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HURDLES TO LEGISLATION BASED CARBON EMISSION REDUCTION SCHEMES

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ABSTRACT

Carbon dioxide emissions are extremely problematic and are a major contributor to climate change. The Earth's nations are becoming increasingly aware of this change, and some regions of the world have tried to implement a system to try control carbon emissions, with varying degrees of success. Most of these systems are in the form of a cap and trade system or a carbon tax. There are many obstacles to successfully implementing one of these plans, and certain conditions must be obtained in order to smoothly transition into a lower carbon economy. In this paper, the "do's and don't's" of carbon reduction schemes are examined.

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Chapter 1

Introduction

I. The Problem

It is estimated that in 2008 worldwide energy consumption was roughly 1 trillion kilowatt hours. Most of the energy came in the form of non-renewable fossil fuels such as coal, natural gas, and petroleum. The combustion of these fuels is associated with numerous deleterious effects, including health damage, environmental destruction, and rising rates of natural disasters. Perhaps the most troubling of these problems is global warming. The combustion of fossil fuels leads to the release of greenhouse gases, which pose a very serious threat to the planet. In the words of British economist Nicholas Stern, “global warming is the largest market failure the world has ever seen” (Benjamin, 2007). This market failure is due to the fact that so few countries properly and fairly regulate carbon and other GHG emissions, resulting in countless negative externalities associated with fossil fuel consumption.

II. Two Possible Solutions: The Basics

A tax on carbon or an emissions trading scheme are two commonly proposed solutions to this problem. This paper aims to discover what the necessary components of these systems are respectively to ensure that they accomplish their goals as well as become popular initiatives amongst the voting populace in wherever they are implemented.

A tax on carbon emissions would make the polluter pay for the damage they are causing, internalizing a negative externality. Recently, the idea of a tax on carbon emissions has gained prominence in many parts of the world. A tax on carbon differs from other excise taxes because it imposes a disincentive to use carbon heavy fuels, thus explicitly designed to reduce environmental externalities. In theory, pricing carbon would bring the market to equilibrium, and global warming would not be one of the largest crises the world is facing. MIT economist Henry Jacoby says that if economists wrote the legislation, the world would have a one-page solution to global warming.

Another proposed solution to reducing CO2 emissions is a "cap and trade" scheme. This type of solution involves a government setting an allowance of pollution, and subsequently issues permits to polluting firms equivalent to this level of pollutant output. The permits can be auctioned or given away for free. Companies then buy and trade these permits, with the hope being that in addition to scaling back pollution, firms will also invest in more energy efficient infrastructure.

The different instruments establish the prices in different ways, however. Under a carbon tax, the price of carbon (or of CO2 emissions) is set directly by the regulatory authority – this is the tax rate. In contrast, under a (pure) cap-and-trade system, the price of carbon or CO2 emissions is established indirectly: the regulatory authority stipulates the allowable overall quantity of emissions; this then yields a price of carbon or CO2 emissions through the market for allowances (Goulder and Schein). In short, under a carbon tax the price of carbon is fixed and the output is uncertain, whereas under a cap and trade system the output level is fixed and the price is uncertain. Both systems in theory are successful in reducing carbon emissions, but there are many obstacles to implementing both systems.

In some parts of the world, a carbon reduction plan has been put in place. Three provinces in Canada, Australia, and the European Union are three of the major regions where carbon regulations have been implemented. However, popular opinion and empirical data show that the results of these policies can be very different, both in terms of emissions reduced and popular opinion. It is paramount to understand the nature and implementation of these schemes, as all public policies are laden with subtleties and unintended consequences. Comparing and contrasting the carbon schemes in Australia, Canada, and the EU using economic theory and scrutinizing emissions reduction and public response are important to find out what can be improved upon by the next government that tries to reduce its carbon footprint. The first section will provide the framework describing what is necessary for a successful carbon tax. The following chapter will examine the successes and failures of the Canadian and Australian models of a carbon tax respectively, evaluating what each model did well or did not do well in accordance with the framework. The final two sections will be in the same fashion, beginning with the necessary components of a cap and trade scheme followed by a review of the European model in this context. In this way I aim to flush out what was done correctly and what should be changed in the respective systems, and provide a loose structure for what future schemes need to include in order to be successful.

