A CAP-AND-TRADE ROADMAP FOR CANADA: LESSONS LEARNED FROM INTERNATIONAL EXPERIENCES

by

JASON BROWN

A Thesis Submitted to the Faculty of Social and Applied Sciences
in Partial Fulfilment of the Requirements for the Degree of

MASTER OF ARTS

In

ENVIRONMENT AND MANAGEMENT

Royal Roads University
Victoria, British Columbia, Canada

Supervisor: CHARLES KRUSEKOPF
JULY, 2017

COMMITTEE APPROVAL

The members of Jason Brown's Thesis Committee certify that they have read the thesis titled A Cap-and-Trade Roadmap for Canada: Lessons Learned from International Experiences and recommend that it be accepted as fulfilling the thesis requirements for the Degree of MASTER OF ARTS in ENVIRONMENT AND MANAGEMENT

CHRIS LING [signature on file]

Final approval and acceptance of this thesis is contingent upon submission of the final copy of the thesis to Royal Roads University. The thesis supervisor confirms to have read this thesis and recommends that it be accepted as fulfilling the thesis requirements:

CHARLES KRUSEKOPF [signature on file]

Abstract

In the pursuit of reducing greenhouse gas (GHG) emissions through climate action planning policymakers have been establishing carbon pricing (Yamin, 2012). Through partnership with the Western Climate Initiative (WCI) the provinces of British Columbia (BC), Manitoba, Ontario, and Quebec initially agreed to align their climate action plans under a common framework (Western Climate Initiative, 2010). The WCI outlines a cap-and-trade system as the main form of carbon pricing, which will need to continue to operate in conjunction with existing carbon taxation (World Bank Group, 2016). In contrast to carbon taxes, cap-and-trade requires wider policy design considerations in order to be effective. The experiences of international implementations are analyzed through a scoping review methodology. The scoping study of policy design on environmental performance is then contrasted to existing narratives surrounding cap-and-trade policies. Recommendations are outlined, including avoiding the drawbacks of other cap-and-trade implementations, including cost pass-through, and encouraging research on successful hybridization of instruments.

Table of Contents

Chapter 1- Introduction

The release of greenhouse gases (GHG) into the atmosphere has been determined to be a significant cause of rising average global temperatures, and as such, governments have recognized the necessity of mitigating emissions and the associated temperature increases (UNFCCC, 2016b). Multiple methods of achieving reductions in emissions have been discussed and implemented, including both regulations and policy tools. Establishing a price on emissions has a main concern for policymakers pursuing the goal of controlling and mitigating greenhouse gas emissions and climate change (World Bank Group, 2016; Yamin, 2012). The Canadian federal position on establishing carbon prices is that the subnational regions should have flexibility regarding the method of carbon pricing, while adhering to the national emissions target (Government of Canada, 2016b). Through climate conferences and government designation, emissions targets have been established and carbon pricing tools have been gradually implemented on the sub-national level (World Bank Group, 2016). A predominant emission pricing mechanism in Canada is the cap-and-trade system, which has been established in Quebec, and is also being implemented in Ontario and Manitoba (World Bank Group, 2016).

Cap-and-Trade Systems

Cap-and-trade systems are an economic tool utilizing markets, which through the use of permit allocation and trading, are able to creative incentives for the reduction of emissions; under cap-and-trade regulation, emitters are required to purchase permits for their level of emissions above a set threshold, creating a financial incentive to innovate in order to reduce emissions and the associated cost of permits (Heinmiller, 2007; Yamin, 2012). The cap-and-trade model is an effective carbon pricing tool due to its ability to encourage both sustainability and economic efficiency, with a cap setting an upper-threshold for emissions, and trading which ensures that resource rights are allocated for the most valued purposes (Heinmiller, 2007). Additionally, cap-and-trade systems have widespread political support, with over half of the members of the Paris Climate Change Conference planning or considering using carbon markets (World Bank Group, 2016). Cap-and-trade systems have been considered the most effective way to reduce emissions by many, citing that economic theory and experience shows that trading can significantly reduce the cost of meeting an aggregate emissions target (Nordhaus & Boyer, 1999).

Program design. The primary target of a cap-and-trade program is to reduce GHG emissions; however, as opposed to the straight-forward nature of carbon taxes, cap-and-trade systems require more thorough policy consideration and design. There is a wide spectrum of cap-and-trade design considerations, and it is important to design the implementation effectively to meet emissions targets (Goulder & Schein, 2013; Heinmiller, 2007). Cap-and-trade systems are a relatively new economic tool, with the first major program targeting direct GHG launching in the European Union in 2005, and it is important to continue to learn from implementations as design choices are further researched (Boemare & Quirion, 2002). Evaluating the consequences of specific design decisions is beneficial to the implementation of newer programs, and as such the process of analyzing existing cap-and-trade implementations will be useful toward learning these lessons. Numerous instances exist of cap-and-trade programs, with unintended design issues which hinder their goal of emissions reductions (Boemare & Quirion, 2002). A scoping review of existing implementations will aid in evaluating the current narratives regarding carbon pricing instruments.

Western Climate Initiative (WCI)

The Western Climate Initiative (WCI) is a North American organization, in which member regions collaborate in order to develop and implement policy to mitigate climate change; seven U.S. States and four Canadian provinces created their Cap-and-Trade Program framework documentation, entitled *Design for the WCI Regional Program* (Western Climate Initiative, 2010). The framework documentation establishes program design recommendations based on documents and materials prepared by WCI teams and committees. A main goal of the WCI is to establish interlinked regional cap-and-trade systems. Additional goals of the collaboration are to reduce greenhouse gas emissions, promote energy efficient technologies, and decrease dependence on oil imports. The active members of WCI are currently British Columbia, California, Manitoba, Ontario, and Quebec; members are continuing to harmonize their policies regarding their emissions trading programs (Western Climate Initiative, 2016). Currently Quebec and California have established linked cap-and-trade programs, and Ontario has established program milestones to join the linked system (Ontario Ministry of Environment and Climate Change, 2016). Manitoba has indicated it is advancing towards a cap-and-trade program as well, to be initially limited to specific large emitters in the province (Government of Manitoba, 2015a, 2015b). Linkages between multiple programs and regions have been shown to create savings, and is thus seen to be beneficial (Goulder & Schein, 2013). Despite the thorough framework documentation established by the WCI, several years have passed since the design roadmap, and there is a gap of knowledge which needs to be addressed and integrated into updated design recommendations. It is the intention of this research to use a scoping review to analyze international experiences regarding carbon pricing programs, in order to determine the impacts of program design on environmental performance.

Research Question

Carbon taxes and cap-and-trade systems are the two main forms of carbon pricing, and are utilized throughout Canada on a sub-national basis (World Bank Group, 2016). Additional perspective on key design choices as well as current narratives regarding these instruments, especially cap-and-trade programs, will help shape the route toward strong environmental outcomes, in the pursuit of Canadian emission reductions. Based on the predominance of the Canadian use of the cap-and-trade system, as well as its associated flexibility and variation in design, it is especially important to review international experiences with its implementation. As Goulder and Schein state, "[t]he performance of the two approaches depends critically on specifics of design. Indeed, the design of the instrument may be as important as the choice between the two instruments" (Goulder & Schein, 2013, p. 2). The research question formed in order to provide insight on this topic is, "what are the impacts of cap-and-trade program design on environmental performance?"

