A Cost-benefit Analysis of the Australian Carbon Tax and the Economics of Climate Change

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Abstract: Within economic literature, the topic of global warming and efforts to mitigate it are being thoroughly discussed. The ability for climate change to impact businesses and households globally has driven economists worldwide to develop policy proposals with carbon emissions reductions as a primary concern. This report discusses climate policy within the United States, the European Union and Australia with the intent of highlighting key difficulties associated with implementing climate policy. Australia receives particular attention in this report due its history regarding the implementation and repeal of a carbon tax. The cost-benefit analysis of the Australian carbon tax conducted within this report suggests the Australian government's decision to repeal the tax was founded.

Keywords: Climate Change, Externalities, Pigovian Taxation, Carbon Tax

1.Introduction

Climate Change has become a topic of worldwide concern in recent years. Across the globe, policy makers and activists are concerned with anthropogenic climate change i.e. continuous global warming caused by humans pumping greenhouse gases into the atmosphere at an excessive rate. The advent of worldwide global warming data collection has been recently used to affirmatively link the exponential production of greenhouse gases to climate change. ("Climate Change Science Overview," n.d.) As a result, a large majority of policies and proposals concerning climate change have laid out detailed strategies with emissions reductions as a key pillar. Although the human race is becoming increasingly educated about the impacts of consumption decisions, the existence of empirical data on the effects of climate policies on the economy is relatively scarce in economic literature.

In 2012, Australia implemented a carbon tax in a proactive effort to support worldwide climate change mitigation efforts. In 2014, the Australian government repealed their carbon tax legislation, facing substantial criticism that the carbon tax was inefficient in achieving its goals. Using rudimentary processes for calculating costs and benefits of the carbon tax, this paper will attempt to make a basic assessment of the effectiveness of this tax.

The structure of this paper is as follows. In Section 2 an overview of economic theory pertinent to the issue of global warming is provided along with an associated literature review. In Section 3, the stance held by the United States, European Union, and Australia in relation to climate change is discussed. Section 4 contains the framework and results of the cost-benefit analysis. Lastly, Section 5 provides a conclusion to the discussion at hand.

2.Theory and Literature Review

The issue of climate change and how it should be dealt with is deeply rooted in economic theory. Although alternative approaches to dealing with this issue are vast, the economic theory behind this issue is relatively straightforward. By progressing through theory most relevant to climate change induced by greenhouse gas emissions, one can gain a better understanding of this issue and the economic decisions required to combat it.

2.1. Externality Theory

Throughout the course of a day individuals make thousands of decisions. Some of these decisions are personal and relate directly and solely to the individual while other decisions do not. Within economic theory, decisions made and actions taken that affect not only the individual, but also the world around them, are considered externalities. It is for this reason that the persistence of climate change is due to the existence of an externality. An externality can more broadly be defined as “whenever the actions of one party make another party worse or better off, yet the first party neither bears the costs nor receives the benefit of doing so" (Gruber, 2007, p. 122). Externalities are commonly divided into two different categories, positive and negative. As a result, everyday decisions that produce carbon emissions are considered to be the creators of negative externalities.

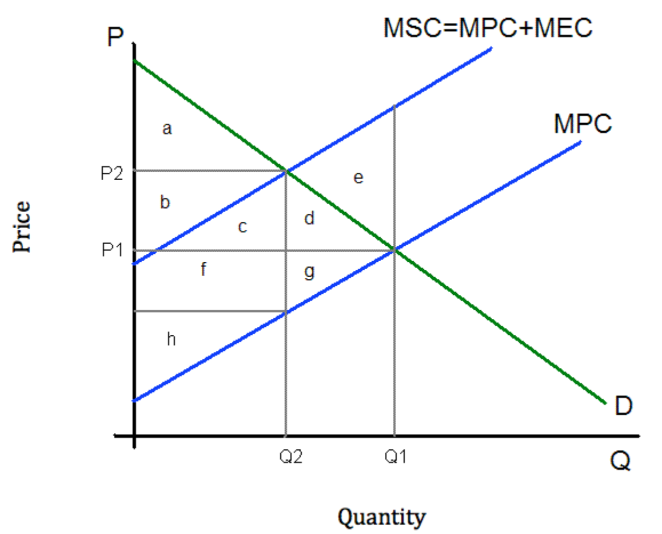
All externalities, both positive and negative, create issues in marketplaces. These related issues have been labeled in economic theory as market failures due to their ability to divert individuals from making economic decisions that appropriately weigh social cost against social benefit. A simpler way of understanding this concept is to distinguish positive externalities from negative externalities, the former incentivizing too little consumption and/or production of a good and the latter incentivizing too much. This misalignment of incentives prevents the market from reaching a socially beneficial equilibrium.

Basic economic theory describes market equilibrium as the quantity where marginal private cost equals marginal private benefit, but when dealing with climate change, the negative effects of everyday human activities and consumption patterns on the environment are not accounted for when calculating private cost. Moreover, as "we move away from the social-efficiency-maximizing quantity, we create a deadweight loss for society because units are produced and consumed for which the cost to society exceeds the social benefits" (Gruber, 2007, p. 124). If left unaccounted for, the creation of this deadweight loss can cause significant disruptions in the efficacy of the markets that they hamper. This is undeniably true in the case of climate change due to the range of widespread effects global warming is imposing and will impose if emissions continue to grow.

2.2. Solutions

Within economic theory dealing with externalities, a variety of solutions are offered on how to counteract their existence and, in turn, properly adjust markets to regain efficiency. Figure 1 depicts the existence of a negative externality within a theoretical market. Without consideration of the negative externality, supply and demand

Figure 1: Negative Externality



(Haab & Whitehead, n.d.)

for this product reaches equilibrium at the intersection of P1 and Q1. At this equilibrium the consumer surplus, or the sum of differences between customer willingness to pay and price, is designated by the sections labeled a, b, c, and d in the graph above while producer surplus, or the sum of differences between price and marginal costs, is designated by all areas below the line P1 and above the MPC curve. (Haab & Whitehead, n.d.). The existence of an external cost, which is represented by sections h, f, g, c, d, and e, in this market creates inefficiency that the upcoming solutions in this discussion attempt to address.

In order to regain efficiency in this market, a new equilibrium must be reached where marginal social cost, or marginal private cost plus marginal external cost, equals demand. As displayed in Figure 1, the intersection between P2 and Q2 indicates an efficient equilibrium. It is important to note that at this new efficient equilibrium a deadweight loss is created. This deadweight loss, designated by d and g in Graph 1, is representative of the individuals who would have purchased this externality-inducing product at the original price but choose to go without it once the external cost is represented in the price. (Haab & Whitehead, n.d.)

The solutions discussed in the following section are separated into two categories, private-sector solutions and public-sector solutions. Utilizing differing approaches, each category provides insight in regards to how policy decisions to limit the persistence of negative externalities such as climate change should be made.

