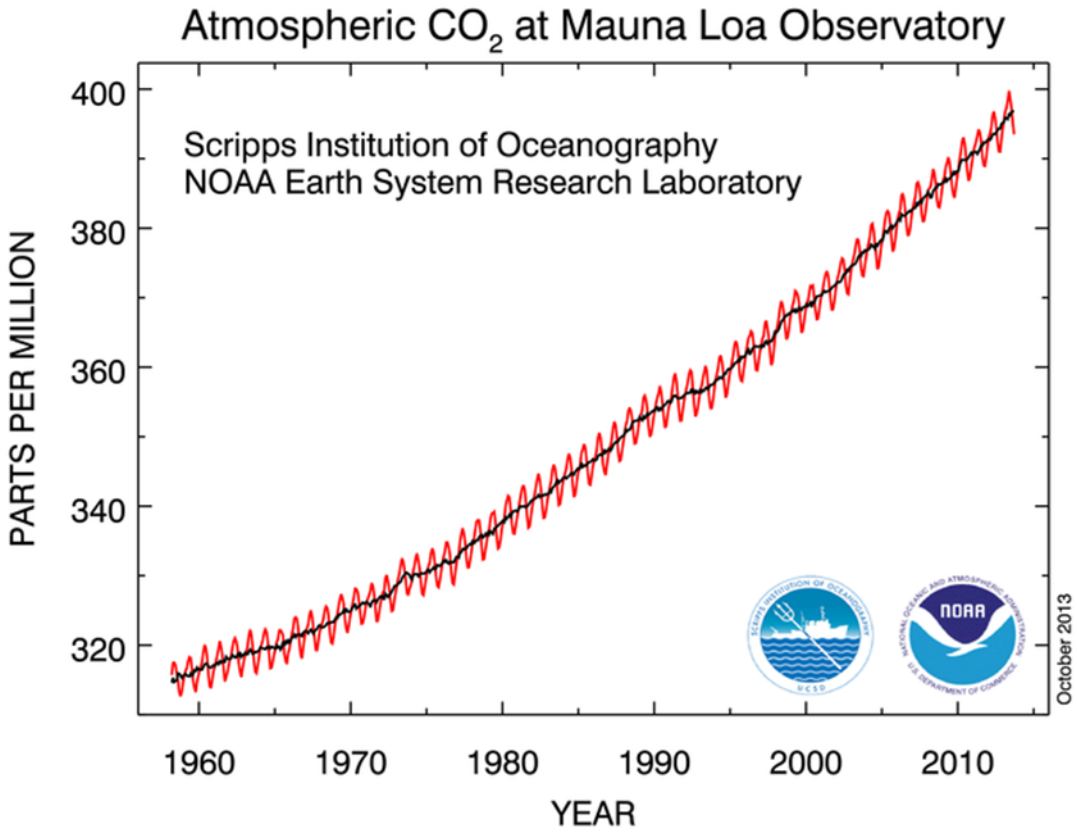

Figure 1. Atmospheric CO_2 at Mauna Loa Observatory (Tans & Keeling, 2013).

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immediate response to this information is necessary to combat the negative effects of climate change, such as extreme weather events, ocean acidification, and other adverse phenomena.

Even the Department of Defense has warned of the dangers of climate change, publishing a report modeling climate change scenarios and their impact upon national security. The researchers find that, "[d]isruption and conflict will be endemic features of life," if climate change is not dealt with (Schwartz & Randall, 2003).

Despite knowing of the massive consequences if CO_2 emissions cannot be reduced and controlled, the United States has yet to formulate a serious policy aimed at reducing carbon emissions due to a multitude of factors. However, the United States is coming around and the question is no longer if carbon policies need to be created, but how they should be created.

To answer the question of how an effective carbon policy must be structured, this paper first examines where policies went wrong to learn from past mistakes, then gathers advice from several policy suggestions. By synthesizing the missteps and successes, an adjustment to a previous model is made to estimate the optimal carbon tax policy. The final section of this paper determines the feasibility of such a policy being enacted in the United States and provides suggestions for further research.

History

One of the turning points in American environmental policy history was the unanimous passing of the Byrd-Hagel Resolution on July 25, 1997. This caused the United States to reject the Kyoto Protocol "because of the disparity of treatment between Annex I Parties and Developing Countries and the level of required emission reductions, could result in serious harm to the United States economy, including significant job loss, trade disadvantages, increased energy and consumer costs, or any combination thereof" (S. Res. 98, 1997).

The vast majority of climate change legislation since have come from local and state initiatives, such as the Regional Greenhouse Gas Initiative, a joint initiative by the northeastern states in the United States and eastern provinces of Canada, which created a cap-and-trade system for CO_2 emissions from power plants. Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, and Rhode Island are current participants in the initiative, while New Jersey withdrew in 2011 (Regional Greenhouse Gas Initiative, 2013).