The findings for this research question will provide insight toward the current issues, considerations, and recommendations for cap-and-trade program design in Canada.

Chapter 2- Research Context

United Nations Framework Convention on Climate Change (UNFCCC)

The UNFCCC is an international treaty, negotiated in 1992 at the Rio Earth Summit, and acts as a framework for cooperative efforts in mitigating climate change (United Nations, 1992). The UNFCCC was followed up with the creation of the Kyoto Protocol five years later, in an effort to bolster the impact of the framework (Newell, Pizer, & Raimi, 2012).

The Kyoto Protocol

The Kyoto Protocol is an international treaty, in which 192 parties, including 37 industrialized countries and the European Community, committed toward reducing emissions of GHG (Newell et al., 2012; UNFCCC, 2015a). The Kyoto Protocol was created in 1997, and was entered into force in 2005 (UNFCCC, 2015a). A main goal of the Kyoto Protocol was to design a global trading market for carbon permits, leading to the creation of three flexibility mechanisms. In addition to emissions trading (ET), the two international crediting mechanisms are Joint Implementation (JI) and the Clean Development Mechanism (CDM). JI allows for investments between Annex B countries, industrialized countries, for projects that reduce GHG emissions (UNFCCC, n.d.). CDM allows industrialized countries to invest in projects that reduce GHG emissions in developing countries instead of in their own country, and requires the project activities to specifically be hosted by the developing country (European Commission, 2015b). The basis of the creation of both of these international offsets is that no matter where GHG emissions are created, they have essentially the same effect on climate change consequences (Newell et al., 2012). While no single global carbon market has been established, both JI and CDM have partial utilization within several regional carbon markets (World Bank Group, 2016).

Paris Climate Change Conference

Concluding in December of 2015, the UNFCCC held the Paris Climate Change Conference (UNFCCC, 2016b). This conference, which was the most recent Conference of the Parties to the UNFCCC (COP), formed with the goal of mitigating climate change. The conference members established Intended Nationally Determined Contributions (INDC), setting specific climate change mitigating goals and strategies based on their own country's expected development; these INDCs are expected to provide the basis for future policy planning. The strategy of having countries set their own targets and carbon pricing is a key difference to that of the Kyoto Protocol, which attempted to establish a single global approach (Newell et al., 2012).

The Paris Agreement. The COP negotiated the Paris Agreement, which outlines a series of terms regarding climate change agreed upon by the conference members. The Paris Agreement specifies the limiting of global average temperatures through emission reductions, as well as the necessary policies to support these temperature goals (UNFCCC, 2016b, 2016c). In order to be entered into force, at least 55 members of COP, accounting for at least 55% of global GHG, must ratify the agreement (UNFCCC, 2016d). While the extent of ratification of INDCs and the Paris Agreement is yet to be seen, they do represent intended policy directions which will be informing implementation of carbon pricing into the future. Additionally, it is important to note that the Paris Agreement is a separate UNFCCC instrument from the Kyoto Protocol, and provides more flexibility due to the discretion of setting targets and with emission pricing being left to each individual country (UNFCCC, 2016d). As of November 4, 2016, enough parties had accepted or ratified the agreement, resulting in the agreement coming into force (UNFCCC, 2016a).

The Canadian government, as part of their INDC, has committed to reducing nation-wide GHG emissions to 30% below 2005 levels by 2030 (UNFCCC, 2015b). According to the most recent Canadian GHG inventories, the total GHG emissions in 2005 were 738 Mt, and in 2015, 722 Mt; this represents only a 2.2% decrease from 2005 levels (Government of Canada, 2017). This is an ambitious target, and it should be noted that past Canadian governments have failed to reach emission targets set for 2000, 2005, and 2010 (Jaccard, Hein, & Vass, 2016).

The Potential Efficacy of Cap-and-Trade Systems

Cap-and-trade systems have had successful implementations in the past, effectively reducing emissions generated in the operating region. An example of a long-term successful cap-and-trade system is the Acid Rain Program (ARP) created in the United States under the Clean Air Act in 1990 (United States Environmental Protection Agency, 2013). The ARP targeted coal-fired power plants with the goal of reducing SO_2 and NO_x emissions, which are the main causes of acid rain. The ARP was able to significantly reduce SO_2 and NO_x emissions, while electricity demand remained stable, indicating that the reductions in emissions were not due to decreased demand for electricity. In the span of time from 1990 to 2013, ARP emitters reduced annual emissions by 12.5 million tons, an 80 percent reduction. The incentives created by the cap-and-trade program were summarized by the United States Environmental Protection Agency (2013):

> These emission reductions represent an overall increase in the environmental efficiency of these sources as power generators installed controls, ran their controls year round,

switched to lower emitting fuels, or otherwise reduced their SO_2 and NO_x emissions while meeting the relatively steady electricity demand. (p. 11)

As is demonstrated by the ARP, cap-and-trade systems can create effective incentives in the pursuit of reducing emissions; however, it is important to note that due to the wide range of policy design choices, it is necessary to understand the trade-offs of each choice.

Carbon Pricing in Canada

Carbon pricing has had considerable momentum in Canada, but its implementation has varied widely between the provinces. With no prior federal stipulations on carbon pricing, the choices of design and implementation have, thus far, been up to the discretion of each province and territory (Government of Canada, 2016b). The federal government has announced plans to implement a minimum, revenue-neutral, carbon tax in any provinces which do not institute any form of carbon pricing; this tax would be designed to start at 10 CAD/tCO_2 in 2018, and gradually increase to 50 CAD/tCO_2 in 2022 (Drost, 2015). Among the Canadian regions participating in the WCI, Quebec, Ontario, and Manitoba have committed to WCI-based cap-and-trade programs, while British Columbia has implemented a carbon tax (World Bank Group, 2016). Alberta is the most recent region to implement a carbon tax, which initiated on January 1st, 2017 (Government of Alberta, n.d.).

It is important to note that it has been estimated that in order for Canada to reach its Paris commitment, without a significant change in regulations, there would need to be a nation-wide price on emissions of $200 by 2030 (Jaccard et al., 2016). This estimation provides a strong case for how urgent it is that Canada begin to increase momentum on emission reduction measures, including regulations, and shift the total effective price on carbon closer to this level.

WCI Program Design

While the WCI framework documentation is thorough, the implementation by participating regions has notable deficits. Additionally, program recommendations and implemented policies should be updated on a frequent basis in order to incorporate the research findings associated with recent emerging and maturing carbon markets. With Manitoba and Ontario establishing cap-and-trade programs, to be linked in partnership under the WCI, it will be beneficial to evaluate the policy implementation of WCI members, and juxtapose it to international experiences and academic research.

Chapter 3- Methodology

A scoping review methodology is used in this study to investigate the research question, "what are the impacts of program design on environmental performance?"