2.2.1. Coase Theorem

In his most circulated article titled “The Problem of Social Cost”, esteemed economist Ronald Coase develops a view on externalities known today as the ‘Coase Theorem’ (Coase, 1960, p. 1). Within this article, Coase advances the idea “that in a world of perfect competition, perfect information, and zero transaction costs, the allocation of resources in the economy will be efficient and will be unaffected by legal rules regarding the initial impact of costs resulting from externalities” (Regan, 1972, p. 427). Essentially, Coase’s theorem states that if the series of aforementioned assumptions are met, rational individuals will regain efficiency in the presence of an externality through bargaining and without intervention or assistance by the public sector. (Coase, 1960, p. 2) In the years since its publication, "The Problem of Social Costs" and Coase's theorem have been the subject of much scrutiny. By discussing the limitations to Coase's Theorem, one can more readily consider the difficulties associated with limiting the negative externality of global warming.

A limitation of Coase's theorem is that it doesn't apply when information regarding which individuals are affected by a negative externality, i.e. its creators and its victims, and by how much, is absent. When assessing the persistence of a negative externality, it is common for there to be multiple sources contributing to its creation, causing the task of assigning equitable blame across a variety of marginal contributors to be difficult or impossible. This limitation emerges in similar form as a roadblock when attempting to identify those worthy of compensation for negative externalities. This is certainly the case with global warming and, more generally, the release of greenhouse gases, considering the interconnectedness of the globe and the dominance of emissions intensive processes in the global economy. Additionally, in relation to victims of a negative externality: "it would be in their interest in any Coasian negotiation to overstate the damage in order to ensure the largest possible payment" (Gruber, 2007, p. 131). The implications of this lack of information as it pertains to global warming is that individuals harmed by global warming may choose to demand more assistance than they truly require while individuals perpetuating global warming will understate their role, aware that all parties involved lack the proper knowledge to question them. Moving forward, it is important to address another key limitation associated with the Coase theorem: the free rider problem.

In economic theory, a public good is a good recognized as both non-excludable and non-rivalrous. In many ways, the existence of Earth and its provision of a place suitable for the survival of its inhabitants is a public good. Therefore, It follows that actions taken by any individual that jeopardize the Earth's role as a public good are the creators of negative externalities. Similar to other public goods, such as protection from criminal activity by the police or fire damage by the fire department, provision of protection of the Earth is susceptible to the 'free rider' problem. The free-rider problem arises "when an investment has a personal cost but a common benefit, individuals will underinvest." (Gruber, 2007, p. 133). Because of the free rider problem, the Coasian assumption of costless bargaining is unlikely to be satisfied when the number of affected parties is large. That is, two or more of individuals who gather to resolve the existence of an externality on their own accord may rationalize reasons not to incur the cost of eliminating it rather than coordinating efforts with each other, via bargaining, to fix it. Similar to the situation with global warming, the result of this gathering would inevitably be persistence of the externality rather than its resolution.

In the previous section, reasons why the private sector alone cannot be relied on to resolve problems associated with negative externalities is expounded. To contrast this discussion, an exploration of why the most practical solutions to the issues created by negative externalities are derived from public sector intervention is conducted. Governments can impose regulations or taxation and, within economic theory, corrective taxation and regulation are both viable options when addressing negative externalities. By looking at how these functions operate, and expressing the theoretical advantages and disadvantages of each, one can more easily interpret the role the government can play in eliminating negative externalities.

2.2.2. Pigovian Taxation

A popular theoretical solution to negative externalities was developed by British economist, Arthur Pigou. In 1920, Pigou published his most famous work, *The Economics of Welfare*, which contained an analysis of negative externalities and a prescription for correcting them known today as Pigovian taxation (Pigou, 1932). Pigovian taxation is the levying of a tax on the excess output of an externality producing product (Main, 2008, p. 4). In a market economy, Pigovian taxation is an efficient means of dealing with negative externalities. As discussed earlier, Pigovian taxation challenges the operating government to accurately estimate the costs of a negative externality in dollar amounts. In reality, this is a nearly impossible task to accomplish. Still, a Pigovian tax that is relatively close to the negative value of an externality is valuable in imposing climate change policy. By estimating this value with a reasonable degree of accuracy, governments can approach efficiency when deterring the production of products that create negative externalities.

2.2.3. Cap-and-Trade Systems

Cap-and-trade systems have received significant attention from economists and researchers due to their ability to create a market for carbon emissions. A cap-and-trade system operates by placing a limit on the aggregate amount of emissions allowed by the individuals and/or businesses operating under it. The system then requires these entities to surrender emissions allowances in proportion to the amount of emissions they produced. The effect that this has is that “while firms have flexibility regarding precisely how much they emit, because they have to surrender an allowance for each ton of their emissions, they will undertake all emission reductions that are less costly than the market price of an allowance” (Stavins, 2008, p. 299). A situation where a cap and trade system effectively directs the economy toward emissions reductions at the least costs is ideal.

Cap-and-trade systems encourage entities who are able to reduce their emissions quickly or inexpensively to profit by selling their emissions allowances to entities more in need of them. Similarly, who refuse or are unable to reduce emissions are then allowed to purchase emissions allowances from within the cap-and-trade market. The key difficulty associated with implementing such a system contrasts that of implementing Pigovian tax policy, where the tax on the externality imposing good is fixed and quantity produced is determined by the market. When implementing a cap-and-trade system, the government seeks to identify and realize the most efficient quantity, or ‘cap’, that should be produced by the market of the externality imposing good. The difficulties associated with accurately identifying this ‘cap’ quantity are identical to those of identifying an optimal tax level. While it is unlikely that a well thought out cap-and-trade system will accurately identify the optimal ‘cap’ quantity, governments are capable of identifying reasonable estimates of the optimal cap quantity, significantly improving market efficiency.

2.3. Dangers related to Climate Change

The dangers posed by climate change to the safety of the Earth, it's inhabitants, and the economy are significant. Outlined below is a brief literature review of the dangers associated with climate change. Admittedly, the following discussion does not encompass the nearly boundless list of potential dangers associated with anthropogenic global warming. Instead, it is designed to provide a glimpse of how these dangers are likely to manifest and how they will have economic repercussions. Focusing attention on the indications for global warming to cause substantial economic costs will strongly emphasize the importance of keeping climate change at bay. This discussion begins by bringing attention to the link between temperature changes and the agricultural sector.

2.3.1. Agriculture

My motive for placing attention on temperature change is grounded in the importance of the agricultural sector and increasing support around the idea that it is particularly vulnerable to the impacts of climate change. As climate change persists, the increased likelihood of drought, or other global warming induced events, ravaging areas that usually prosper agriculturally will put a strain on the lifestyle and economic stability of all those involved. By discussing literature related to agriculture and global warming within the United States alone, one can more readily understand another way in which global warming is a worldwide economic threat.

The United States' agricultural sector serves millions of people daily and plays a major role in the overall economy. The Environmental Policy Agency, delegated as the overseer of human health and environmental safety in the U.S., reports: "In addition to providing us with much of our food, the crops, livestock and seafood that are grown, raised, and caught in the United States contribute at least $200 billion to the economy each year" ("Agriculture and Food Supply," n.d.). With the integral role that the agricultural sector plays within the United States economy in mind, it becomes clearer why the relationship between varying temperatures and agricultural productivity is of importance.