Appendix A includes a slightly more in-depth look at the history of climate change legislation, as well as an easier to read timeline of specifically American legislation in Table A1. Overall, the history of climate change legislation in the United States paints a picture of the current landscape in American environmental politics. State and municipal governments are being forced to create their own initiatives since the federal government has yet to come up with its own.

Policy Critiques

Kyoto Protocol

Since the release of the first IPCC report in 1990, there has only been one major global effort to reduce greenhouse gas emissions. The Kyoto Protocol, an international treaty originally adopted in 1997, creates binding obligations for industrialized countries to reduce their greenhouse gas emissions. Countries are separated into categories based upon their UNFCCC classification, with Annex I parties (industrialized and in transition economies) generally required to reduce their greenhouse gas emissions to a base year level (most often 1990) by 2012, while non-Annex I parties have no such responsibility.

There are a total of 42 Annex I parties, with 84 signatories to the Kyoto Protocol, and a total of 192 parties present at the Kyoto Protocol convention in 1997. Only 43% of those present

signed the Kyoto Protocol and the treaty only affects 21% of the parties. The imbalance between the binding obligations Annex I countries were given while non-Annex I parties had no obligations, became one of the main motivators behind the Byrd-Hagel Resolution, officially titled, "Expressing the sense of the Senate regarding the conditions for the United States becoming a signatory to any international agreement on greenhouse gas emissions under the United Nations Framework Convention on Climate Change" (S. Res. 98, 1997). What was intended to be a global effort to reduce greenhouse gas emissions became a document signed by less than half of the parties present, targeting only one fifth of the UNFCCC attendees.

President George W. Bush expressed similar concerns to those laid out in the Byrd-Hagel Resolution, writing that he opposed the Kyoto Protocol, "because it exempts 80 percent of the world, including major population centers such as China and India, from compliance, and would cause serious harm to the U.S. economy" (2001). To make matters worse, Canada withdrew from the treaty in 2011, with the Canadian environment minister, Peter Kent, stating, "[t]he Kyoto Protocol does not cover the world's largest two emitters, the United States and China, and therefore cannot work" (Kent, 2011).

Flexibility mechanisms. The Kyoto Protocol defines three "flexibility mechanisms," which Annex I parties can utilize to reduce their greenhouse gas emissions. Each mechanism awards an emissions trading unit, equivalent to one tonne of CO_2 reductions.

Joint Implementation. Joint Implementation (JI) is described in Article 6 of the Kyoto Protocol and allows Annex I parties to invest in an emission reduction project in another Annex I party's country by purchasing Emission Reduction Units (ERUs). This mechanism is intended to allow Annex I parties to invest in cheaper greenhouse gas emission reduction projects.

Clean Development Mechanism. Article 12 of the Kyoto Protocol defines the Clean Development Mechanism (CDM), which allows Annex I parties to purchase Certified Emission Reductions (CERs) from non-Annex I parties. CDM is similar to JI, but CDM is targeted at reducing emissions in developing economies, while JI is targeted at industrialized and in transition economies.

International Emissions Trading. International Emissions Trading (IET), defined in Article 17 of the Kyoto Protocol, creates a framework for trading emissions units amongst Annex I parties. Each Annex I party is given Assigned Amount Units (AAUs) from 2008 through 2012, based upon their emissions targets. Parties that emitted less than their allotment of AAUs would then be allowed to sell their excess AAUs to parties that exceeded their quota.

Issues. While these mechanisms were well-intentioned, numerous criticisms of their effectiveness have been made, mainly of the CDM scheme. It is extremely difficult to determine whether CDM projects actually make additional reductions in greenhouse gas emissions, since most investment goes towards projects that have already been planned (Delay, Grubb, Willan, & Counsell, 2009; Haya, 2007; Schneider, 2007). Only an estimated 30% of CDM revenues actually go to their intended project (Carbon Retirement, 2009). The CDM Executive Board suffers from a lack of transparency, staffing, and financial resources, as well as political pressures from many interest groups that clash with scientific findings (Despines, et al., 2009; Flues, Michaelowa, & Michaelowa, 2008; Wara & Victor, 2008). Forest conservation projects are also not accepted by the CDM, despite deforestation representing nearly one fifth of global emissions (Stern, Stern Review: The Economics of Climate Change, 2006).

As has been noted earlier in this paper, the Kyoto Protocol only applies to Annex I parties, which offers an incentive to effectively outsource carbon-intensive industries abroad and

import the finished products, so as to avoid an increase in reported carbon emissions. Because non-Annex I parties tend to have more carbon-intensive production processes than Annex I countries, the offshoring of production could increase carbon emissions by more than initially expected (Ahmad & Wyckoff, 2003). The effect of the Kyoto Protocol upon the types of goods traded internationally has already been observed, as Ahmad & Wyckoff note that "the average basket of goods traded internationally tends to be more carbon-intensive than the average basket of goods consumed domestically" (2003).