Definition

Scoping reviews are relatively new methodology, and are utilized to map broad topics; this methodology will provide an aggregation of reasoning and repercussions for policy design choices, as well as identify environmental outcomes, by creating a map of cap-and-trade programs (Dijkers, 2015; Pham et al., 2014). A scoping study seeks to identify all relevant literature regardless of the design of the included evidence and studies; identification requires multiple iterations to ensure a comprehensive discovery of relevant sources (Arksey & O'Malley, 2005). A scoping review can also be beneficial by being utilized to challenge an existing narrative regarding carbon pricing instruments (Dijkers, 2015; Levac, Colquhoun, & O'Brien, 2010). A scoping review is applicable to environmental management, and in particular carbon pricing due to the fact that there are a wide variety of cap-and-trade programs as well as a broad span of choices regarding possible program designs. Being able to aggregate information on this broad topic provides a chance to challenge existing narratives.

Debates. Due to the fact that the methodology is relatively new and increasing in popularity there are still several debates regarding standardizing a definition of scoping reviews (Colquhoun et al., 2014; Dijkers, 2015; Pham et al., 2014).

One debate is whether the literature on the topic should be systematically or non-systematically surveyed. Studies by Dijkers as well as Colquhoun et al. present scoping reviews as a type of information gathering characterized by systematically searching and selecting the knowledge; systematic reviews ask highly focused questions (Colquhoun et al., 2014; Dijkers, 2015). An article by Pham et al. as well as an article by Arksey and O'Malley present the information gathering as potentially non-systematic if a broad topic is addressed where multiple study designs are applicable (Arksey & O'Malley, 2005; Pham et al., 2014). Additionally, since systematic reviews are time consuming, there is a potential increase in the breadth of studies that can be analyzed by using a non-systematic approach (Arksey & O'Malley, 2005). This study will use a non-systematic survey in regard to the literature due to the fact that the research question is one with a wide scope.

Another debate is in regard to whether the weight or quality of the evidence of the studies reviewed should be discussed (Arksey & O'Malley, 2005; Dijkers, 2015). Ascertaining the weight of each point of evidence creates more depth, but is time-consuming and thus can detract from the overall breadth of the research (Arksey & O'Malley, 2005). The article by Arksey and O'Malley specifies that there is no ideal type of review, and that while a scoping study needs some analytic framework or thematic organization in order to present a narrative of available literature, it is not necessary to provide an assumption of weight or quality of the evidence (Arksey & O'Malley, 2005). This study will not specifically discuss the quality of the evidence of the studies, but will rather focus on organizing the sources based an analytic framework based on region.

A third debate is whether or not a narrative should be constructed based on the evidence presented in the included studies; this narrative information builds on a non-systematic review and contextualizes evidence in order make it more understandable (Arksey & O'Malley, 2005; Dijkers, 2015; Levac et al., 2010). This study will construct a narrative based on the evidence presented in the included studies, since it is non-systematic.

Contrasting methodologies. Scoping reviews will be contrasted with other methodologies that could have been applied in order highlight the advantages and disadvantages of using a scoping review.

Traditional literature review. This methodology shares a considerable amount in common with scoping reviews in that both provide a summary of a body of literature; however, it differs in that scoping reviews build narratives and focus on mapping key concepts of the literature (Arksey & O'Malley, 2005). In this study the key concepts are the policy design parameters, such as allowance allocation. Scoping reviews also require developing an analytical/thematic framework to construct coherent narratives (Levac et al., 2010).

Qualitative comparative analysis. This methodology would be used to identify aspects common to effective cap-and-trade programs, and then contrast them to less effective programs (Ragin, 2000, 2008, 2014; Rihoux & Ragin, 2009). There is a lack of positive cases, in which cap-and-trade programs have been implemented on a national scale, long-term, and provided strong positive results; thus, the ability to contrast positive cases to less effective cases would not be possible.

Single case study research. This methodology would have allowed for greater depth on a single case study, such as the European Union emissions trading scheme, the largest, rather than focusing on a wide breadth of programs; this is beneficial in providing in-depth analysis, but does not provide multiple sets of comparison, as a scoping review does (Arksey & O'Malley, 2005; Merriam, 1988; Yin, 2013). The wider span of programs provide identification of common issues of policy design and help form a narrative to examine (Arksey & O'Malley, 2005; Levac et al., 2010). Additionally with a single case study such as the European Union, a formed narrative could not be applied to Canada as it would not be as beneficial for developing and discussing broad narratives regarding program design.

Comparison summary. The use of a scoping review is a more interesting analysis than usual comparative methods such as literature reviews or single-case studies due to the ability to aggregate information on a broad topic, track reasoning behind design choices, and identify existing narratives.

Application of methodology

Methodological steps outlined by Arksey and O'Malley provide conduct guidance for scoping reviews; the first stage begins by identifying a research question (Arksey & O'Malley, 2005). The question in this study, is a broad, and seeks information about the impacts of cap-and-trade program design on environmental performance.

The second stage is to identify relevant studies (Arksey & O'Malley, 2005). In regard to this scoping review, identifying relevant studies was conducted by searching electronic databases, using reference listings, searching governmental documentation, and noting highly cited studies.

The third stage is the study selection (Arksey & O'Malley, 2005). In this scoping review the studies selected are those which fulfill at least one of three criteria, preferably more. The criteria are studies on cap-and-trade regions which have a large emissions coverage, a well-established program length, and demonstration of consistently impactful policy design.

The fourth stage is charting the data (Arksey & O'Malley, 2005). This scoping review collects data on the main policy design parameters for each selected cap-and-trade region. Graphs and diagrams are also used to provide concise comparisons of each program.

The fifth stage of scoping reviews is to collate, summarise, and report the results (Arksey & O'Malley, 2005). This scoping review collates data based on the region of the cap-and-trade system. Each region has a summary of details of the policy design choices, as well as relevant studies which provide more information on the region. All policy design choices of each region follow the same order in order to create consistency.

Document collection and analysis

This method of data gathering will provide significant data to inform subsequent discussion and recommendations due to the fact that the official planning and report documentation from governments, academic research, and relevant organizations provide the policy framework and results for each examined region. Each region is analyzed based on design parameters, such as permit allocation and sector inclusion, in order to identify program design choices. These design parameters will then be evaluated based on their impact on establishing a carbon price and the reduction for GHG emissions. The results will be used to evaluate current narratives regarding carbon pricing instruments.

Criteria for source selection. Primary sources used in the scoping review will be documents written by policy actors including government reports and reports by environmental non-governmental organizations. Secondary sources used will be documents written by observers and analysts including academic studies, newspaper reports, and energy exchange websites.

A practical consideration addressed in regard to document analysis is that official first-party documentation does not provide all of the necessary data; for example, reviewing academic studies gives more data on policy perspectives and unintended consequences of design. Due to the potential for information gaps on various policy parameters, supplemental data collection including related retrospective studies, will aid in providing a more complete analysis (Patton, 1999). A second practical consideration is that there may be some contradicting information between retrospective studies; it is important to review multiple regions and academic evaluations in order to examine whether there are established patterns of negative consequences, and also identify situations in which a policy does not always result in a specific outcome (Patton, 1999).

International experiences. The scoping review is categorized by region in order to analyze the policy choices of each program of relevance. Regions, for the purpose of this research, are selected based on the extent of emissions coverage, established program length, and demonstration of significant environmental impact. Each region will be analyzed to form an understanding of its initial policy framework, how the program was implemented, and the results of the program in their regional context.

Chapter 4- Scoping Review

The review of relevant international experiences and academic studies will provide a comprehensive understanding of the current knowledge and flaws regarding policy design, and as such will provide a basis to evaluate the efficacy of the existing WCI programs.