The United States Department of Agriculture released a government paper titled "Climate Change and Agriculture in the United States: Effects and Adaptation" where it discusses the relationship between the impacts of greenhouse gas emissions and the agricultural sector. In short, this paper looks at how "increases of atmospheric carbon dioxide, rising temperatures, and altered precipitation patterns will affect agricultural productivity" (United States Department of Agriculture, 2013). It posits that variations in temperature, "will reduce productivity of crops, and these effects will outweigh the benefits of increasing carbon dioxide" (United States Department of Agriculture, 2013). The science behind how temperatures impact crop production is noteworthy in relation to this discussion.

As expressed by the USEPA, "Agriculture and fisheries are highly dependent on specific climate conditions [and so]... changes in the frequency and severity of droughts and floods could pose challenges for farmers and ranchers" ("Climate Change Science Overview," n.d.). Given the ideal conditions for crop production, there is strong evidence that varying temperature trends have and will continue to have a significant effect on production levels. The USDA has concluded that if temperature variations continue, "shifts may occur in crop production areas because temperatures will no longer occur within the range, or during the critical time period for optimal growth and yield" (United States Department of Agriculture, 2013). Based on this evidence, one can see how allowing climate change to run its course and for temperature trends to become altered can prove economically detrimental to agricultural productivity. In California, these effects are being felt currently.

California leaders have been forced to act unprecedentedly in response to the effects of global warming. A four year long drought beginning in 2012 in California has demanded that Governor Jerry Brown issue an executive order “directed at the State Water Resources Control Board to impose a 25 percent reduction on the state’s 400 local water supply agencies, which serve 90 percent of Californians, over the coming year” (Nagourney, 2015, p. 2). Regulation such as this may or may not be effective in California’s attempt to outlast its lengthy drought. Nonetheless, the impacts of global warming on the economy and people of the United States, exemplified by the water crisis in California, are undeniably being felt. The California government reported that: “Millions have been spent helping thousands of California families most impacted by the drought pay their bills, put food on their tables and have water to drink” (Brown, 2015, p.1). By disrupting cyclical rainfall patterns, global warming has come with a price to California. Other areas of the United States have experienced costs from global warming in the form of dangerous natural disasters. By looking at the economic impact of infamous Hurricane Sandy, who’s devastation ravaged sections of the United States in 2012, one can see further how the potential for increased frequency of extreme weather events caused in part by global warming is a threat to economic stability in the regions affected.

2.3.2. Natural Disasters

Hurricane Sandy is a tropical storm that traveled up the east coast of the United States in 2012, creating a majority of it's havoc in the north eastern states. The damages caused by Hurricane Sandy were immense: a report titled the Annual Global and Climate Report released by Aon Benfield, a global reinsurance firm, reported that Hurricane Sandy caused upwards of 65 billion dollars in damages, making it largest and most costly natural disaster of 2012 (Rice, 2014, p. 2). It is evident that in the long run costly natural disasters such as this are bound to occur with frequency, impeding the growth rate of human and economical development. For this reason, it is important to note that the concept of global warming and data collection regarding global warming are too new and insufficient to directly connect any particular event with climate change. Still, scientists have found that outcomes of an increase in global temperatures include increased risk of drought and increased intensity of storms, including tropical cyclones with higher wind speeds, possibly, more intense mid-latitude storms" ("The Impact of Climate," n.d.) While the connection between one event and global warming is currently difficult to ascertain, increased frequencies of events such as droughts and natural disasters is clearly of economical concern.

As more advanced processes are developed for making these connections, the valuation of damages caused by climate change will grow. These global warming effects on the environment, as displayed by high costs to the United States caused by Hurricane Sandy and the drought facing California, are evidence that global warming is a threat to economies worldwide. The next step in this discussion is to highlight three key global greenhouse gas emitters, the United States, the European Union, and Australia in order to provide further information on the steps necessary for effectively combating the threat of climate change to economies worldwide.

3. Global Policy

3.1. United States

In this section attention will be brought to the United States and their earliest role in the international global warming discussion. By providing a brief history of the Kyoto Protocol's development leading up to a somewhat unexpected move on the part of the United States, one can more readily understand the obstacles brought on by the need for international cooperation in climate change debate.

The United States was one of the first countries to recognize the threat of climate change by agreeing to become a member of the United Nations Framework Convention on Climate Change (UNFCC). Upon its formation in 1992, 196 member-countries (or parties) of the UNFCCC accepted a "legally non-binding, voluntary pledge that the major industrialized/developed nations would reduce their greenhouse gas emissions to 1990 levels by the year 2000, and that all nations would undertake voluntary actions to measure, report, and limit greenhouse gas emissions" (Saundry, 2006) While this agreement showed promise and facilitated discussion on the issue of growing greenhouse gas emissions, it did not apply sufficient pressure on its member-countries.

Concerns regarding the looseness and effectiveness of the UNFCCC to encourage emissions reductions arose in the years following its conception. In fact, decreases in emissions were being tallied at such a slow rate that "by 1995, [parties] realized that emissions reductions provisions in the Convention were inadequate, [launching] negotiations to strengthen the global response to climate change" (Background on the UNFCCC," n.d.). The outcome of these negotiations was the creation of the Kyoto Protocol, which was signed but not ratified by the U.S. Although the U.S. had taken a leadership role in the development of efforts to mitigate climate change, U.S. leaders refused to ratify the Kyoto Protocol due to an important clause in its design and how that clause would affect the ability of the United States to achieve their emissions target.

This treaty was developed with an emphasis on parties doing their share to combat climate change. In principle, this is logical but the approach to this concept in the provisions of the Kyoto Protocol did not sit well with the U.S. In 1998, rather than ratifying the Protocol, the Clinton Administration refused to "submit [it], to the Senate for advice and consent, acknowledging that one condition— meaningful participation by developing countries in binding commitments limiting greenhouse gases — had not been met" (Saundry, 2006). Essentially, The U.S. saw the exemption of developing countries, also referred to as Non-Annex I countries, from binding targets as too significant of a disadvantage to suffer in the world economy. In relation to the world market for emissions, "the developing countries' acceptance [to binding targets]... would have had the effect of authorizing emissions trading between developing and industrialized nations, which the [Clinton] Administration anticipated would reduce US compliance costs by as much as 60% compared with trading only among Annex 1 countries" (Harrison, 2007, p. 103). From an economical standpoint, ratification of the Kyoto Protocol proved to be too daunting of an agreement for the U.S. to accept. This decision had negative repercussions as it affected the credibility of the United States, via the Clinton Administration, in relation to their ability and/or willingness to do their part. (Harrison, 2007, p. 92). Nevertheless, The United States' decision was a valuable one as it further emphasized the need for equitable action amongst developing and developed nations in dealing with global warming. This general concept is integral to the progression of climate change discussion and will arise as a key consideration in the remainder of this discussion. Moving forward, the European Union's role as a conglomeration of various different states and a leading developed nation make its history with combating climate change an insightful one.