Chapter 2

Carbon Tax

I. Revenue Neutrality

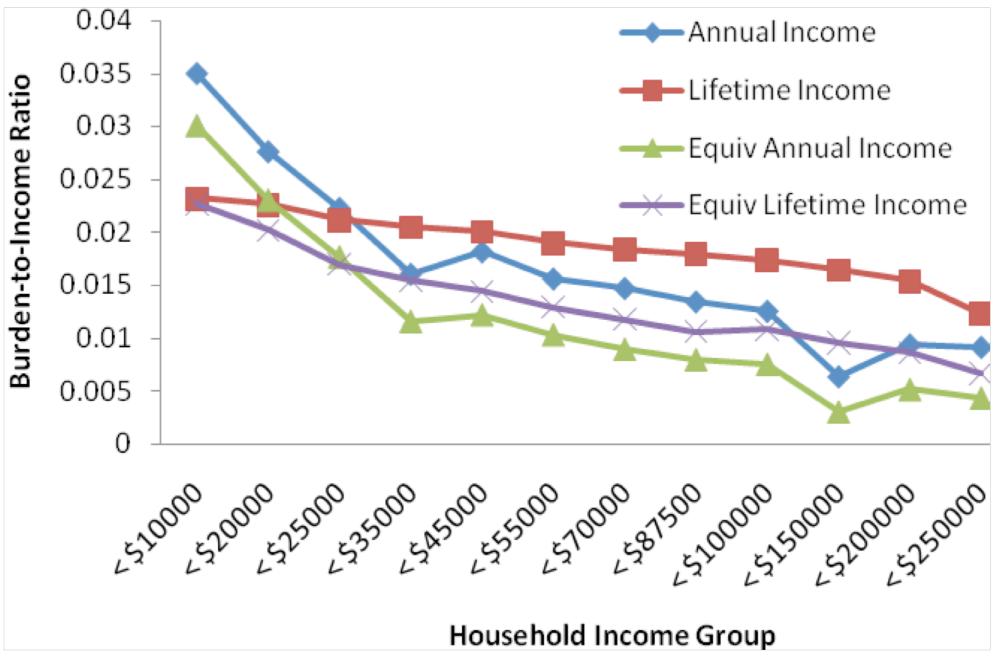
For a carbon tax to be successful in its goal of reducing carbon emissions and remain popular with the voting populace, it is necessary to include an equivalent income tax reduction or other tool to make the tax distributionally neutral. For the present, it will take a tax that does not burden the average household to remain sustainable and popular, and thus carbon reducing in the long run. Carbon taxes are naturally regressive; that is, a tax on carbon would disproportionately affect lower income households. In the United States, lower income households spend a much larger proportion of their annual budget on CO2 intensive goods, namely home heating and travel expenses such as vehicles, gasoline and motor oil (Consumer Expenditure Survey, 2003). Naturally, a tax on carbon emissions will raise the price on every carbon intensive good.

There are a number of ways to lower the incidence of a carbon tax on the average household and to address the regressivity of a carbon tax. Some of the biggest criticisms of carbon tax reforms are related to the disproportionate impact on lower income households, but there is ample room to design a solution that is both revenue and distributionally neutral. A tax with provisions to account for regressivity and to be revenue neutral so as not to bring budgetary concerns into the issue is the only kind that can be successful.