These issues with the Kyoto Protocol, as well as others, have resulted in the failure of the agreement to have a meaningful impact upon greenhouse gas emissions.

EU Emissions Trading Scheme (ETS)

The EU ETS, a cap-and-trade system implemented in 2005, is the first large CO_2 emissions trading scheme in the world, and is the EU's main carbon reduction policy (Ellerman D., 2008). According to the EU ETS factsheet, the policy covers around 45% of all EU emissions, including over 11,000 power stations and manufacturing plants in 28 EU member states, as well as Iceland, Liechtenstein, and Norway (European Union, 2013).

A cap was set on total emissions and emissions credits were then allocated or auctioned to participants. If a participant exceeded their allotted emissions, they could purchase emissions allowances from others who had an excess of allowances. This system would theoretically find the most efficient ways to mitigate CO_2 emissions without requiring government intervention (Ellerman D., 2008).

Phase I. The first phase of the emissions trading scheme lasted from 2005 – 2007. Official trading of emissions credits began on January 1, 2005, with the price of carbon increasing steadily until its peak in April 2006, hovering around €30 per tonne of CO_2

(Querejazu, 2012). From there, prices began to decline to near €0 per tonne of CO_2 in 2007, due to an oversupply of emissions allowances (Nielson, 2008).

Phase II. Norway, Iceland, and Liechtenstein, non-EU members, joined the EU ETS program in 2007, expanding the reach of the program outside of just EU states, and emissions from aviation were brought into the program, covering a larger percentage of total EU emissions (Emissions trading: Commission announces linkage EU ETS with Norway, Iceland and Liechtenstein, 2007).

This phase also introduced a link between the Kyoto Protocol flexibility mechanisms, so that CERs, AAUs, and ERUs can be converted into emissions allowances and traded on the EU ETS market (Aguilar & Bai, 2005).

Compared to Phase I, Phase II saw success in the carbon market, with average prices hovering near €20 per tonne of CO_2 in 2008 until the global recession caused a decrease in price (Committee on Climate Change, 2009).

Phase III. Phase III runs from 2013 – 2020, and increases the number of participating countries in the EU ETS to 31 (AIRETS, n.d.). To further expand the reach of the EU ETS program, a full link will be created with the Australian carbon trading scheme. According to Greg Combet, Australian Minister for Climate Change and Energy Efficiency, "' The same carbon price will cover 530 million people.'" (Grubel, 2012).

Phase IV. The fourth phase of the EU ETS has been talked about, but no decisions have been made as to the time period it would run through, or whether any policy changes would be made. However, some suggestions have centered upon tightening the environmental regulations to increase the price of emissions allowances and to extend the coverage of the program (European Commission, 2012).

Issues. One of the major issues that affected the EU ETS in its first stages was the over-allocation of emissions credits, due to a variety of factors. First, the cap on emissions did not really force producers to change their production processes to reduce emissions, as it was not set low enough. This caused an oversupply of emissions credits in the market, eventually leading to a crash in prices in 2007 (Ellerman & Buchner, 2006). Phases II and III did implement measures to reduce the severity of this issue.

Phase II's implementation of the link between the Kyoto Protocol's flexibility mechanisms also reduced the efficacy of the program to actually reduce carbon emissions by allowing the import of credits from outside the EU through JI and CDM projects (Committee on Climate Change, 2008). Brinkley & Less found that 33% of net EU emissions were imported during this phase (Brinkley & Less, 2010).

State and Local Initiatives

Issues. State and local initiatives, while they may have great policy features, have a few flaws that make them insufficient as an optimal response to reducing the United States' carbon emissions. The first problem with state and local initiatives is that they do not cover the entire United States by definition. Because of this, each region of the United States must draft their own carbon policies and pass the legislation in their congresses.

The second problem utilizing only state and local initiatives poses is with the added complexity that multiple carbon policies within the United States would cause. Producers with production facilities spanning policy lines would need to figure out their differing costs associated with emissions depending upon location.

Linking together several disparate regional initiatives solves some of this problem, by creating a unified policy, but the linked initiatives attempts to emulate what is easier done as a national policy.

Criteria for Successful Policy

Consumption-Based Carbon Accounting

One of the important pieces of the policy puzzle is determining how effective current tools are at measuring what they claim to measure, and whether those measurements are actually useful with regards to a policy's goals.