3.2 European Union

Amongst efforts worldwide in combating climate change, the European Union has been a pioneer. In 2005, the European Union launched an ambitious climate and energy package that included the first ever emissions trading scheme ("The EU Emissions Trading," n.d.). The European Union's emissions trading scheme covered nearly 50 percent of the European Union's total carbon emissions at launch, making it "the largest 'cap-and-trade' carbon trading scheme in the world -- an ambitious and highly challenging policy experiment" (Betz & Sato, 2007, p. 351). In many ways, this unprecedented multinational greenhouse gas cap-and-trade system truly was one countries' ambitious attempt at tackling the formidable challenge that is climate change mitigation. Nevertheless, the European Union's ambition has been met with recognizable success in that they were able to develop and maintain a cap-and-trade system that has and will continue to serve as a prototype for other nations to learn from and emulate (Betz & Sato, 2007, p. 352). To begin discussing the impact and global economic implications of the European Union's emissions trading system, a look at the goals for the European Union's comprehensive climate package and the progression of its emissions trading system within it, is necessary. A brief background and overview of the European Union's efforts to combat climate change with a focus on the development of its renowned emissions trading system provides one a better understanding of this country's present and future role in the global effort to combat climate change.

On April 29th 1998, The European Union joined a wide collection of countries committed to the Kyoto Protocol, an international agreement to limit global greenhouse gas emissions through the implementation of country-specific emissions targets. The establishment of the Kyoto Protocol, which was adopted in Kyoto, Japan on December 11th 1997, served as one of the earliest indicators that climate change and its economic implications had become widely recognized as a formidable threat ("United Nations Framework Convention," n.d.). More importantly, the Kyoto Protocol acknowledged the necessity that each country must have, dependent on various factors influencing their level of greenhouse gas output, "common but differentiated responsibilities" ("United Nations Framework Convention," n.d.) in the global collective effort to mitigate climate change. This consensus, while relatively straightforward, serves as an integral component of the Kyoto Protocol's framework. Specifically, the EU, along with several other developed and heavy emissions-reliant countries committed to the Kyoto Protocol, embraced this responsibility with the understanding that "unless they can control their own high emissions there is little prospect of controlling emissions from developing countries that start from a very much lower base." (Oberthur, 2010, p. 144). With this approach to the role deemed necessary of them, the EU has developed a dynamic plan for meeting the demands placed on them by the Kyoto Protocol and the growing threat of climate change.

Following negotiations, The Kyoto Protocol demanded the EU's emission target be an 8 percent decrease compared to 1990s level during its first commitment phase, from 2008-2012 (Wurzel & Connelly, n.d.,). In order to achieve such a goal, it became necessary that a well rounded and largely encompassing system for greenhouse gas emissions reductions be put in place. Acting more preemptively than required of them, leaders of the European Union developed a climate and energy package to meet three specific objectives by 2020: "a 20% reduction in greenhouse gas emissions from 1990 levels, raising the share of energy consumption produced from renewable sources to 20%, and a 20% improvement in the European Union's energy efficiency" ("Kyoto Emissions Targets: Joint," n.d.). To reach this goal, it was evident that the facets of this climate and energy package would need to conquer both the standard issues related to achieving emissions reductions and those unique to a member-nation such as the European Union. The following section will touch briefly on the unique challenge facing the EU as a conglomeration of countries and their progress towards reducing emissions, leading into a closer look at the emissions trading system and its important development.

When discussing the topic of climate change and mitigation efforts within the EU, it is important to remember these efforts, similar to those related to global mitigation, must cater to the various circumstances of the various nations it is composed of. This is a characteristic unique to the EU and therefore achieving emissions reductions within the EU requires special attention. In search of a solution to this key issue, The European Commission gathered and determined a set of key principles that placed emphasis on concepts relatable to emissions reductions, such as cost effectiveness, flexibility, fairness, and competition, that were central to the development of their effort-sharing allocations. (“Kyoto Emissions Targets: Joint,” n.d.). This approach has allowed the EU to foster a scenario that “aim(s) to equalise marginal costs across all member states and all sectors, both for GHG emission reductions as well as for the deployment of renewable energy.” (Oberthur, 2010, p. 144) With this accomplishment, The European Union sets an important example for the rest of the globe to follow on the effectiveness of effort sharing. Moving forward, a closer look at the European Union’s emissions trading scheme and its progression sheds even more light on the European Union’s ability to reduce emissions.

3.2.1. EU Emissions Trading Scheme

The EU launched an ambitious climate and energy package beginning in 2015 that included the first ever emissions trading scheme. As a cap and trade system, “a ‘cap’, or limit, is set on the total amount of certain greenhouse gases that can be emitted by the factories, power plants and other installations in the system” (“The EU Emissions Trading,” n.d.) This system has evolved significantly over time in order to improve its functioning and to provide a growing incentive for companies to innovate and develop new, energy-efficient technologies and practices. The EU ETS is currently in its third phase of operation. By providing a timeline on this integral system’s development, one can see more clearly how the European Union is progressing in tackling climate change and it’s effects.

Phase one of the EU ETS, which spanned from 2005-2007 and was intended to be an experimental or trial phase, “covered only CO2 emissions from power generators and energy-intensive industrial sectors" ("EU ETS 2005-2012," n.d.). Businesses within these sectors received allowances free of charge and were penalized 40 euros per ton of CO_2 emitted above their allotted amount. Furthermore, the cap on allowances, or overall limit on the amount of emissions allowed, was not determined by the leaders of the European Union. Instead, the EU-wide emissions cap was determined by member states under National Allocation Plans. To increase their flexibility in achieving these National Allocation Plans, many nations utilized Clean Development Mechanisms which "allow a country with an emission-reduction or emission-limitation commitment under the Kyoto Protocol to implement an emission-reduction project in developing countries [to] earn saleable certified emission reduction (CER) credits, each equivalent to one tonne of CO_2, which can be counted towards meeting Kyoto targets" ("United Nations Framework Convention," n.d.). Overall, the significance and most important accomplishment of this phase was the strengthening of a belief that placing a price on carbon is an effective way of facilitating emissions trading amongst different countries. (Oberthur, 2010, p. 66) Concluding with this knowledge allowed phase one to serve as a basis upon which the EU could adjust and improve its emissions trading scheme moving forward.

In 2008, following the end of the EU ETS' first phase, European leaders reconvened and evaluated the effectiveness and drawbacks of their first attempt at a cap-and-trade system. With greater insight regarding their three 20% 2020 objectives, they developed a new and revised ETS, which functioned during the first Kyoto Protocol commitment period between 2008-12 and onward through the third phase of the EU ETS.

Particularly, there were two major changes between the initial EU ETS and the more recent phases.

The first major change affected the way the "cap" portion of the cap and trade model was determined. As mentioned previously, the phase one emissions cap for the entire EU was determined by the creation of independent National Allocation Caps. This caused issues with coordination because this approach lacked centralization, a component necessary for the proper functioning of this market mechanism over the long run. The new EU ETS demanded that National Allocation Caps no longer be used and that the emissions cap be determined with the entirety of the EU in mind. (Oberthur, 2010, p. 72) The second major change to the new EU ETS was associated with how emissions allocations are obtained. While the old EU ETS allowed free distribution of emission allocations, the new program demands majorly auctioning of allocations. The intent of this new approach is to "[take] into account the power of the producer's ability to pass on the increased costs of CO2 emissions" (Oberthur, 2010, p. 72) and limit it. Auctioning allocations decreases this ability to pass on costs by placing a premium on the ability to emit, thus improving the overall effectiveness of the EU ETS.