II. Incidence of a Carbon Tax

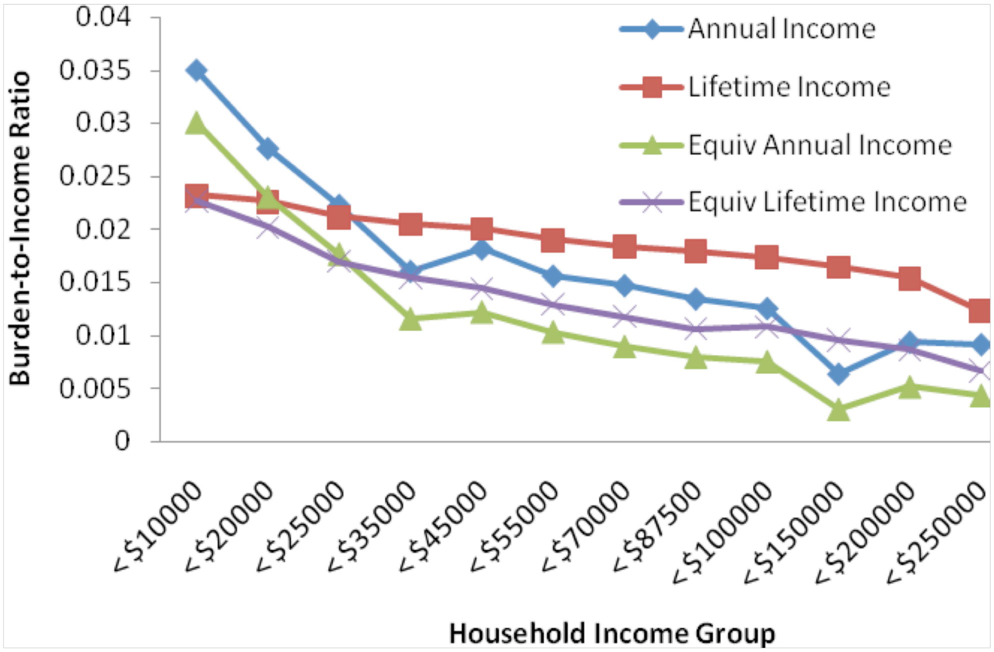
Grainger and Kolstad (2009) have produced a table showing the relationship between annual household income and the incidence of a carbon tax of $15/ton (see Figure 1 below). The burden as a share of annual income for the lowest income quintile is almost four times higher than the burden to income ratio for the highest quintile (Grainger and Kolstad, 2009). This figure shows the relationship between the amount in extra taxes a household has to pay relative to their income. For example, looking at annual income, if a household earns around $70,000 annually, the burden-to-income ratio is around .015. Similar findings occur in a 2009 study on the incidence of a carbon tax on gasoline prices.

Figure 1: Broad CO2 Tax Burden by Household Income Group (Grainger and Kolstad, 2009).



This relationship holds true when focusing exclusively on energy-intensive goods only, shown in Figure 2 below.

Figure 2: CO2 Tax Only on Consumption of Energy Goods (Grainger and Kolstad, 2009).



An earlier study done by Poterba (1991) that divided American households into deciles and used a tax of $100/ton carbon found that the tax would impose a burden of 10.1% of annual income on the lowest decile, while only imposing a burden of 1.5% of annual income on the highest decile. The full set of impacts across all income deciles are shown in Figure 3.

Figure 3: Distributional Incidence of $100/ton Carbon Tax, United States, 1986 (Poterba, 1991).

Distribution Across Income Classes

Income Decile	Total Burden	% of Income
1 (Lowest)	$451.9	10.1%
2	374.6	5.0
3	484.6	4.6
4	521.0	4.1
5	563.7	3.6
6	608.6	3.0
7	689.6	2.7
8	762.6	2.3
9	875.3	2.1
10	889.7	1.5

The Congressional Budget Office did a noteworthy study in 2012 that examined the average household expenditures on energy intensive (thus carbon emitting) items. Their findings are summarized on Figure 4.

Figure 4 (Dinan, 2012).

Average Annual Household Expenditures on Energy-Intensive Items, by Income Quintile, 2007

(Dollars)

	Quintile					All
	Lowest	Second	Middle	Fourth	Highest	Households
Utility Expenditures	1,203	1,596	1,840	2,181	2,847	1,934
Gasoline Expenditures	1,046	1,768	2,418	2,988	3,696	2,384
Total spending on energy-intensive items	2,249	3,364	4,258	5,169	6,543	4,318
Total as a percentage of income	21.4	12.2	9.2	7.1	4.1	6.8

Source: Congressional Budget Office based on data from Bureau of Labor Statistics, Consumer Expenditure Survey, 2007 (www.bls.gov/cex/2007/Standard/sage.pdf).

Note: Energy-intensive items include natural gas, electricity, fuel oil, other heating fuels, gasoline and motor oil.

This table breaks down the total amount spent on utilities and gasoline, respectively, across five income quintiles, sums these amounts in the third line, and, in the last line, shows the percentage of total income spent on energy-intensive items in each quintile. This data firmly suggests that a tax on carbon would disproportionately affect lower income households. Numerous studies show that poorer households spend a much higher percentage of their incomes on carbon intensive goods. Several types of solutions could mitigate this problem and allow for a carbon reform program that lowers CO2 emissions while not disproportionately burdening certain segments of the populace.