The failure of carbon policies to effectively reduce global carbon emissions leads to the conclusion that current policies are using an incorrect indicator to determine the magnitude and cause of carbon emissions. The Kyoto Protocol relies upon a carbon accounting method that measures carbon emissions produced within the borders of a country. However, in the modern, globalized world, it is possible for certain countries to outsource their emissions to other countries.

The idea of purposely outsourcing pollution to other countries was taken to an extreme in the Summers Memo, a supposedly sarcastic memo that advocated, "dumping a load of toxic waste in the lowest wage country," and "under-populated countries in Africa are vastly under-polluted" (Enwegbara, 2001). Johnson, Pecquet, & Taylor argued that the shifting of emissions-intensive industries to poorer countries "effectively exports toxics to them," just as written in the Summers Memo (2007).

Evidence has been found for the growing dichotomy between the amount of CO_2 emitted and the amount of CO_2 consumed, proving countries that have reduced their CO_2 emissions based upon Kyoto Protocol reporting guidelines have actually replaced their domestic emissions

with emissions from China, Russia, and other export countries (Ahmad & Wyckoff, 2003; Atkinson, Hamilton, Ruta, & Van Der Mensbrugghe, 2010; Brinkley & Less, 2010; Davis & Caldeira, 2010; Druckman, Bradley, Papathanasopoulou, & Jackson, 2008; Helm, Smale, & Phillips, 2007; McIlveen, Helm, & Less, 2010; Nakano, et al., 2009; Shui & Harriss, 2006; Weber & Matthews, 2007).

Ahmad & Wyckoff used an input-output model to find that emissions associated with international trade were usually above 10% of domestic production. China and Russia's emissions from production exceeded their emissions from consumption by 10% and 15%, respectively (Ahmad & Wyckoff, 2003).

Looking specifically at American international trade, Weber & Matthews used a multi-regional input-output model of the United States and its seven largest trading partners to quantify the environmental impacts of international trade between the years 1997 and 2004. The amount of carbon emissions embodied in United States imports had risen 9% – 14% in 1997 and 13% – 30% in 2004 (Weber & Matthews, 2007).

To provide a further example of the improvement consumption-based emissions accounting methods have in fully measuring emissions a country are responsible for compared to production-based accounts, reported emissions for the United States rose 17% between 1990 and 2006. With a consumption-based accounting method, the United States' consumed emissions actually rose 43% in the same time period (Brinkley & Less, 2010).

In order to determine comprehensive carbon consumption account requirements for the United States, it is useful to look at the necessary tasks an accurate measurement must accomplish as laid out by Helm, Smale, & Phillips for the United Kingdom:

- Capturing consumption in a non-UK territory, for example during business trips and holidays.
- Capturing consumption between countries, for example through international aviation and shipping.
- Capturing consumption of greenhouse gases embedded in imported goods.
- Measuring the full global warming impact (for example, in aviation).

Conversely, there are some activities within the UK which are not consumed by UK residents. Thus, it is necessary to subtract both consumption within the UK by non-UK residents (eg, tourists), and exports from the UK. (2007)

Reduce Carbon Intensities

As defined by the World Wildlife Fund for Nature, carbon intensity is a "measure of how much carbon economies emit for every dollar of GDP they produce" (Carbon Intensity and Energy Saving, n.d.). By reducing carbon intensities in sectors that emit high levels of greenhouse gases, the United States would be able to produce the same amount of output while emitting less carbon.

Globally, the average reduction in carbon emissions per unit of energy consumed has been 0.3% since 1860 (Nakicenovic, 1997). There are two ways to decarbonize: shifting to more efficient energy sources and deindustrialization, with Sweden and France examples of more efficient sources of energy, and Ireland and the United Kingdom examples of deindustrialization (Jenkins, 2012).

However, these methods are expensive or not possible, respectively, for the United States. Reducing carbon intensities is a good long-term ideal, but will not be the focus of the policy outlined in this paper.

Better Data

Even in countries with established CO_2 emission reduction policies like the United Kingdom, there is a lack of necessary data available to reliably and confidently compare carbon reduction policies (Druckman, Bradley, Papathanasopoulou, & Jackson, 2008).

More granular and specific data would allow for a greater knowledge of the optimal tax rate during the taxation process. For example, if certain regions of the United States are deemed to be more susceptible to the effects of CO_2 emissions, the model could incorporate that into the calculation of the tax to more efficiently incorporate the externalities into prices of the good.

Clear Policies

Simple, clear policies are preferable, as the implications of the policy can be easily understood by firms and consumers, and thus minimize the costs associated with implementing such policy recommendations (McIlveen, Helm, & Less, 2010). Regardless of whether or not a policy would result in carbon emission reductions, enacting such a policy is pointless if it is not also cost-effective.