It is difficult to argue that the EU ETS, despite its imperfections, has not been a powerful tool. The initial phases of the EU ETS have "offered ample data and has produced a new and enormous wave of ex-post ETS evaluation studies within the environmental economics literature." (Liang, Sato, & Comberi, 2013, p. 3). Many countries have benefitted from the EU's leadership and ambition. By setting it's goals high and achieving results as the first ever system of its kind, "the success of the EU ETS has inspired other countries and regions to launch cap and trade schemes of their own"

("EU ETS 2005-2012," n.d.) This inspiration lead Australia to a failed experiment regarding climate change that reminds one of the attention necessary for a market, such as a carbon emissions market, to be designed and to flourish. By taking a closer look at Australia, its now collapsed cap and trade system, and the context under which it was developed and implemented, knowledge can be acquired about said systems and how they should most effectively be used to combat the economic implications of climate change.

3.3 Australia

3.3.1. Susceptibility to Climate Change

Australia's concern with climate change is as practical as it is political and environmental. Unlike a majority of countries worldwide, Australia's interactions with climate change have invaded the public sphere to such an extent that it has altered the course of elections and ignited new and unfamiliar policy. The prevalence of climatological concern in the Australian population comes as no surprise upon revealing a few unique characteristics of Australia and the political context behind climate change within it.

The first unique characteristic of Australia is its unusually high emissions in proportion to its population level. Figures provided by the United Nations indicate that "Australia's emissions of greenhouse gases were the highest per capita in the west, apart from Luxembourg, and that they had grown by 1.5 tonnes a head since 1990" ("Australia Suffers Worst Drought," n.d.) Australia's strangely high emissions per capita has contributed greatly to global warming awareness within the country but it is not the only factor to blame. Another characteristic that has played a role in boosting climate change awareness is confirmation that Australia is particularly vulnerable to the effects of climate change.

Research shows that climate change threatens Australia in more than the traditional ways of higher temperatures and declining rainfall. A key example supporting this is the significant threat global warming poses to biodiversity in Australia, supported by reports from The World Wide Fund for Nature that report within the last 200 years 40% of mammal extinctions have occurred in Australia (Australian Species and Climate, 2008, p. 4) This percentage is significant and as awareness of the threat of climate change continues to grow globally, the prevalence of global warming as a key issue within the general public and politics of other countries will mirror that of Australia. As a highly political topic within Australia, an understanding of the political ebbs and flows regarding climate action is relevant. In the upcoming section, an overview of Australian political interaction with climate change and, more specifically, climate change policy in recent years will be discussed.

3.3.2 Political Context

In September 2013, a pivotal Australian election initiated a major shift in political power from the incumbent Labor Party leader, Kevin Rudd, to the Liberal Party leader, Tony Abbott. As the two most influential political parties in Australia, this political shift had major implications. Major issues during this specific election period ranged widely from concerns around deficit growth to immigration laws to, the topic of this discussion, climate change policy. The political context and history surrounding the outcome of this election tells a story of Australia’s battle with climate change and the economic and political implications of action versus inaction. Using a timeline to depict the progression of political support, or lack thereof, for Australia's climate change policies, one can better understand Australia's overall stance on climate change.

In 2006, Kevin Rudd became the leader of the Australian Labor Party and "In 2007, [He] led Labor to a landslide election victory against the Liberal government". ("Profile: Kevin Rudd," 2013) Kevin Rudd placed specific attention on the issue of climate change early in his first term by making "Kyoto ratification his first official act and pledging to introduce a national emissions trading scheme by 2011" (Bailey, MacGill, Passey, & Compston, 2012). Seeking a more in-depth understanding of the potential impacts of climate change on Australia, Rudd requested a comprehensive assessment of the issue that he intended would provide clarity for all Australian citizens. The official title of this assessment was the The Garnaut Climate Change Review, which "was first commissioned by Australia's Commonwealth, State and Territory Governments in 2007, to conduct an independent study of the impacts of climate change on the Australian economy" (The Garnaut Climate Review, 2008). Completed in September of 2008, this report advocated strongly for the immediate development of an emissions trading scheme in Australia, citing Australian susceptibility to climate change as a key national concern. Professor Ross Garnaut, conductor of the assessment and official climate change advisor of the Australian Government, was quoted stating, "To delay is deliberately to choose to avoid effective steps to reduce the risks of climate change to acceptable levels" (Laxley & Curtis, 2008). With the support of Garnaut's assessment, Rudd began development of an emissions trading scheme titled the Carbon Pollution Reduction Scheme (hereafter, CPRS).

Rudd was confronted with obstacles as he pursued construction of the first Australian emissions trading scheme. In 2010, facing criticism on its effectiveness and looseness, “Prime Minister Kevin Rudd announced the deferral of his flagship climate-change policy, the Carbon Pollution Reduction Scheme, after it twice failed (August 13 and December 2nd 2009) to gain the support of the Australian Senate” (Bailey, MacGill, Passey, & Compston, 2012). While many factors contributed to this lack of support, the most important was undoubtedly the untimely change of leadership within the Liberal Party one day prior to the second senate vote on CPRS legislation.

On December 1st 2009, Tony Abbott acquired leadership of the Australian Liberal Party from Malcolm Turnbull. Turnbull had voiced support for Rudd’s CPRS despite the fact “more than half the [Liberal Party's] 37 senators [had] formally declared their opposition to Malcolm Turnbull's desire to cut a deal with Labor on the emissions trading scheme” (Coorey, n.d.) Tony Abbott gained support for his campaign by promising not to support any legislation allowing the implementation of an emissions trading system in Australia. His ascension to the helm of the Liberal party, and its direct impact of stifling Kevin Rudd’s CPRS, foreshadows the significance of the pivotal 2013 election these two prominent Australian politicians will eventually engage in. Additionally, as a primary role player in Rudd’s decision to postpone development of an Australian emissions trading system, Tony Abbot contributed to the early stages of the Australian government’s deteriorating reputation regarding climate change.

Kevin Rudd’s decision to sideline his CPRS severely damaged his credibility and political support for his advances. Facing criticism that this decision had “contributed to the curtailment of [his] premiership and confirmed climate change as one of the most toxic issues in Australian politics." (Jordan, Rüdiger K.W. Wurzel & Anthony R. Zito, (2013), Rudd opted to resign from his position as leader of the Labor party, having caught wind that his deputy Prime Minister, Julia Gillard, was preparing for an internal party challenge. On June 24th of 2010, Julia Gillard, replaced Rudd as Prime Minister, with a plan to deliver on an Australian emissions trading system and promising the Australian citizens she would not institute a carbon tax. ("Yes, I Vowed No Carbon," 2011) To the disappointment of both her supporter and her dissenters, Gillard's plan for an emissions trading system included an opening phase that did not uphold her promise.

In November 2011, Gillard's government passed legislation in which "a carbon tax would begin in July 2012, before the nation moved to an emissions trading scheme in three to five years" (Taylor, 2011). Indications of opposition to the carbon tax were apparent early, as results of a public poll revealed, "48 per cent of those surveyed were opposed to the carbon price, 35 per cent supported it, and 18 per cent were undecided" (Taylor, 2011). Despite this wavering support from the public, the carbon tax came into effect in July 2012. Surrounding the time of its implementation, indications of further declining support for the tax showed as another assessment "said support for the tax was at its lowest since it was announced 15 months ago, falling 4% in the last month to 33%" ("Australian PM Gillard Defends," 2012). Determination of the effectiveness of this tax is key to assessing Australian climate policy and the approaches made to dealing with it by the politicians involved. The success or failure of this policy will be discussed in detail in the following section, where a cost-benefit analysis of the effect of the tax on Australia's economy will be assessed. Prior to beginning this assessment, an understanding of why the election between labor party leader Kevin Rudd and liberal party leader Tony Abbott was a key moment in Australian climate policy is necessary.