III. Alternative Policies with Different Distributional Effects

Using the tax revenue to provide an offsetting cut in the income tax tied to payroll taxes accomplishes the twin goals of revenue and distributional neutrality. Metcalf proposes “an environmental earned income tax credit equal to the employer and employee portion of the payroll tax up to cap. The cap serves to contribute to progressivity by putting a limit on the rebate for higher income workers. Second, it ensures revenue neutrality by putting a limit on the aggregate rebate to workers. The credit would be designed to ensure that households with very low income tax liability would still be able to receive the credit" (Metcalf, 2008). This policy would be rather straightforward to put into place, as there is an existing EITC system for non-environmental credits, and this would operate in an almost identical fashion. An alternative with similar results would be to simply expand the already implemented EITC system. This would also be straightforward to administer, and if the increase were proportional to the existing credit then most of the benefits would go to lower income households, as 46% of EITC recipients in 2009 were families with incomes of less than $15,000 (Dinan, 2012). Metcalf further delineates the results of implementing this credit, showing that with this credit the tax would likely be progressive, as opposed to being regressive in isolation.

There are four major areas of taxation that could be partially offset with the carbon tax revenue. These areas are personal income taxes, corporate taxes, payroll taxes, and reductions in transfer programs. All of these areas could benefit from carbon tax revenues, which two MIT economists have dubbed a "win-win-win" for the corporate climate, individual households, and the environment. Rausch and Reilly propose estimates for utility changes based on a carbon tax of \$20/ton of CO_2 that increases by 4% in real terms annually, implemented in 2015 in Figure 5.

Figure 5: Annual Welfare Change, billion 2006 constant dollars (Rausch and Reilly, 2012).

	CT PersInc	CT Corp	CT Payroll	CT½ PersInc	CT½ Corp	CT½ Payroll	CT Transfers	CT½ Transfers
2015	2.4	2.7	2.2	−1.7	−1.5	−1.7	2.9	−0.9
2020	4.9	5.4	4.7	2.0	2.4	1.8	4.9	0.7
2025	7.4	7.9	7.0	5.8	6.3	5.6	5.8	2.1
2030	8.9	9.3	8.6	9.3	9.7	9.1	6.8	3.9
2035	9.6	9.8	9.4	11.9	12.2	11.7	8.3	5.8
2040	9.9	9.8	9.8	14.5	14.6	14.4	8.8	8.5
2045	10.3	10.0	10.4	18.1	17.9	18.0	8.6	12.1
2050	8.7	7.5	9.2	21.7	21.0	21.9	5.8	16.4

Name	**Scenario**
Ref	Current law with Bush tax cuts and payroll tax cuts expiring[a]
CTPersInc	Carbon tax[b] revenue used to reduce the personal income tax rates
CTCorp	Carbon tax revenue used to reduce corporate tax rates
CTPayroll	Carbon tax revenue used to reduce payroll taxes
CT½PersInc	As in CTPersInc but ½ of revenue diverted to investment
CT½Corp	As in CTCorp but ½ of revenue diverted to investment
CT½Payroll	As in CTPayroll but ½ of revenue diverted to investment
CTTransfers	Carbon tax revenue is used to increase transfer payments
CT½Transfers	As in CTTransfers but ½ of the revenue is diverted to investment

Figure 6 shows estimates of how welfare would change for certain groups. For example, if revenue collected from the tax was used to implement an equivalent reduction in corporate tax rates, one can see in the third column that by 2030, welfare for this segment would increase by $9.3 billion. By these estimates, reductions in taxation to offset the burden of an emissions tax greatly increase societal welfare, especially in the long term. The research strongly supports the theory that a carbon tax complemented with a reform program is a mostly pain free solution to global warming.

Chapter 3

The Canadian and Australian Models

I. The Canadian Model

Although there is no federal carbon tax in Canada, three of the twelve Canadian provinces have implemented a tax on CO2 equivalent emissions in some capacity with varying degrees of success. Alberta became the first province, state, or country in North America to implement such a tax. Alberta is responsible for one third of Canada's carbon emissions and is second only to Qatar in terms of its carbon footprint per capita, largely due to its vast natural resources (Dembicki, 2012). In June of 2007, Alberta gave industrial emitters of over 100,000 tons of CO2 per year one year to reduce their emissions per unit by 12%, and then charged the emitter $15 a ton for every ton over this threshold. If the companies in question could not meet these targets, they had the option of buying carbon offsets elsewhere in the country (namely British Columbia). The revenue collected by the government goes to a clean energy fund (Dembicki, 2012). This relatively simple scheme will be up for a parliamentary review in 2014.