Another benefit of keeping policies as simple as possible is the reduction of administrative costs that add friction to the political process. By reducing the amount of added work these departments must do on top of their current job functions, cost-effective legislation becomes an easier objective to reach.

Model

Mattoo et al. utilize the Environmental Impact and Sustainability Applied General Equilibrium (ENVISAGE) model, developed at the World Bank, to model several different climate change policies. Based upon their analysis, the use of a border tax adjustment that taxes

imports based upon the home country's emissions rate and subsidizes exports would offer the best reduction in global carbon emissions (2009).

Fischer & Fox come to the same conclusion as Matoo et al., by testing several different policy options against each other using simulations of the electricity and oil sectors, as shown in Table 2 below (2011).

Table 2

Effects of Adjustment Policies on Energy Sectors

	Production Loss Avoided		Net Export Loss Avoided		Additional Net Reductions	
	ELE	OIL	ELE	OIL	ELE	Oil
Import Tax (foreign carbon intensity)	4%	14%	61%	148%	0%	1%
Import Tax (home carbon intensity)	3%	10%	53%	102%	0%	1%
Export Rebate	5%	12%	71%	107%	0%	1%
OBR	81%	42%	126%	191%	-13%	-1%
FBA (foreign carbon intensity)	8%	25%	132%	255%	0%	2%

The data from Fischer & Fox also show that a full border adjustment policy, taxing imports and subsidizing exports with respect to the foreign country's carbon intensity, would alleviate many of the competitiveness concerns in the United States, while not seriously damaging trade with foreign countries. However, the tax would result in increased prices for goods, which would, in effect, be a regressive tax upon consumers.

Specification

In Fischer & Fox's model, there are two countries, the home country and foreign country, where it is assumed the home country has pollution controls and the foreign country does not. The home country produces good H and the foreign country produces good F, a substitute for good H. The per-unit cost to produce good H, c_H, rises as emissions reductions increase.

$$c_H = c_H(r_H)$$

The foreign good's per-unit cost, c_F, is not a function of reductions, since the foreign country has no incentive to reduce its emissions. Emissions for good H, e_H, can be determined by subtracting r_H from the good's baseline rate of emissions, e_H^0.

$$e_H = e_H^0 - r_H$$

Global emissions can then be calculated as the total amount of emissions due to the production of good H and good F.

$$E = (e_H^0 - r_H)H + e_F F$$

The total amount of good H produced is the amount of H demanded by consumers in the home country, represented by h, and the amount of H demanded by foreign consumers, represented by x. Similarly for good F, the total amount of good F produced is the amount of F demanded by home consumers, represented by m, and the amount of F demanded by foreign consumers, represented by f. Demand for each good is a function of the prices of both goods in the country.

$$H = h(p_H, p_M) + x(p_X, p_F)$$

$$F = m(p_H, p_M) + f(p_X, p_F)$$

Fischer & Fox assume the constant elasticity of demand functions, with own-price elasticities negative and cross-price elasticities positive, as the goods are considered substitutes.

$$h = \alpha_h {p_H}^{\beta_{hH}} {p_M}^{\beta_{hM}}$$

$$m = \alpha_m {p_H}^{\beta_{mH}} {p_M}^{\beta_{mM}}$$

$$x = \alpha_x {p_x}^{\beta_{xH}} {p_F}^{\beta_{xF}}$$

$$f = \alpha_f {p_X}^{\beta_{fX}} {p_F}^{\beta_{fF}}$$

A full border adjustment model provides a subsidy to exports of good H to the foreign country based upon the amount of emissions reductions and taxes imports of good F based upon the baseline rate of emissions. This tax rate is represented by t.

$$p_F = c_F$$

$$p_H = c_H + t(e_H^0 - r_H)$$

$$p_M = p_F$$

$$p_X = p_H - t(e_H^0 - r_H)$$

Modifying Fischer & Fox, which taxes the imported good F based upon the emissions rate for producing F in the foreign country, this paper taxes good F based upon the baseline emissions rate in the home country. The idea to tax good F based upon the home country's baseline emissions rate comes from Mattoo et al., who find that such a policy would address the competitiveness concerns of home country producers while not seriously damaging international trade (Mattoo, Subramanian, Van Der Mensbrugghe, & He, 2009).

So:

$$p_M = p_F + t(e_H^0)$$

Revenue from the taxes would then be distributed to consumers, rather than used as a subsidy for exports, based upon the percentage of the total consumption of goods H and F they consumed to correct for the regressive nature of the tax.

So the total subsidy amount that can be distributed to consumers, S, and the new p_X would be:

$$S = t(e_H^0 - r_H)H + t(e_H^0)F$$

$$p_X = p_H$$

Policy Recommendation

In accordance with crafting a policy that is clear and easy to understand, it would first be necessary to remove all previous legislation that may muddle actual price of carbon or tax rate upon sectors due to their carbon emissions. This is because there are a variety of state and federal regulations that span multiple bureaus and departments, without a centralized source to easily determine the expected cost of producing a good may be.