European Union Emissions Trading System (EU ETS)

The EU ETS is the world's first large-scale emissions trading program, covering 15 countries at first implementation of phase I in 2005 (European Commission, 2015b). The EU ETS provides the most comprehensive review of policy designs and consequences, as it not only has the largest emissions coverage in operation, but also has the longest length of operation among major CO_2 markets (World Bank Group, 2016).

Operational phases. The EU ETS has had three phases, with each phase having a longer trading period. Phase I began with coverage of power stations and industrial installations, with emissions thresholds varying depending on type of operation (European Commission, 2015b). Phase II began in 2008, with aviation being added as a covered sector in 2012. Phrase III began in 2013, with an intended trading period scheduled to conclude in 2020 (European Commission, 2015b). Phase IV is scheduled to begin in 2021, concluding in 2030 (ICAP, 2016; World Bank Group, 2016). The EU ETS has extended its participation during its operation, and as of phase III consists of 31 countries, accounting for approximately 45% of GHG emissions, and the sectors of power, industry, and aviation (ICAP, 2016).

Carbon price. As of July 10 2017, the auction settlement price was $6.27 USD/ tCO2 (European Energy Exchange, 2017).

Emissions coverage. As of October 2016, GHG emissions coverage from the cap-and-trade program is approximately at 45% (World Bank Group, 2016).

Policy design. As the first major cap-and-trade system, it is no surprise that there were several issues associated with the policy design of the EU ETS. Until the implementation of this program, there had been a limited extent of practical application of the underlying economic theories. The phased design of the EU ETS has gradually increased sector coverage and as a pioneering program, has uncovered important design lessons in the process.

Trading periods. The European Commission (2015c) conducted several reviews with the goal of increasing predictability of prices. It was determined that a trading period, also known as a phase, is viewed as a span of regulatory stability, and as such, a span of predictability. Upon review of the effects of trading period length on predictability and market certainty, it was determined that longer trading periods were beneficial. Longer trading periods are able to create clearer analyst forecasting in regard to prices, as well as providing operators planning flexibility for clean technology investment and emission reduction measures. While longer trading periods have been determined as beneficial for multiple reasons, there is also academic criticism that longer trading periods, in conjunction with banking rules, can reduce the certainty of reduction outcomes for specific years; this is based on emission reduction measures potentially being delayed until the latter stages of a trading period (European Commission, 2015c).

Allowance allocation. Phase I had close to 100% free allocation of allowances, using the method of grandfathering, which is allowance allocation based on historic GHG emissions(ICAP, 2016; World Bank Group, 2016). Phase II operated in a method similar to phase I, with mostly free allocation, and only 3% of total allowances being derived from auctioning (ICAP, 2016). Phase III, beginning in 2013, is the first phase with considerable use of auctioning; phase III utilizes auctioning for approximately 40% of total allowance allocation (ICAP, 2016). Due to the fact that the EU ETS is a multinational program, there are additional circumstances to consider, one of which being the impact on member states with low GDP per capita. The member-states with a lower GDP per capita in 2013, below 60% of the average, have been given permission to continue to use free allocation for the energy sector, in order to help fund modernization (European Commission, 2015e).

Over-allocation. The aggregation of several designs flaws of the program resulted in a dramatic carbon price drop during phase I in 2007, in which carbon prices dropped from 30 Euro/tCO_2 to below 5 Euro/tCO_2 (Schopp, Acworth, Huppmann, & Neuhoff, 2015). Over-allocation occurred, in which more allowances were allocated than actual emissions were generated. There were multiple causes for this over-allocation, including bottom-up allocation issues, an excess of international offset credits, and a general reduction in emissions due to economic downturn (European Commission, 2015c; Schopp et al., 2015). With a lack of a price stabilizing mechanism, each problem would need to be addressed in order to provide an effective price signal. A main cause for the over-allocation of allowances was the design of the allocation system, using a bottom-up approach, each member-state was given the discretion of assigning their own allowance caps within their regions (Grubb, Azar, & Persson, 2005). In phase III, 2013, this design shifted, and the EU ETS adopted an EU-wide allowance cap in order to establish more controlled allocation (European Commission, 2015c). Another reason for the over-allocation of allowances can be considered to be the result of improper measurement; the emissions data from which the allowances were measured and allocated were potentially inaccurate. Over-allocation continued to be such an issue, that the EU ETS introduced provisions such as back-loading of allowances in order to attempt to alleviate an excessive supply of permits (European Commission, 2012). Back-loading is a policy in which the auctioning of a certain amount of allowances is postponed until a future date (ICAP, 2016). The European Commission (2012) highlights the extent of the supply-side issue, by mentioning in their own report that the effects of the surplus will be felt up-to and beyond 2020.

Free allocation. The use of grandfathering as a method of free allocation has been a concern in the operation of the EU ETS. Grandfathering, allowance allocation based on historical GHG emissions, has been criticized as creating several detrimental effects; grandfathering rewards inefficient industries and punishes emitters who have already innovated, since it uses historical GHG as a baseline (Clò, 2010; Woerdman, Arcuri, & Clò, 2008). There is considerable academic support in favour of using benchmarking rather than grandfathering as a method of free allocation, as it bases allowances on sector averages rather than individual history (Groenenberg & Blok, 2002). Benchmarking was originally deemed impractical for the EU ETS based on the heterogeneity of emitters, as even within one sector there are varying product types and processes used (Ellerman & Buchner, 2007). The exception within the EU ETS were the cases in which there were no historical GHG emissions for an emitter, and as such benchmarking had to be used (Ellerman & Buchner, 2007). Many cap-and-trade programs implemented after the EU ETS have switched to benchmarked free allocation, supporting that it is in fact practical with proper evaluation of sub-sector differences (World Bank Group, 2016). Recently, the policymakers behind the EU ETS decided that due to positive results with benchmark-based free allocation, that when free allocation is preferable, it would be used further. Additionally, benchmark values will be updated twice in the period spanning 2021-2030; updating benchmarks help reflect technological advancement over time, and continues to encourage innovation (ICAP, 2016; World Bank Group, 2016).

Free allocation has been criticized as unintentionally creating windfall profits, in particular in electricity production; emitters are able to pass on the opportunity cost of emissions into the electricity price (Sijm, Neuhoff, & Chen, 2006). It is estimated that free allocation rules have resulted in approximately one billion Euros in profit for receiving emitters (European Commission, 2015c). Additionally, cost pass-through is expected to continue through the duration of phase III (Bruyn, Markowska, & Nelissen, 2010).

The European Commission determined that industry was at considerable risk for carbon leakage, and as such, was included on the carbon leakage list. Industry was provided free allocation, under the assumption that it would not be able to pass-through the price to the consumer. Research has been conducted which shows that cost pass-through in industry has actually been occurring, to varying levels (Bruyn et al., 2010; European Commission, 2015d). Bruyn et al. (2010) provides three aspects determined "crucial for carbon costs not to be passed through into final product prices: (…) 1. Firms would base their pricing on the expenditures for allowances rather than the opportunity costs of allowances. 2. Firms would engage in average cost pricing rather than marginal cost pricing. 3. Firms are price takers instead of price setters." (Bruyn et al., 2010). Without all three of these conditions, carbon costs can be passed into the product price.