On October 1st, 2007, Quebec began collecting a small tax on petroleum, natural gas, and coal. This tax forced energy producers, distributors, and refiners to pay about $200 million a year in taxes. This affected about 50 energy companies. Spread across Quebec's population of (by 2006 estimates) 7,546,000, this equates to $26.75 per capita annually (carbontax.org). Refiners have to pay C$.8 per liter on gasoline and C$.9 on diesel. Power and gas companies are taxed as well. In January of 2013, an emissions trading scheme was implemented as a complement to the tax. Companies that emit 25,000 tons or more of CO2 equivalent will be subject to the system, with the familiarization period having begun in mid-2012. Emissions must be cut to under the threshold set by the government for each company, or the company must buy carbon credits at government auctions lest they be subject to a penalty (energyadvantage.com). While this scheme has achieved some success, the relatively small scope and scale do not provide a precedent for carbon schemes to come.

II. British Columbia

The most recent and most significant Canadian carbon scheme is the carbon tax implemented by British Columbia in Western Canada. The tax was implemented in 2008 at an initial rate of C$10 per ton of CO_2 equivalent, and gradually increased to $C30 per ton by 2012 and then leveled out. The tax is implemented at the point of consumption, so for gasoline the tax is reflected in prices at a gas station. The table below shows that the target rates were very close to being achieved. The tax rate is different across fuel types due to the various carbon content of each individual fuel. For example, jet fuel has a higher carbon content than gasoline, so the tax on jet fuel is higher.

Figure 6: Selected Carbon Tax Rates by Fuel (Wesanko, 2010).

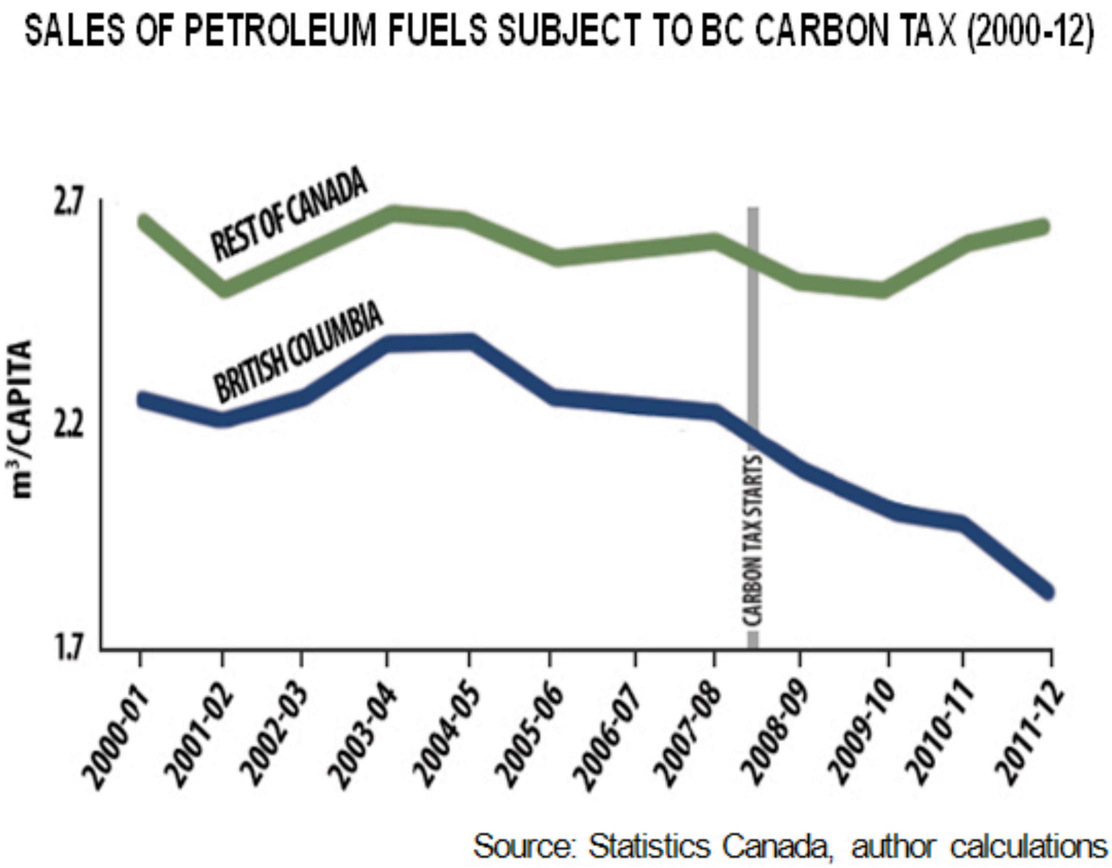
	UNITS FOR TAX	TAX RATE JULY 1, 2012
Gasoline	¢/liter	6.67
Diesel (light fuel oil)	¢/liter	7.67
Jet Fuel	¢/liter	7.83
Natural Gas	¢/cubic meter	5.70
Propane	¢/liter	4.62
Coal - high heat value	$/ton	62.31
Coal - low heat value	$/ton	53.31