The baseline emissions rate, e_H^0, would be determined by Environmental Protection Agency (EPA) and differ for each major sector, as identified by the North American Industry Classification System (NAICS), the standard for classifying industry sectors by the United States Census Bureau.

The tax rate on imports would be based upon the e_H^0 decided upon. Customs and Border Protection already monitors the types of goods that enter the United States in order to determine any duties that must be paid on those imports, so this could fall under their domain.

For products created in the United States, there is currently no departments that monitor carbon emissions by firm or sector. Pulling from European policy, firms would be required to monitor and report the amount of emissions throughout their production process to the EPA.

The EPA would be tasked with assessing the rate of emissions the particular firm produces related to the production of their good and determining the firm's r_H. It is important to keep in mind that this assessment of the emissions rate must include all emissions incurred by production of the good, such as the emissions created by shipping (plane, ship, truck, etc.) and other production processes.

Based upon the e_H^0 and r_H, each firm's tax rate can be determined. Using an input-output model with Global Trade Analysis Project (GTAP) data, two separate studies estimated a tax rate of $55 per tonne of CO_2 to most likely be the optimal (Atkinson, Hamilton, Ruta, & Van Der Mensbrugghe, 2010; Fischer & Fox, 2009).

The taxes collected from imports and goods created in the United States would then be disbursed to the consumers of the taxed goods. Consumers would be required to report their expenditure upon each taxable good they would like to be reimbursed for, and a total expenditure for all consumers in a sector would be calculated. The percentage each consumer spent out of the total expenditure in a sector would determine the percent of the total amount of taxes collected that would be paid out.

Feasibility

Recent gains in public awareness of environmental concerns has improved the overall public perception of sustainability legislation. Most voters would generally respond positively to legislation designed to protect the environment.

However, in order to meet the first part of this policy, all legislation regarding carbon taxation or regulation must be repealed. Not only is this a huge logistical problem, as each of the regulations must be identified, it also poses a large political problem, as legislation from international trade agreements as well as Congressional policies must be repealed to keep the carbon tax simple and precise (Atkinson, Hamilton, Ruta, & Van Der Mensbrugghe, 2010; Fischer & Fox, 2009; McIlveen, Helm, & Less, 2010).

Threats of a border tax war could also hinder the efforts of those attempting to implement a full border adjustment policy. Since imports into the United States would be taxed, foreign countries, worried about the loss of production in their own country, may threaten to place an

import tax upon exports from the United States. In order to reduce the negative effects upon international trade, the tax rate placed upon imports would be based upon the baseline emissions rate for the United States.

Disagreements with the policy recommendation would most likely stem from differing views upon the implementation and process of reducing carbon emissions. From a general politics standpoint, talk of taxation is never taken well in the United States. A large number of voters believe in small governments, and increasing the amount of taxes as well as the responsibility of a number of departments would not sit well with these groups.

Furthermore, the price of goods imported into the United States and produced in the United States would rise, due to the carbon tax. To combat the regressive nature of this tax, all tax revenues are then distributed back amongst consumers. This helps to alleviate some of the price increases.

Overall, the likelihood of the recommended policy being implemented is very low due to the variety of political and logistical challenges.

Further Research

Policy mixtures, based upon the amount of exports a sector produces could be an interesting idea to look at. Using output-based rebates for high export sectors and full border adjustment for lower export sectors may be more optimal. The policy mixture would need to have a clear line that would separate those industries that would receive an output-based rebate and those that would not.

Another area of further research could look into the optimization of departments that would administer the policy. It may be the case that certain bureaus or departments would be more efficient.

Running simulations using things like the Global Trade Analysis Project (GTAP) could provide useful information about expected effects of the policy recommendation upon international trade.

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Appendix A

History of major climate change legislation.

1960 – 2001

The idea of global warming and responsibility for the environment is a relatively new concept for the United States and the world, with the majority of the major conferences and policies happening after the 1960s. Table 1, below, provides a brief timeline of major emissions-related legislation in the United States starting in 1955.

In 1969, President Richard Nixon sent delegate Daniel Patrick Moynahan to the North Atlantic Treaty Organization (NATO) to establish NATO as a hub of research in the civil region, especially environmental topics. Moynahan named acid rain and the greenhouse effect as challenges that could be tackled by NATO, but the initiative failed (Hünemörder, 2004).

In 1979, the first World Climate Conference was hosted by the World Meteorological Organization (WMO) in Geneva, Switzerland. This was one of the first major international conferences dealing specifically with climate change, and was largely attended by scientists (Information Unit on Climate Change, 1993). This would later lead to the creation of the IPCC.