Allowance policy harmonization. The allowance caps of the first two phases were too high to effectively reduce emissions, as the allowance cap helps create scarcity, and subsequently the price signal, and incentives to innovate (European Commission, 2015c). Allowance caps in the EU ETS were originally designed using fractured policy, in the first two phases (2005-2012) member-states proposed their own individual allowance caps and allocation methodology, titled National Allocation Plans (NAPs); the total allowance cap for the EU was created by summing up the cap of each member-state (Olson, 2015). Phase III addressed the allocation issue by setting an EU-wide allocation cap and policy, in which the European Commission decides on the total allowance cap, and the method of allocation (European Commission, 2015b). The primary concern with using NAPs is that it potentially had the result of over-allocation of allowances, as member-states had differing procedures for developing their cap; additionally, there was inconsistency in the methodologies used for allocation for each member-state, leading to a possible distortion of incentives and competition (European Commission, 2015c).

Free allocation versus auctioning. In review of retrospective studies and empirical data of the first two trading phases, the European Commission determined that auctioning is the more desirable allocation method (European Commission, 2015c). A key component of the cost-effectiveness of auctioning, is that it avoids the administrative time and cost involved in assessing individual benchmarks and emitter-set allocation plans (European Commission, 2015c). The European Commission also found that auctioning avoids the problem of windfall profits, which have been associated with free allocation. Starting with phase III, auctioning was recommended as the default method of allocation, with auctions making up an average of 40% of total allowances, and 100% of allowances for the electricity sector (ICAP, 2016).

Compliance. The Dutch Emissions Authority (2015) found that the EU ETS creates unnecessary transaction costs due to complexity of compliance; the compliance and reporting systems of the EU ETS were found to have a lack of user-friendliness, clarity, and flexibility. Compliance forms were determined too extensive and complex, causing an unnecessary administrative burden for the emitters (Dutch Emissions Authority, 2015). Additionally, a study on the EU ETS found that transaction costs are comparatively high for smaller emitters, and lower quickly with emissions above a certain threshold; since installed capacities rather than actual emissions are used to determine EU ETS coverage, many small emitters are included, creating unintentional and unnecessary administrative costs (Heindl, 2012; World Bank Group, 2016).

Carbon leakage. The European Commission defines age as, "those sectors that may suffer a material competitive disadvantage against competitors located in areas outside the EU which do not have similar emission reduction commitments, which could in turn lead to an increase in greenhouse gas emissions" (European Commission, 2015c). A reduction in emissions from one region is only an effective reduction of emissions if it does not lead to an increase in emissions from another region (Clò, 2010).

In an attempt to protect sectors, which are potentially at risk of carbon leakage, the EU ETS implemented a policy of exemption from auctioning for industries potentially at risk from competition outside of the program jurisdiction. Critics suggest that exemption from auctioning is often detrimental due to overcompensation as it is not sufficiently based in economic data (Clò, 2010). A review of retrospective studies by the organizations, Ökoinstitut and Ecofys, determined that there is no clear indication of a connection between carbon price and a loss of international market share in EU industry (Ökoinstitut & Ecofys, 2013). There is considerable support for the concept that free allocation has been excessive and should be determined on a sub-sector level, with stronger criteria for exemption (Clò, 2010; Grubb et al., 2005). Supporting the criticism of the excessive free allocation, in preparation for phase IV the EU ETS policymakers have acknowledged the lack of evidence of losses from many sectors claiming carbon leakage; the European Commission is planning to produce a reduced list of sectors provided free allocation due to carbon leakage (European Commission, 2015c; World Bank Group, 2016). The European Commission (2015b) has committed to reassessing carbon leakage status every five years, and evaluating sub-sectors when they apply for inclusion on the carbon leakage list.

Free allocation is typically assigned to the power sector due to worries about the economic repercussions of more expensive electricity; however, research regarding the impact of energy prices found that even a 10% increase in the energy price difference between two regions would only increase imports by approximately .2% (Sato & Dechezleprêtre, 2015). This research predicts that even at a price level of 40–65 Euro/tCO_2, it would only increase Europe's imports from the rest of the world by less than 0.05% and decrease exports by 0.2%.

Offsets and Credits. Under the EU ETS, the trading mechanisms of JI and CDM have both been utilized, providing credits for EU ETS emitters which invest in emission reduction projects for developing countries (European Commission, 2015b)**.** In phase I, the EU ETS allowed an unlimited use of both credits, while in phase II the use of both associated credits were assigned percentage limits, based on the NAPs of each member-state (ICAP, 2016)**.** The use of offset credits during the first three phases of the EU ETS has been criticized as too high, that the extensive use of credits have resulted in a depression of the price on emissions with the EU itself (Koch, Fuss, Grosjean, & Edenhofer, 2014).

Auction revenue. As the allowance allocation method of the EU ETS shifts towards a greater percentage of auctioning, it also provides a greater source of potential funding for climate action programs. The European Commission established that at least 50% of auction revenues should be used for the purpose of climate action (European Commission, 2015c). Prior to this, member-states were given the flexibility of doing what they choose with auction revenues;

another example of a lack of harmonization between regions within the EU ETS during its first phases (Germanwatch, 2013).

After a considerable period of limited auctioning, in 2013, the auctioned over 40% of allowances; auctioning raised €3.6 billion in this timeframe, with approximately €3 billion slated to be used for mitigating climate change (European Commission, n.d.). The European Commission plans to increase auctioning to cover up to 57% of allowances through 2013-2020 (European Commission, n.d.).

Emissions reduction. While there has been a 10% reduction in emissions since the beginning of phase II, 2008, a major cause of these emissions reductions is likely to be associated with the concurrent economic crisis and recession (European Commission, 2012).

Price stabilizing mechanisms. As the longest-running major cap-and-trade system, the EU ETS has had several reviews of their policy design and inherent flaws in the system; the EU ETS has implemented numerous changes and additions to create a more robust and resilient carbon market. Unique program design, specifically policy tools not used by other programs, provide important lessons in creating more effective carbon markets.

Market Stability Reserve (MSR). In 2014, the European Commission proposed the implementation of a MSR in order to attempt to mitigate the negative impacts of allowance surpluses; the proposal of a MSR was then endorsed by the European Council (European Commission, 2015a, 2015c). The MSR is a stability mechanism which will regulate auction volumes, and is set to begin operating in 2019 (European Commission, 2015a). Price volatility has been one of the major flaws of the EU ETS policy design, as is demonstrated by the significant price drop in 2007 due to the excess of allowances, a supply-side failure. Supply-side issues are expected to persist in the near future, and as such, the MSR is expected to help stabilize auction levels, and subsequently carbon prices. The European Commission (2015b) has stated that it expects the MSR to contribute to increased emission prices, and improve the long-term effectiveness of the EU ETS. Despite the planned introduction of the MSR, the UK government has expressed concern that there is still an allowance oversupply issue, and as such, cancellation of a portion of the current surplus volume is necessary (Department of Energy & Climate Change, 2014).