During her time in office, Julia Gillard's popularity declined as she faced increasing criticism for going back on her word on climate policy and as Kevin Rudd's legacy haunted her. Consistently polling behind both Kevin Rudd and the Liberal opposition, Julia Gillard acted unprecedentedly to spite her critics and scheduled a national election for September 14th, 2014, feeling that her position as Prime Minister needed to either end or become more solidified by a victory (Associated Free Press, 2013). Leading up to this election, a resurgence of support for Kevin Rudd allowed him to successfully reclaim helm of the Labor party by defeating Julia Gillard in a party leadership ballot with 57 votes to her 45 (Pearlman, 2013). This victory positioned Rudd to face Liberal opposition leader, Tony Abbot, in the highly anticipated national election.

As mentioned at the outset of this political timeline development, the national election between Kevin Rudd and Tony Abbott played a significant role in Australia's ongoing interactions with climate change. Tony Abbott's defeat of Kevin Rudd had immediate and foreseeable repercussions as it indicated a new chapter in Australian leadership regarding climate policy. Abbot immediately targeted Gillard's carbon tax legislation upon entering office, effectively fulfilling a campaign promise that repealing the carbon tax would be his first official act as Prime Minister ("Australia Carbon Tax: Abbott," 2013). Abbot's explanation for the repeal, and the area of most criticism for the carbon tax, was that the legislation "will cause a large economic contraction, high unemployment, higher electricity prices and the demise of the coal industry" (Meng, Sirwardana, & McNeil, 2014). In the following section of this paper, details of the carbon tax are addressed as a preface to a cost benefit analysis of its effectiveness.

In 2011, the Australian government announced that it will be "pricing carbon by introducing a carbon tax from July 1st 2012 with a view to transforming the policy to a market-based emissions trading scheme in three to five years time from its introduction" (Meng, Sirwardana, & McNeil, 2014). The Australian carbon tax priced a ton of carbon dioxide emissions at 23$ per ton in the first year of its implementation then moved to a higher price of 24.15 dollars from 2013-14 (Robson, 2014, p. 2). Unlike the EU ETS, the companies that were subject to the Australian carbon tax were determined by the amount of emissions they released rather than majorly which industry they belonged to. Under the tax, "facilities that emitted more than 25,000 tons of carbon dioxide equivalent annually during 2012-13 or 2013-14 were directly liable" (Repeal of the Carbon, n.d.), totaling about 370 Australian businesses. Although the cap and trade phases of the carbon tax were never realized, it is important to note that in the long term, the Australian government expected, "slightly less than half of the expected CO2-e abatement in the period to 2050 [would] occur as a result of domestic reductions in emissions, with the most abatement being sourced from purchases of overseas permits" (Robson 2014, p. 3) As mentioned earlier, the major criticism of the carbon tax was that it drove electricity prices up and contracted the economy. Beginning with an explanation of the factors involved in the cost-benefit analysis, the following section will attempt to address these criticisms.

4. Cost-Benefit Analysis

In this section, an attempt will be made to judge the efficacy of the Australian carbon tax. This tax, which had only been in place for two years before being repealed, provides valuable insights pertaining to the construction of climate policy to reduce emissions. The following cost-benefit analysis will serve as a proxy for assessing the effectiveness of the tax. Moreover, a cost-benefit analysis will support or detract from Liberal party Prime Minister Tony Abbott's decision to repeal the carbon tax. It is important to note that the following analysis is highly simplified and is, therefore, only a best estimate of the tax effectiveness. This analysis is preceded by details regarding the approach and variables used in calculating the benefit and cost sides. Foremost is an explanation of how this analysis uses two variables to calculate the benefit of emissions reductions during the carbon tax period.

4.1. Benefit

The two variables utilized in this cost-benefit analysis are changes in Australia's emissions levels and estimates of the social cost of carbon (hereafter, SCC). The equation below depicts the method by which benefits are calculated in this analysis, where E1 equals annual emissions the year before the carbon tax period and E2 equals annual emissions during the last year of the carbon tax period.

$$\textbf{Benefit} = (\textbf{E1} - \textbf{E2}) * \textbf{SCC}$$

Essentially, the equation asserts that the benefits of the carbon tax are equal to the change in annual emissions during the life of the program multiplied by the social cost of carbon.

4.1.1. Emissions Data

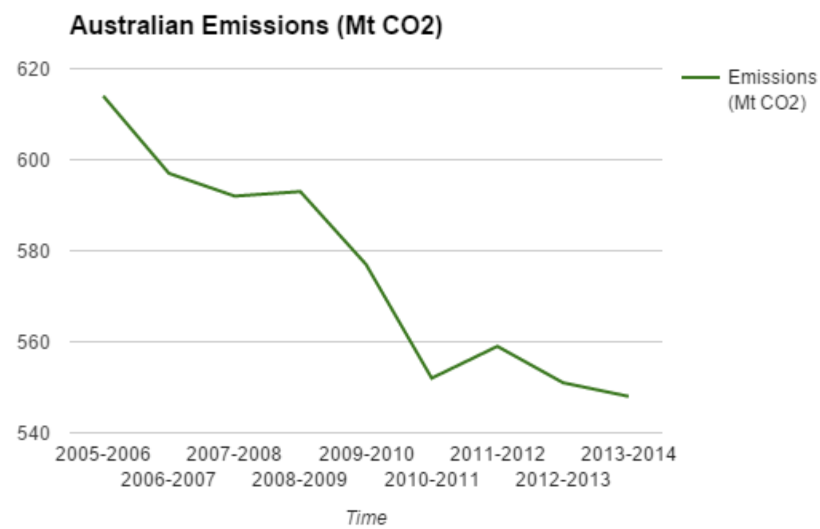
The first proxy variable necessary for estimating the benefits portion of the cost-benefit analysis in this paper is Australian emissions data. Referencing emissions data for Australia, which was retrieved from the Australian Government's Department of the Environment database, allows an opportunity to assess the effect of the carbon tax on Australia's emissions levels. As can be seen in Figure 2 and 3, Australia's carbon tax undeniably played a role in emissions reductions during its lifetime. In the year before the carbon tax was implemented, 2011-2012, annual emissions totaled 559 million tons (Mt) of carbon dioxide. Two years later, in the year 2013-2014, the year before the carbon tax was repealed, annual emissions totaled 548 Mt of carbon dioxide. Therefore, the change in quantity of emissions between the beginning of the tax period and the end was -11 Mt of carbon dioxide. This number will be integral in reaching the final results of this analysis when coupled with the second proxy variable used in calculating benefits, the social cost of carbon.