Implemented at the same time as this tax were four similar measures that tried to offset the burden the tax imposes on the taxpayer. These provisions are “a 2% cut to the lowest provincial personal income tax rates in 2008, and a 5% cut by 2009, a reduction in the general corporate income tax rate from 12% to 11%, a reduction in the small business corporate income tax rate from 4.5% to 3.5%, and an introduction of a new ongoing low-income Climate Action Tax Credit to help low-income individuals and families with the carbon taxes they pay” (British Columbian Ministry of Small Business and Revenue). This reduction in tax rates is essential to the success of the British Columbian tax plan, and for all carbon tax plans. In January of 2010, the tax was applied to diesel and other fuels, after rebate checks had been sent out to all British Columbians (CTV News). The carbon tax in Canada has been successful, and perhaps more provinces will adopt a similar scheme in the future.

III. Success in BC

The evidence gathered from the British Columbian system can support this conclusion. As of January 2013, British Columbia collected $1 billion on average each year since 2008 (Kuow, OPB). As the British Columbian minister of environment Terry Lake said: “it’s simple, it makes sense, it’s well accepted.” A five-year study conducted by Sustainable Prosperity concluded that British Columbian fuel consumption had fallen by 18.8% relative to the rest of Canada between 2008 and 2013.

Figure 7



Additional conclusions drawn from the study show that British Columbia's GDP has kept pace with the rest of Canada during that time period and that British Columbians have the lowest income tax rate in the country (Sustainable Prosperity). However, there are many that argue that the tax does not go far enough in reducing overall emissions.

IV. The Australian Model

The Australian "Carbon Pricing Mechanism" is one of the most recent, having gone into effect on July 1, 2012. It is a hybrid system of sorts, including a tax on carbon and a cap and trade mechanism. This system began by imposing a flat tax on carbon emissions in the energy, transport, waste, and fugitive emissions (meaning landfill facilities with direct emissions of 25,000 tons or more of CO2) sectors. The price started at $23 per ton and will increase by 2.5% each year (Australian Clean Energy Regulator). The government collected the tax by giving away unlimited permits at this price. However, beginning in 2014, the scheme is intended to transition to a cap and trade scheme in which the government will limit the amount of pollution permits tied to a emissions cap. The Australian mechanism differs from the Canadian models because it includes a comprehensive emissions trading system. With this system, the government requires emitters to purchase "carbon units" equivalent to all their emissions. Certain industries will get free allocations of carbon units. In addition, the 260 or so entities affected by the tax and emissions system may offset up to 5% of their emissions instead of using their carbon units. This system differs from a pure emissions trading program because the government sets the initial price. Despite a 9% drop in emissions in the 6-month period following the implementation of the tax, the newly elected Tony Abbott administration has pledged to repeal the tax, and has rallied much support to this cause (ABC News Australia). Mr. Abbott says that his bill to repeal the tax "delivers on the coalition's commitment to the Australian people to scrap the toxic tax… This is our bill to reduce your bills, to reduce the bills of the people of Australia" (Packham, 2013).

V. Where Australia's Model Failed

Why then is Australia's carbon taxation reform described as "A Wolf In Sheep's Clothing?" (Spash and Lo, 2012). The taxation scheme in Australia does not properly incorporate a tax reduction program to properly offset the regressive incidence on Australians, and it is for this reason that Australia's carbon scheme was unlikely to be well received from its inception.