The theory behind a MSR. A MSR operates by temporarily removing allowances from the market, mimicking the effect of private banking on allowances (Schopp et al., 2015). Allowances which would have been auctioned, are instead stored in the reserve, in the event of allowances reaching an upper-threshold; in the event that a lower threshold is reached, the allowances are then reintroduced from the reserve (Schopp et al., 2015). Additionally, there is academic support for the notion that utilizing stabilizing mechanisms reduces the inherent financial risk of holding allowances or derivatives (Bessembinder, 1992; Wang, 2001). The financial risk created by the surplus of allowances would be mitigated by the balancing effect of a MSR (Schopp et al., 2015).

Korean Emissions Trading Scheme (KETS)

The KETS implemented phase I of its cap-and-trade program in 2015, accounting for approximately 67.7% of national GHG emissions (ICAP, 2016; World Bank Group, 2016). As compared the EU ETS, this program is more comprehensive in its coverage of sectors and total

GHG emissions. The KETS applies to the sectors of power, industry, buildings, transport, domestic aviation, and waste, with only the exclusion of forestry.

Operational Phases. Phase I of KETS is operating over the span of 2015-2017, providing 100% free allocation of permits over this time, without auctioning (Park & Hong, 2014; World Bank Group, 2016). Phase II of KETS is scheduled to operate during 2018-2020, and will have 97% free allowances, with 3% auctioning. Phase III is scheduled to operate in 2021-2025 with approximately 90% free allowances, and 10% auctioning (ICAP, 2016). The design of KETS in regard to allowance allocation is significantly different than that of the EU ETS, as it has no plan to switch to an auction predominant method.

Carbon price. As of October 2016, the auction settlement price was approximately $15 USD/tCO2 (World Bank Group, 2016).

Emissions coverage. As of October 2016, GHG emissions coverage is at 68% (World Bank Group, 2016).

Policy design.

Allowance allocation. The KETS uses a bottom-up approach for allowance allocation, in which emitters choose the allocation method, and submit a proposal which undergoes review from academic and private sector experts; the allowance cap includes allowances which are allocated for indirect emissions (ICAP, 2016; World Bank Group, 2016). The methods of grandfathering and benchmarking are both available methods for proposal. This allocation approach is similar to that of the EU ETS in its first two phases, as it also utilized a bottom-up approach with emitter proposals. As this program is only recently implemented, the impact of its varying allocation methods on harmonization is a matter for review and debate.

During planning, emitters depicted that allocation levels were inadequate, mirroring the issues within the EU ETS in which member-states and emitters lobbied for as many allocations as possible; the KETS approach is much more cautious, equipped with the information that the lobbying for more allowances in the EU ETS helped result in a significant price drop when emissions were measured and declared (ICAP, 2016). This is an example of the benefits of reviewing the international lessons learned, previous mistakes can be avoided through comprehensive analysis of program implementation.

Offsets. The KETS has a policy design for the first two phases, which excludes external Kyoto Protocol emission units, focusing only on domestic offset options, and domestic CDM credits (Park & Hong, 2014). There is expected to be an increasing amount of offset projects within KETS, as the policymakers are aiming to allow a high level of flexibility reduction methods (Park & Hong, 2014). Following 2020, international units will be available to use for up to 10% of an emitter's surrender requirements (Park & Hong, 2014).

Compliance. Emitters are provided with market information on a regular basis, utilizing a market monitoring system. Additionally, KETS has established the 'ETS Consultative Body' which will be utilized to communicate and engage with stakeholders; this is a tool in order to incorporate a wide spectrum of stakeholder opinions (ICAP, 2016; World Bank Group, 2016).

Carbon leakage. Similar to other cap-and-trade programs, this program provides 100% free allocation to emission-intensive and trade-sensitive businesses (Park & Hong, 2014).

New Zealand Emissions Trading Scheme (NZ ETS)

The NZ ETS was implemented in 2008, originally limited to coverage of the forestry sector (New Zealand Government, 2016). In subsequent years, the NZ ETS expanded to coverage of most sectors, with the exception of pastoral agriculture, covering a total GHG emissions of approximately 52%. The NZ ETS is unique among carbon markets, in that it operates under annual trading periods, rather than multiple year periods (ICAP, 2016).

Carbon price. As of October 2016, the auction settlement price was approximately $12 USD/ tCO2 (World Bank Group, 2016).

Emissions coverage. As of October 2016, GHG emissions coverage is at 52% (World Bank Group, 2016).

Policy design.

Allowance allocation. The allowance allocation of the NZ ETS is based around emissions intensities and trade exposure. The program provides 90% free allocation for highly emissions-intensive and trade exposed activities, as well as 60% for moderate emissions-intensive and trade exposed activities (New Zealand Government, 2016). The NZ ETS introduced a fixed-price option as a transitional tool, in order to help emitters adjust to carbon pricing; this fixed-price option acts as a price ceiling (New Zealand Government, 2016).

Allowance cap. The NZ ETS has no set allowance cap, not wanting to set an upper threshold for emissions (ICAP, 2016).

Offsets. At implementation, the NZ ETS was designed with linkage to international credits, utilizing both JI and CDM as offset mechanisms (New Zealand Government, 2016). The use of international units was extensive, international units, CERs and ERUs, consisted of more than 95% of the units surrendered in 2014. The government announced that it would restrict the use of Kyoto Protocol units, and transition to a more domestic-focused system in 2015. The New Zealand Government announced it would reach the 2013-2020 emissions target under the Paris Agreement instead of the Kyoto Protocol. There were multiple reasons for this transition to domestic allowance units, including the considerable price difference between domestic and Kyoto protocol units. An additional reason for the switch to domestic allowance units is the flow of funds offshore due to the purchasing and surrendering of the international units.

Compliance. The New Zealand Government (2016) conducted interviews in order to determine the efficiency of the compliance process, and received mixed responses. Some emitters found that there was a general lack of information and clarity in the regulatory process. The trend found by the interviews was that the lack of information and clarity was mainly experienced by small emitters, as they lacked the resources to keep up to date with new and changing regulations.

Emissions reduction. According to phase 1 of the Kyoto Protocol, New Zealand had an emissions target at the baseline level of 1990 (Ministry for the Environment: New Zealand, n.d.). As of 2014, New Zealand has experienced a gross emissions increase of 23% since 1990, and a 1% increase since 2013 (Ministry for the Environment: New Zealand, 2016). Net emissions within New Zealand have actually met the Kyoto target, not due to the NZ ETS, but due to a 600,000-hectare reforestation, which was funded by private sources in the 1990s. This reforestation provided New Zealand with significant carbon sequestration, but it will face difficulty in meeting future emissions targets, as the forests are to be harvested (Ministry for the Environment: New Zealand, n.d.).

Tokyo Cap-and-Trade Program

While most cap-and-trade systems operate on larger levels, the Tokyo Cap-and-Trade Program is a municipal-based emissions trading system, covering only the Tokyo Metropolitan Area (Bureau of the Environment: Tokyo Metropolian Government, 2010). Larger scale programs are able to include coverage of direct emissions from power plants; however, the power plants supplying Tokyo are outside of the city, so this municipal program focuses solely on indirect emissions, created through consumption (Rudolph & Kawakatsu, 2012). The majority of consumption in the city originates from commercial office buildings, and as such building owners are targeted within Tokyo as they influence a large extent of the power consumption (Kreiser, Duff, Milne, & Ashiabor, 2013). As a result of the program's implementation, many building owners convinced tenants to switch to energy-saving choices including introducing lights-off times, led lighting, and low-energy computing.