Figure 2: Emissions Data (Mt of CO2)

Year	Emissions
2005-2006	614
2006-2007	597
2007-2008	592
2008-2009	593
2009-2010	577
2010-2011	552
2011-2012	559
2012-2013	551
2013-2014	548

Source: (Australia's Abatement Task, 2015)

Figure 3: Emissions Trend (Mt of CO2)



Source: (Australia's Abatement Task, 2015)

4.1.2. Social Cost of Carbon

The second proxy variable utilized in the following cost-benefit analysis is a device that converts emissions reductions into a monetary value. In economic literature, this value is labeled the social cost of carbon. In relation to examining global warming, the SCC is a useful tool for intrinsic reasons. Specifically, the SCC is particularly useful due to the large percentage (77%) of global emissions produced by the burning of carbon ("Global Greenhouse Gas Emissions," 203). Measured in dollars per ton of carbon emissions, the SCC is best defined as the "[monetization of] damages associated with an incremental increase in carbon emission, intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services" (Greenstone, Kopstis, & Wolverton, 2011). It follows that the SCC serves as a monetary estimate of the extent to which greenhouse gases are causing damage to the economy and the Earth's ability to sustain itself. While solely an estimation, valuations of the social cost of carbon are most often used to assist policy makers in calculating optimal emissions tax levels. The cost benefit analysis developed within this section uses the SCC differently. Here, the SCC, along with emissions measurements, will be used in calculating the benefits of emissions reductions made during the Australian carbon tax's two-year lifespan.

Inherent in any attempt to forecast the impacts of events occurring today into the future is a significant amount of uncertainty. Due to "small and not-so-small differences in the structural assumptions and the underlying studies used for parameter calibrations"(Marten and Newbold), a large variety of SCC estimations have been produced ranging from very low values to dangerously high values. This analysis utilizes eight SCC estimates derived using integrated assessment models (IAMs). IAMs aim to accurately combine "scientific and socio-economic aspects of climate change primarily for the purpose of assessing policy options for climate change control" (Kelly & Kolstad). These eight estimates were derived by two sources, the U.S. interagency working group on the social cost of carbon and a published scholarly article. Following is an overview of the sources that developed the estimations used in this analysis, the values that they produced and the processes by which they constructed the calculations.

4.1.3. SCC Estimates

The first set of SCC estimates used in this analysis were developed by the United States government's interagency working group on the social cost of carbon (hereafter USIWG), a task force composed of twelve United States government agencies with the primary purpose of producing SCC estimates. Since its foundation, the USIWG has produced two published documents, titled technical support documents, that present their SCC estimates (The Social Cost of Carbon," n.d.). The first technical support document was released in February 2010 and was followed by a revised issuance in May 2013. For reference, a table containing SCC values from both issuances is provided below.

Figure 4: USIWG SCC Estimates ($/ton CO2)

February 2010	5.7	23.8	38.4	72.8
May 2013	11	37	57	109

Sources: (Technical Update of the Social, 2013), (Social Cost of Carbon, 2010)

At a glance, one can see that significant revisions occurred between the EPA's February 2010 SCC estimations and May 2013 SCC estimations. This can be explained most directly by factors such as time surpassed in between estimations, the constantly changing nature of this field and, most specifically, adjustments made to the model configurations used to produce the 2010 estimates (The Social Cost of Carbon," n.d.). It is for this reason that the SCC values used in calculating the benefits side of this analysis are taken from the most recent USIWG valuations produced in Figure 4.

The second source of SCC estimates used in this analysis were derived by economists Alex L. Marten and Stephen C. Newbold in their published article, "Estimating the social cost of non-CO2 GHG emissions: Methane and nitrous oxide". The assessment developed by Marten and Newbold provides a valuable perspective because rather than placing its focus on solely estimating the SCC, the article attempts to estimate the social costs of two other key greenhouse gases, methane and nitrous oxide, as well. Marten and Newbold's attempt to calculate social cost is founded: methane and nitrous oxide global release rates are second and third highest at 14% and 8%

respectively. In order to account for methane and nitrous oxide, Marten and Newbold completed their assessment by altering the USIWG models slightly.

Leaving a majority of the key aspects in tact, Marten and Newbold adjusted the USIWG model to account for the fact that "the standard version of the model includes an explicit representation of stocks and flows of carbon dioxide in the atmosphere, but other GHGS are represented only implicitly in a catch-all 'exogenous forcing' variable" (Marten and Newbold 960). The values produced within Marten and Newbold's calculations, which can be found in Figure 5, are intended to isolate this 'exogenous forcing' variable in support of their efforts to estimate the social costs of methane and nitrous oxide. Although the cost-benefit analysis within this paper will not incorporate the costs and benefits of a decrease in methane or nitrous oxide emissions during the

Figure 5: Marten/Newbold SCC estimates

Marten/Newbold's SCC estimates	9.4	33	52	14

(Marten & Newbold, 2012)

carbon tax period, the context under which Marten and Newbold's SCC estimates are produced justifies their use as a valuable contrast to those of the USIWG.

With an understanding of how the benefits side of this analysis is calculated, it follows that an explanation of how the costs side is calculated is necessary. Similar to the benefits calculation, there are two variables used to calculate the costs side of this analysis. These variables and their sources are discussed in more detail below.

4.2. Cost

The two variables utilized in calculating costs of the carbon tax are Australian electricity prices and quantity of electricity consumed in 2014. The equation for calculating cost using these two variables is displayed below. Here, Q represents Australian electricity consumption in 2014 while P1 and P2 equal the price of electricity

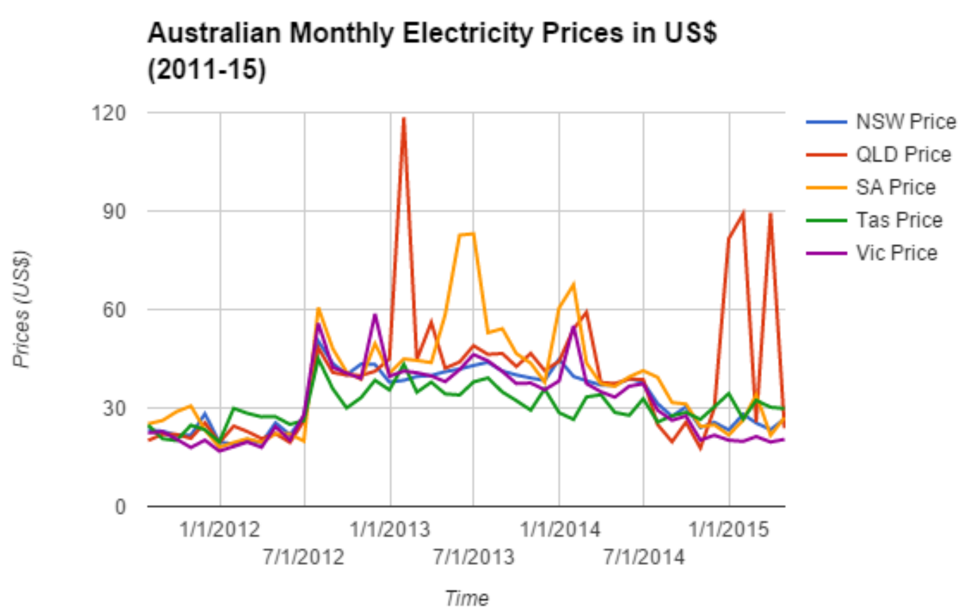
Costs = Q * (P2 - P1)

electricity the year before the carbon tax repeal and the last year of the carbon tax, respectively.