The Montreal Protocol on Substances that Deplete the Ozone Layer, still in effect today, was created in 1987. One of the first universally ratified treaties in United Nations (UN) history, the international treaty has been ratified by all UN members and is designed to protect the ozone layer by phasing out production of substances believed to be responsible for ozone depletion (Ozone Secretariat, 2012).

Then in 1988, the IPCC was set up by the WMO and United Nations Environment Programme (UNEP), and tasked with assessing the "risk of human-induced climate change" (Intergovernmental Panel on Climate Change, n.d.). One of the most famous and influential

functions of the IPCC is the publishing of their assessment reports, which aim to be the most comprehensive scientific reports on climate change. The first IPCC Assessment Report was published in 1990, and a new version is slated for release in 2013/2014 (Intergovernmental Panel on Climate Change, 2013).

1992 saw the creation of the United Nations Framework Convention on Climate Change (UNFCCC) at the Earth Summit in Rio de Janeiro, Brazil, with the objective of "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (United Nations Framework Convention on Climate Change, n.d.). While not setting any limits on greenhouse gas emissions itself, the treaty provides for the creation of protocols, which would lead to the creation of the Kyoto Protocol in 1997.

The Kyoto Protocol created binding obligations for countries to reduce their greenhouse gas emissions based upon their UNFCCC classification. In the first commitment period from 2008 – 2012, Annex I parties (industrialized and transition economies) were required to reduce their greenhouse gas emissions to a base year level, most often 1990, by 2012, while non-Annex I parties had no such obligations (United Nations Framework Convention on Climate Change, n.d.). The Doha Amendment was made to the Kyoto Protocol in 2012, creating a second commitment period from 2013 – 2020, but this has not yet taken effect (United Nations Framework Convention on Climate Change, n.d.).

One of the turning points in American environmental policy history was the unanimous passing of the Byrd-Hagel Resolution on July 25, 1997. This caused the United States to reject the Kyoto Protocol "because of the disparity of treatment between Annex I Parties and Developing Countries and the level of required emission reductions, could result in serious harm

to the United States economy, including significant job loss, trade disadvantages, increased energy and consumer costs, or any combination thereof" (S. Res. 98, 1997).

Bush Administration

On August 28, 2001, the New England Governors and Eastern Canadian Premiers Climate Change Action Plan 2001 was adopted, which committed to reductions in greenhouse gas emissions and the creation of a Regional Greenhouse Gas Registry to track emissions in the Northeastern United States and Eastern Canada. Signatories included Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, and New Brunswick, Newfoundland, Labrador, Nova Scotia, Prince Edward Island, and Quebec, in Canada (New England Governors/Eastern Canadian Premiers, 2001).

California Governor Gray Davis approved AB 1493 on July 22, 2002, which directed the California Air Resources Board to create standards for the maximum feasible and cost-effective reduction in greenhouse gas emissions from motor vehicles. This bill is now the California Vehicle Global Warming Law. Then in September 2002, Governor Davis approved SB 812, which required the California Climate Action Registry to adopt protocols for carbon sequestration in forests.

The Climate Stewardship Act of 2003 was introduced in the Senate in 2003, but was not passed. The bill would have capped greenhouse gas emissions for 2010 at the 2000 level, tasked the Commerce Department with biennial evaluations of the policy to determine compliance with UNFCCC objectives, and established a National Greenhouse Gas Database to allow for emissions trading and an inventory of emissions and reductions (Lieberman, 2003).

A joint initiative by the northeastern states in the United States and the eastern provinces of Canada, titled the Regional Greenhouse Gas Initiative, created a cap-and-trade system for CO_2

emissions from power plants. Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, and Rhode Island are current participants in the initiative, with New Jersey withdrawing in 2011 (Regional Greenhouse Gas Initiative, 2013).

In 2005, the EU created its ETS to become the first carbon emissions trading scheme implemented in the world, utilizing a cap-and-trade system. The ETS now covers all 28 EU member states, as well as Iceland, Liechtenstein, and Norway, or about 45% of the EU's greenhouse gas emissions (European Commission, 2013).

California Governor Arnold Schwarzenegger signed executive order S-3-05, establishing emissions reduction targets to 2000 levels by 2010, 1990 levels by 2020, and 80% below 1990 levels by 2050 (Schwarzenegger, 2012).

The 31st G8 summit was held in July 2005 in Auchterarder, Scotland, with global warming named as a major priority of the conference. Despite a joint declaration by all G8 countries' academies of science, the United States still did not join the Kyoto Protocol as was hoped by many activists and attendees (The National Academies, 2005).