Carbon price. As of October 2016, the auction settlement price was approximately $15 USD/tCO2 (World Bank Group, 2016).

Emissions coverage. As of October 2016, GHG emissions coverage is at 66% (World Bank Group, 2016).

Policy design.

Allowance allocation. The allowance allocation of this program uses the grandfathering method of free allocation (ICAP, 2016; World Bank Group, 2016). The program utilizes an absolute cap, which was set with the goal of achieving GHG emissions at 25% below 2000 amounts by 2020 (Bureau of the Environment: Tokyo Metropolian Government, 2010).

Offsets. The Tokyo Cap-and-Trade Program utilizes several types of offsets, for the purpose of providing flexibility, and extending policy effects to unregulated sectors and regions. The Tokyo Cap-and-Trade program allows credits from other Japanese regions to be used. This program does not use Kyoto Protocol based units (Bureau of the Environment: Tokyo Metropolian Government, 2010).

Compliance. In contrast to the compliance complexity of the EU ETS, the Tokyo Cap-and-Trade Program was designed with transparent and user-friendly compliance in mind (ICAP, 2016). The Tokyo Metropolitan Government used experiences based on international standards, but further strengthened their monitoring, reporting, and verification (MRV) guidelines by combining measuring and calculating emissions; their comprehensive MRV include the fact that, "[e]missions are calculated based on energy consumption measured by effective gauges and verified by energy bills" (Rudolph & Kawakatsu, 2012, p. 13). The program was designed with particular attention toward providing a clear understanding of new policies for businesses, including fostering awareness of mid and long term reduction targets. The program also provides targeted feedback, has an active help desk to answer questions, and holds annual seminars. Additionally, the Tokyo Metropolitan Government produces best-practice reports for compliance facilities and tenants, and discloses the names of the most efficient facilities, with how they achieved their efficiencies.

Emissions reduction. The Tokyo Cap-and-Trade Program managed to reduce emissions by 23% four years into the first compliance phase, as compared to the base year (ICAP, 2016). This emissions reduction is significant, and marks an effective set of policies, in contrast to the many of the issues, which emerged from the fractured policy of the EU ETS.

California Cap-and-Trade Program

The California Cap-and-Trade Program began operation in 2012, and became linked with Québec in 2014 (California Environmental Protection Agency, 2015). Since both regions are based on the WCI framework, they share many of the same design choices. This program has compliance periods of three years each, with phase III to begin in 2018.

California is proposing revisions to the cap-and-trade program, which would further increase the cost of GHG emissions beginning 2021 (Mcmahon & Mccarthy, 2017). This proposed new version of the program would increase the minimum cost of emissions to 20 USD/tCO_2, require linked markets to match their price on GHG emissions, and an adjustment tax on carbon-intensive imports at the border. This program also proposes raising the minimum cost to 60 USD/tCO_2 starting 2030 (Mcmahon & Mccarthy, 2017).

Carbon price. As of May 2017, the auction settlement price was $13.80 USD/tCO2 (Government of Québec, 2017)

Emissions coverage. Coverage started at 35% in 2015, and has increased to 85% (World Bank Group, 2016).

Policy design.

Allowance allocation. This program assigns allowances based on benchmarks for each sector (ICAP, 2016; World Bank Group, 2016). Banking of allowances is allowed in this program, in order to provide emitter safeguards against price volatility and shortages (California Environmental Protection Agency, 2015). The majority of industrial allocation is through free allowances, based on the sector being perceived as being vulnerable to carbon leakage (ICAP, 2016; World Bank Group, 2016).

Allowance cap. In 2013 the allocation cap was set at approximately 2 percent below the emissions level forecast for 2012, declined at 2 percent in 2014, and is set to decline at a rate of 3 percent up to and including 2020 (California Environmental Protection Agency, 2015). There is no allowance cap set on industrial allocation (ICAP, 2016).

Offsets. This program does not use Kyoto units for offsets; only domestic offsets are utilized within this program, and each emitter is limited to use up to 8% towards their surrender obligation (California Environmental Protection Agency, 2015). ***Auction revenue.*** The auction revenue derived from the program is used to invest in GHG reductions in the sectors with the highest emissions (Institute for Climate Economics, 2015). The program also operates on the rule that at least 25% of the auction revenues must serve disadvantaged communities (Institute for Climate Economics, 2015). The California cap-and-trade program utilizes multi-year planning as well as conservative revenue estimation, in order to hedge against the variability of auction revenue (Institute for Climate Economics, 2015).

Emissions reduction. According to GHG emissions inventories, total emissions as well as emissions per unit GDP have been decreasing in California since the implementation of the cap-and-trade program (California Environmental Protection Agency, 2016).

Québec Cap-and-Trade System

The Québec Cap-and-Trade System began operation in 2013, and became linked with California in 2014 (ICAP, 2016; World Bank Group, 2016). Phase I operated during 2013-2014, and exclusively covered the electricity industry. Phase II and III extended sector coverage to include the fuel importation and distribution used in the sectors of building and transport, as well as small and medium sized businesses (ICAP, 2016; World Bank Group, 2016).

Carbon price. As of May 2017, the auction settlement price was $13.80 USD/tCO2 (Government of Québec, 2017)

Emissions coverage. Coverage started at 30% in 2015, and has increased to 85% (World Bank Group, 2016).

Policy design.

Allowance allocation. The Québec Cap-and-Trade System uses 100% auctioning of allowances as the allocation method for fuel distribution and electricity (ICAP, 2016; World Bank Group, 2016). This allocation method, as retrospective analysis of the EU ETS relates, is both cost-effective, and able to avoid the issue of windfalls and unintentional incentives created by methods of free allocation. Free allocation is set to be reduced by 1-2% annually (ICAP, 2016).

Allowance cap. The program is based on rigorous protocols utilized by the province, with mandatory emissions reporting, and verification using ISO standards which helps enact an effective allowance cap (Government of Québec, 2015b).

Offsets. Only domestic offsets are utilized within this program, and each emitter is limited to use up to 8% towards their surrender obligation (ICAP, 2016). This program does not use Kyoto units for offsets.

Carbon leakage. In this program industry is generally considered at risk and is provided a portion of allowances through free allocation (ICAP, 2016).

Compliance. Administrative costs have been considered more important than expected by some entities having to comply within the cap-and-trade program (Lachapelle, Papy, Pineau, & Trudeau, 2017); this implies a possibility of necessary improvements in cost reducing measures such as streamlining or automation.

Auction revenue. The auction revenues generated by the Québec Cap-and-Trade System are sent to the Québec Green Fund. The Québec Green Fund fights climate change, using the strategy outlined in the Climate Action Plan; projects under the Climate Action Plan include (Government of Québec, 2012). Québec, as of November 2016, has held thirteen auctions, and generated a total of $1.42 billion CAD, which has been paid to the province’s Green Fund (Government of Québec, 2017).

Ontario Cap-and-Trade

After a review process, the Government of Ontario decided to implement a cap-and-trade system as the basis for its carbon pricing (Government of Ontario, 2016a). The Ontario cap-and-trade program officially started on January 1st, 2017, with significant exemptions slotted for the first four years.

Ontario is scheduled to join the linked auction market with Québec and California in 2018 (California Air Resources Board, 2016b).