4.2.1. Variable 1: Electricity Price Data

The simple goal for calculating the costs of the Australian carbon tax in this analysis is to assess changes in electricity prices caused as a result of imposing the tax. In order to calculate these changes, this analysis uses Australian monthly electricity price data from five different states, which is displayed in Figure 6 below, from the Australian Energy Market Operator (hereafter, AEMO). The AEMO was created in 2009 by

Figure 6



("AEMO Average Price Tables," n.d.)

the Australian government to "strengthen the national character of energy market governance by drawing together under [AEMO,] the one operational framework responsibility for electricity and gas market functions" ("AEMO Average Price Tables," n.d.). By assessing changes in electricity prices from the period just before imposition of the Australia's carbon tax to its repeal in the context of the second factor of the costs calculations, one can draw conclusions regarding the economic impact of the carbon tax on Australia's families and businesses.

4.2.2. Electricity Consumption Data

The second proxy variable used in assessing the costs of the Australian carbon tax in this analysis is electricity consumption measurements. The source of electricity consumption data used to calculate costs of the carbon tax is the Energy Supply Association of Australia (ESAA). The ESAA hosts a consortium of members, including government owned corporations, within the Australian energy sector with the purpose of positively influencing development and maintenance of the Australian energy market and energy policy (CITE their website). In Table 6 below, Australian electricity consumption in 2015, measured in megawatt hours, across 5 Australian states is displayed. Although

Figure 7: Annual Electricity Consumption (Mwh)

State	NSW	QLD	SA	TAS	VIC
Consumption	66,308,900	43,689,700	12,849,100	10,098,600	43,440,900
Customers	3,535,719	2,064,283	836,365	278,756	2,663,871

("ESAA Policy & Research," n.d.)

data for the quantity of electricity consumed in each Australian state coupled with electricity price data within those states is sufficient for calculating costs of the carbon tax, accessing customer data from the ESAA as well allows for calculations of costs per customer and consumption per customer values. Data found in Figure 7 depicts the number of consumers in the Australian electricity markets to which we are concerned and will allow costs per customer calculations to be made. With an understanding of the

Figure 8: Customers (Quantity)

State	NSW	VIC	QLD	SA	TAS
Customers	3,535,719	2,663,871	2,064,283	836,365	278,756

("ESAA Policy & Research," n.d.)

variables utilized in this analysis and where they came from, the calculations and results of this cost-benefit analysis are expounded upon below.

4.3. Results

With emissions levels of 559 Mt of CO2 from 2011-2012 (E1) and emissions levels of 548 Mt of CO2 from 2013-2014 (E2), emissions reductions during the carbon tax period were 11 Mt of CO2. Use of emissions reductions during the carbon tax period along with multiple SCC estimates allows this analysis to produces eight different benefits estimates which are displayed in Figure 9. Figure 9 indicates that, given SCC estimates from the USIWG and Marten and

Figure 9: Benefits Estimations

	SCC Estimate ($/ton CO2)	Benefits (Million $)
USIWG	11	121
	37	407
	57	627
	109	1109
Marten and Newbold	9.4	103.4
	33	363
	52	572
	14	154

Newbold, the benefits of the carbon tax ranged from as low as 103.4 million dollars to as high as 1.109 billion dollars. The results of calculating the costs of the carbon tax, along with other reference data such as cost per customer and consumption per customer, are displayed in Figure 10.

Figure 10 reports that Australian electricity prices increased by an average of 17.78 US$ per megawatt hour between the year prior to the carbon tax and the last year of the tax. Consuming

Figure 10: Cost Estimations

	NSW	QLD	SA	TAS	VIC	Average (Total)
P1	22.55	22.09	23.01	24.76	20.73	22.62
P2	39.72	44.4	46.9	31.9	39.13	40.41
Price Change (P2 - P1)	17.17	22.31	23.89	7.14	18.4	17.78
Cost	1,138,417,719	974,542,448	306,923,881	72,144,398	799,295,183	658,264,726 (3,291,323,631)
Cost per Customer	321.98	472.1	366.98	258.8	300.05	343.98
Cons. per Customer	14.25	16.09	11.68	27.53	12.39	16.39

an average of 16.39 megawatt hours annually, Australian electricity consumers spent an average of 343.98 US$ more each year of the carbon tax period. Monthly, this equates to a premium of 28.67 US$ on electricity during this period. Additionally, as can be seen by comparing the calculations of Figure 9 to those of Figure 10, there is no scenario in which the benefits of the carbon tax outweighs the costs. Utilizing the EPA's SCC estimates and those of Marten and Newbold, this analysis produces benefits peaking at 1,138,417,719 US$ while costs estimations total 3,291,323,631 billion US$, or nearly three times that of benefits.

The sharp electricity price increases experienced throughout Australia during the lifespan of the carbon tax indicates that the tax had an immediately noticeable effect on Australia's electricity market. Although this connection is relatively clear upon referencing Figures 6, 9, and 10, it is vital that one recognizes the carbon tax as only one factor amongst many dictating price changes in the Australian electricity market. Nonetheless, the evidence of price changes during the carbon tax period coupled with the cost and benefits comparison of this analysis allows one to draw some rough conclusions about the effectiveness of the program. The low benefits estimations of this analysis compared with the significantly higher cost estimations suggest that the Australian carbon tax was too costly of a policy to the Australian public. According to the rough calculations of this analysis, Julia Gillard's carbon tax was not efficient in achieving emissions reductions and Australia's Liberal party led government's decision to repeal was the correct choice.

5. Conclusion

At its current pace, mankind will experience increasingly warm temperatures and other adverse effects of climate change in both the short and long term. Unfortunately, only a portion of the general public understands or appreciates the importance of keeping climate change at bay via emission reduction efforts. This lack of understanding and appreciation can be attributed to the long list of obstacles and costs associated with converting the world economy, which is fueled by greenhouse gas emitting processes, to a greener and more environmentally conscious future.

In this paper, an assessment of the efficiency of the Australian carbon tax in reducing emissions is made. The assessment, which produced cost values nearly three times higher than the largest estimation of the program's benefit, suggests that the Australian economy was not sufficiently compensated for significantly higher electricity prices experienced from 2012 to 2014. The conclusion reached by this assessment is a product of the variables used in calculating the cost and benefit values. With this in mind, the limitations these variables' ability to accurately deduce the impact of the carbon tax is relevant. In an effort to improve and expand this assessment, one should attempt to isolate the effects of the carbon tax on prices more precisely rather than associate all price changes with the implementation of the tax. Similarly, the production of more precise estimates of the social cost of carbon should be used in the future to improve the accuracy of all conclusions derived via their use.

Halting and reversing global warming effects will be a challenge faced by generations to come. The ability to accurately assess the cost and benefit of climate policies will be integral in driving the world economy toward a more sustainable and environmentally conscious future. As is the case in Australia, precise estimates of the cost and benefit of programs similar to the carbon tax will allow policy makers to confidently assess policies proposed to them. The result of these analyses will be the minimization of climate change and the damages imposed by it. Throughout this paper the importance of minimizing these effects is emphasized but the extent to which the world economy will be affected by global warming demands a more thorough analysis of the topic. In the future, researchers must continue to seek effective processes for judging the threat of climate change and the costs associated with it.

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