This type of emissions trading scheme is unpopular with taxpayers because despite its increase in allocative efficiency, taxpayers do not directly see the benefit. Although the scheme has been successful in the reduction of carbon emissions, the average Australian cannot see tangible evidence of this reduction. What the average Australian can see, however, is an expected rise in household bills of about $5 per week (Maiden, 2012). They can also see that the Australian Housing Industry Association reported that the average price of a new house will be between .8% and 1.7% higher due to the carbon tax (HIA, 2012). Because the Australian government did not effectively provide returns for taxpayers, households are worse off. Taking into account what will almost definitely be a successful repeal of the bill, modeling by the Australian treasury shows that removing the tax will reduce average costs of living by $550 in 2014 (Australian Department of the Environment, 2013). It is interesting to note that Metcalf estimates in one of his studies that a revenue neutral tax rebate cap would be approximately $560 per worker per year (Metcalf, 2008). Australia did not provide an effective tax reform and hence their carbon tax scheme was hugely unpopular, and it will likely take a long time for legislation such as this to be proposed again. Abbott and other legislators opposed to the tax are able to sway public opinion based on these statistics, and instead of working to reform the scheme it will simply be eliminated. The Australian carbon tax would have set a great global precedent should it have been linked to the EU ETS in demonstrating that a global, and not only regional, scheme can be implemented. However, the bill has not been killed yet and it is still possible that compensation to firms and households will be given by the government. Payments called the Clean Energy Advanced have been scheduled to provide some relief to low and middle income households (Department of Human Services, 2012). Furthermore, under the Carbon Farming Initiative, farmers will be able to plant trees in order to obtain carbon offset credits that they can then sell to firms (McDonald, 2012). The expansion of these programs and others could possibly save the carbon scheme from being repealed, and further progress could possibly be made from there.

Chapter 4

Cap and Trade and the European Model

I. Price Volatility

A major issue and the cause of much criticism of cap and trade programs is the volatility in the price of emission permits. Because the number of permits issued or auctioned as well as other factors such as fuel prices and the macroeconomic environment influence the price of permits, it can be difficult for businesses to work with this system. For example, in the infant stages of the EU ETS, the price of permits tripled in the first six months, halved in price in a one week period, then went to effectively $0 in the next year (Pew). Whereas the carbon tax can be easily adjusted upwards if carbon emissions remain high, "misjudging the number of permits… could send permit prices either skywards or through the floor, with immediate, and costly, economic consequences. Worse, a fixed allotment of permits makes no adjustment for the business cycle (firms produce and pollute less during a recession)" (The economist). Another example of the extreme volatility of permits is the United States' Regional Clean Air Incentives Market program intended to curb nitrogen oxide emissions. During the California energy crisis of 2000, prices varied between $400 and nearly $100,000 per ton (rff.org). Obviously, this enormous price range is unacceptable to most businesses, and should a cap and trade scheme be successful, there must be a way to curb this volatility.

II. The Safety Valve

The best solution for reducing permit volatility is the idea of a safety valve. A "safety valve," is a model in which a cap-and-trade system is coupled with a price ceiling at which additional allowances can be purchased (in excess of the cap). So long as the allowance price is below the safety-valve price, this hybrid system acts like cap-and-trade, with emissions fixed but the price left to adjust. When the safety valve price is reached, however, this system behaves like a tax, fixing the price but leaving emissions to adjust. To impose a ceiling on allowance prices, the regulator may either introduce into circulation additional allowances whenever the stipulated ceiling price is reached so as to prevent allowance prices from rising further, or allow firms to pay a set fee to emit instead of submitting allowances (Goulder and Schein). This allows for a more flexible supply curve, and makes it so that firms are not unduly crippled if the price of permits rises too high. However, Pizer notes that there is one possible problem with this basic safety mechanism. "Suppose the cap needs to be tightened and as a result the safety-valve price is expected to increase dramatically at some point in the future. With an ordinary safety valve, an expectation of much higher prices in the future would lead rational firms to buy as many allowances as possible at the current, low safety-valve price in order to save them for use later when prices are high. Absent a mechanism to limit such purchases, they could effectively overwhelm efforts to tighten the future cap, thereby undermining long-term environmental policy goals. An allowance reserve would address this potential problem by placing an upper limit on the available number of extra allowances" (Pizer). This solution addresses one of the main goals of the cap and trade system; that is, to have a fixed number of emission allowances so that the goal of carbon abatement is reached.

III. Intertemporal Banking

Another way to reduce potential price volatility is to allow for intertemporal banking and borrowing of allowances. Intertemporal can be defined as banking permits for future use or borrowing permits for future allocations (Slechten). With intertemporal borrowing, firms can apply toward present emissions the allowances allocated to them for future time periods. Similarly, with intertemporal banking, firms can save the allowances they do not use in the current period and apply them to future periods. Such intertemporal flexibility makes the current supply of allowances more elastic and thereby can dampen price volatility (Goulder and Schein). A cap and trade system allows information learned about costs and benefits gained during the initial implementation of the policy to be effectively used today. This new information learned about the previous period can be used to adjust future caps so that firms can bank or borrow now to equate marginal costs over time periods (Pizer). With a banking allowance, a cap and trade system provides more stability for businesses while keeping emissions levels stable, making this banking system essential so that an ETS scheme will be accepted by the business community.