John McCain sponsored a revamp of the original Climate Stewardship Act from 2003, titled Climate Stewardship and Innovation Act of 2005, which provided very similar provisions to the original Climate Stewardship Act. However, this new act gave the task of policy evaluations to the Administrator of the Environmental Protection Agency (EPA) (McCain, 2005).

On July 19, 2006 in California, Governor Arnold Schwarzenegger proposed the formation of the Climate Action Board under the California EPA. This new group is responsible for implementing initiatives to reduce global warming and produces climate change assessment to inform policy (Climate Action Team & Climate Action Initiative, n.d.).

Arizona Governor Janet Napolitano signed the Climate Change Action executive order on September 8, 2006, creating state initiatives to reduce greenhouse gas emissions to the 2000 level by 2020, and 50% below the 2000 level by 2040 (Napolitano, 2006).

Later in 2006, on October 30th, the Stern Review was published, which is a report commissioned by the British government and written by economist Nicholas Stern. It has been one of the most comprehensive and significant reports on climate change, calling climate change "the greatest market failure the world has ever seen" (Stern, Stern Review: The Economics of Climate Change, 2006). The report covers the consequences of climate change, ways to prevent or mitigate climate change, and the benefits of early action versus waiting.

A third strengthening of the Climate Stewardship Act occurred in 2007, resulting in the Climate Stewardship and Innovation Act of 2007, which stuck with the majority of previous provisions, but included a gradual reduction of the emissions cap, targeting 2004 levels by 2012, 1990 levels by 2020, and 60% below 1990 levels by 2050 (Lieberman, 2007).

The Global Warming Pollution Reduction Act of 2007 was introduced by Senator Bernard Sanders to set emissions standards for new vehicles, create a renewable fuels requirement for gasoline, set low-carbon electricity generation standards, introduce a cap-and-trade emissions system with an 15% greenhouse gas emissions reduction target by 2020, and require evaluations by the National Academy of Sciences to determine emissions targets (Sanders, 2007).

March 2007 saw the creation of a Congressional subcommittee focused upon global warming by Nancy Pelosi, titled the House Select Committee on Energy Independence and Global Warming, until it was killed in 2011 (Cantor, 2011).

Obama Administration

During his presidential campaign in 2008, President Barack Obama introduced his New Energy for America plan, called for the implementation of a cap-and-trade program and the expanded use of renewable energy. Under this plan, the White House Office of Energy and Climate Change Policy was created by executive order, until it was merged with the Domestic Policy Council in 2011 (Domestic Policy Council, n.d.).

The 2010 United States federal budget, titled A New Era of Responsibility: Renewing America's Promise, President Barack Obama outlined a cap-and-trade emissions program which would auction emissions credits. The proposed budget also provided for a 10-year investment of $15 billion per year to support renewable energy development, sustained by the profits from the emissions credits auction (Office of Management and Budget, 2009).

The American Clean Energy and Security Act was passed in the House of Representatives on June 26, 2009, but was eventually defeated in the Senate. The bill would have established an emissions trading plan similar to the EU ETS (Waxman, 2009).

The United States played a large part in drafting the Copenhagen Accord, created December 18, 2009, which was subject to much criticism. While not legally binding, the United States did pledge to reduce emissions 17% by 2020 (United Nations Framework Convention on Climate Change, 2009).

Table A1

Timeline of Major Emissions Legislation Events in the United States

Year	Name	Comments
1955	Air Pollution Control Act	
1963	Clean Air Act (1963)	
1967	Air Quality Act	

1969	National Environmental Policy Act	
1970	Clean Air Act (1970)	
1977	Clean Air Act Amendments	
1987	Montreal Protocol on Substances that Deplete the Ozone Layer	Universally ratified treaty by the United Nations.
1990	Clean Air Act (1990)	
1997	Byrd-Hagel Resolution	
2001	New England Governors and Eastern Canadian Premiers Climate Change Action Plan 2001	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont are members.
2002	California AB 1493	Now the "California Vehicle Global Warming Law."
2002	California SB 812	
2003	Climate Stewardship Act of 2003	Did not pass the Senate.
2005	California Executive Order S-3-05	
2005	Climate Stewardship and Innovation Act of 2005	
2005	Regional Greenhouse Gas Initiative	Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, and Rhode Island are signatories.
2006	California Climate Action Board Created	

2006	Arizona Executive Order Climate Change Action	
2007	Climate Stewardship and Innovation Act of 2007	Strengthening of the Climate Stewardship and Innovation Act of 2003. Did not pass the Senate.
2007	Global Warming Pollution Reduction Act of 2007	Did not pass the Senate.
2007	Western Climate Initiative	Arizona, California, New Mexico, Oregon, and Washington are members.
2009	American Clean Energy and Security Act	Passed the House of Representatives but did not pass the Senate.
2009	Copenhagen Accord	United States joined the accord.