IV. The European Model

The European Union Emissions Trading Scheme was implemented in 2005, and is largely recognized to have occurred in four phases. It is a relatively straightforward cap and trade scheme, which presently includes all 28 EU member states and Iceland, Norway, and Liechtenstein. Essentially, the EU commission sets a limit on the amount of total carbon emissions for the participating countries. Permits are auctioned or given away and firms must monitor their carbon output, and turn in permits to cover their emissions. If a firm covered under the plan cannot, they must purchase permits from other firms who are under their allotment. This scheme consists of four phases.

Phase I took place in 2005-2007, and set the stage for all changes up to the present. It included 12,000 installations, representing 40% of the EU's CO2 emissions. The 15 then-members of the EU all signed on. Phase II expanded the scale of the operation, and the three non-EU countries joined the scheme. Aviation emissions were also included in this phase. There was an over-allocation of permits in Phase I, which, coupled with a recession, led to a price of carbon so low that it is unlikely to have incentivized firms to reduce their output (eubusiness.com). In Phase III (2013-2020), a move was made to set an overall EU cap, tighten limits on the "banking" of allowances between Phases II and III, and a switch from allowances to auctioning. Additionally, Croatia joined the scheme, bringing the total number of countries involved to 31.

Phase IV contains an additional set of regulations added to Phase III, including a reduction in allowable emissions of 2.2% annually from 2021 to 2030 (European Commission) and a push to link up the European trading scheme with other schemes across the globe, including the Australian scheme. The EU system has been met with very mixed responses due in part to the large number of cultures and countries it crosses, but it will be interesting to see the far-reaching effects that this carbon pricing mechanism has upon Europe as the emissions cap grows tighter and additional phases are implemented and realized through time.

Perhaps the greatest criticism of the European ETS is the great price volatility of the permits, particularly in the early stages. To solve this problem, the European scheme should have a safety valve option implemented in Phase IV of the scheme in order to reign in the excess number of permits. A smaller number of permits should be auctioned off initially, and then the EU Commission can adjust the safety valve price depending on how the market for permits behaves. Another issue with this initial overallocation was that firms' incentive to invest in green energy infrastructure was removed, as they able to pollute for nothing. Furthermore, this allocation was decided on a country-by-country basis, leading to great inequalities between firms of differing nationalities. If a safety valve option was implemented, fewer initial permits could be issued and a more stable market price would be established. Another issue with the EU ETS is the restriction and limitations on intertemporal banking. Banking was not allowed at all in the first two phases of the ETS, and this has created an incentive for firms to emit as much as they can in the current period. In the future, to ensure success for the current system, changes should be made to allow for intertemporal banking to reduce volatility, as well as a safety valve option to mitigate the effects of unequal and uncertain allocations.

Chapter 5

Conclusions

Global warming needs to be addressed in some capacity for the wellbeing of future generations. Cap and trade systems and carbon taxes are two such solutions, and hopefully models like the Canadian and European ETS will become more prominent in future years. A carbon tax can be popular, reduce emissions, and be cost minimizing and non-regressive provided that it has some sort of rebate to consumers. A cap and trade system can be successfully implemented as long as there is an associated price ceiling and price floor to properly address the needs of firms. Although the mechanism did not achieve success in Australia, perhaps future generations will be able to learn from that trial's mistakes, and more nations will come to adopt an efficient system.

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ACADEMIC VITA

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Education

The Pennsylvania State University, University Park, PA

Bachelor of Science in Finance
Bachelor of Science in Economics
The Schreyer Honors College

Honors and Awards

Paterno Fellow in the Liberal Arts

- Scholar in an academic and leadership program
- Accepted duties such as double majoring and holding leadership positions

Professional Experience

The Nottingham Group, LLC, Pittsburgh, PA

- Worked in a boutique forensic accounting firm assessing economic aspects of litigation
- Did valuations for legal cases ranging from wrongful death compensation to stolen fuel values
- Utilized Microsoft Excel to create effective spreadsheets to assist with data evaluation

Association Memberships/Activities

Beta Alpha Psi Professional Fraternity, Treasurer

- Helped organize professional events for the benefit of the organization with many different firms
- Served as liaison between the pledge class and the board to better serve the interest of both parties
- Organized fund raisers and professional events to benefit the organization
-

International Business Association, Treasurer

- Help to organize, raise, and manage the association's capital
- Director of marketing and promotion for "International Night" with several business executives