Carbon price. As of June 2017, the auction settlement price was $18.30 CAD/tCO2 (Government of Ontario, 2017)

Emissions coverage. As of October 2016, GHG emissions coverage is at 82%. (World Bank Group, 2016).

Policy design.

Allowance allocation. In order to gradually transition the economy into the cap-and-trade system, numerous exemptions will be made initially, with significant free allowances allocated at the beginning (Government of Ontario, 2016a).

Allowance cap. Similar to other cap-and-trade programs, the allowance cap is set to reduce each year, with the intention of reducing emissions incrementally on an annual basis (Government of Ontario, 2016b).

Offsets. The Government of Ontario is considering to allow emission offsets in uncapped sectors including agriculture and forestry (Government of Ontario, 2016a).

Auction Revenue. The Government of Ontario anticipates raising $1.9 billion per year from auction revenue, although it too will be subject to variability dependent on the volume of allowances which are sold through the quarterly auctions (Government of Ontario, 2016b). The intention is that all the revenue generated from the auctions will be invested into green projects, which aim to help families and businesses; the goal is for these projects to create jobs, improve energy-efficiency, and help transition Ontario to a low-carbon economy (Government of Ontario, 2016a).

WCI Joint Auctions

The WCI joint auctions, the primary allowance market, began on November 25, 2014, with the auction of current vintage allowances, and a portion of future vintage allowances, set three years into the future (California Air Resources Board, 2016a, 2017c). According to a report on the joint cap-and-trade auctions between Québec and California, they have been successful, selling all current vintage allowances on auction during the first five joint auctions, and nearly all in the sixth joint auction (California Air Resources Board, 2016a). Following initial successes, Auctions 7 and 8 only resulted in 11% and 35% allowances sold respectively. These low auction volumes in the primary allowance market were the result of lower secondary market prices and political uncertainty regarding a Californian lawsuit over carbon pricing; the secondary market is where previously allocated allowances are traded by their owners (California Air Resources Board, 2012; McCarthy, 2016).

The result of the weak sales within auctions 7 and 8 created a revenue shortfall compared to projections from the two regions (California Air Resources Board, 2016a). Auction prices rose closer to initial levels in Auction 9, with 88% of available current vintage allowances being sold. In auction 10, in February 2017, the percentage of units sold once again fell, reaching only 18% (California Air Resources Board, 2017a). Auction 11, in May 2017, sold 100% of current vintage allowances, and 22% of the advance 2020 vintage allowances (California Air Resources

Board, 2017b). Auction allowance sales have proven to be unpredictable, as demonstrated by considerable fluctuations in these percentages sold.

Occasional low allowance sales result in a reduction in funding for climate action, depicting the need to incorporate flexible budgets into the use of revenues. As of May 2017, the auction settlement price was $18.82 CAD (Government of Québec, 2017).

Once Ontario joins the joint carbon market, the WCI partnership will cover a population of 62 million, and a GDP of over 3.7 trillion CAD (Government of Québec, 2016). Despite the limited coverage of Manitoba's proposed program, the WCI cap-and-trade system is flexible, and as such allows for a limited linkage, allowing Manitoba to join future auctions (Government of Québec, 2016).

If California implements its new proposed, more aggressive, cap-and-trade program, Quebec and Ontario will have to agree to the higher minimum allowance costs by 2021 in order to pursue a continuation of cap-and-trade program linkage (Mcmahon & Mccarthy, 2017).

Price stabilizing mechanisms. Both the California Cap-and-Trade Program and the Québec Cap-and-Trade System set a price floor as a stabilizing mechanism within the joint auctioning system. The price floor per GHG emission was set in 2012 at $10 CAD, and increases each year at a rate of 5% plus inflation; the minimum price for bids being the higher of the California and Québec minimums, based on the exchange rate (Government of Québec, 2014).

Auction reserve floor. The WCI programs of California and Québec have a price management tool, a price reserve floor, which increases by 5% annually (ICAP, 2016; World Bank Group, 2016).

Allowance price containment reserve. A price containment reserve is utilized by California and Québec, which effectively acts as a price ceiling, and also increases at a rate of 5% annually (Government of Québec, 2014).

Regional Greenhouse Gas Initiative (RGGI)

The RGGI is the first market-based program in the United States, initiated in 2009, and is participated in by nine states (RGGI, 2017).

Carbon price. The carbon price fluctuates regularly, and as of June 2016, the auction settlement price was $2.53 USD/tCO2 (RGGI, 2017).

Emissions coverage. As of October 2016, GHG emissions coverage is at 21%. (World Bank Group, 2016).

Policy design.

Allowance allocation. The majority of emission allowances are sold through auction (RGGI, 2017).

Offsets. 3.3% of a liability is allowed to be covered through the use of offsets, through five different types of offset projects (RGGI, 2017).

Compliance. The obligations are applied to fossil fuel power plants operating at a capacity of 25 Megawatts or above, within the RGGI region. As of 2016 there were 163 power plants obligated to comply within the initiative (RGGI, 2017).

Auction Revenue. Auction revenue is invested in consumer benefit programs to increase installation of renewable energy technology and increase energy efficiency (RGGI, 2017).

BC Greenhouse Gas Industrial Reporting and Control Act (GGIRCA)

British Columbia introduced the GGIRCA in January, 2016; this act provides a single framework for GHG legislation, and allows the province to set GHG emission intensity benchmarks (World Bank Group, 2016). A main addition that this act has over previous iterations is compliance reporting requirements, including for LNG entities (World Bank Group, 2016). The act also incorporates flexibility to introduce incentives to invest in GHG reduction projects, offsets are purchased from the government or from a secondary market in order to be under emission limits (World Bank Group, 2016).

This act implements three main regulations, which were created with the input of stakeholder dialogue – the GHG emission reporting regulation, the GHG administrative penalties and appeals regulation, and the GHG emission control regulation (Government of British Columbia, 2016).

Criticism has been aimed at this act in regard to the facilitation of the production and export of liquefied natural gas (LNG); hard caps on emissions were repealed in order to introduce the intensity targets, which have been criticized as allowing GHG emissions to rise due to the fact that it only requires a limit on emissions per tonne of LNG, and not a limit on total emissions (Lupick, 2014).

Alberta Output-based Allocation System Engagement

Alberta will be introducing an output based emission allocation system beginning in January of 2018; this system will be used to manage facilities in certain sectors which emit 100,000 tonnes or more of GHG (Government of Alberta, 2017). This system will allow potentially trade-sensitive companies to be excluded from the carbon levy under the threshold of industry specific benchmarks; its flexibility is similar to a cap-and-trade system, credits are given to entities under the limit, and any above the limit are required to purchase offset credits (Government of Alberta, 2017).

This system is scheduled to replace the Specified Gas Emitters Regulation (SGER), which is currently in place in Alberta (Government of Alberta, 2017).

Canadian Carbon Taxes

Carbon taxes present the main policy alternative to cap-and-trade systems, having an active implementation in British Columbia, as well as a more recent implementation in Alberta. Additionally, with the upcoming national benchmark and carbon tax coming into effect in 2018, carbon taxation will be an important part of carbon pricing for the foreseeable future (Government of Canada, 2016a). While carbon tax policy design isn't as diverse as cap-and-trade, it is a subject that still warrants discussion, as there are several design philosophies operating within Canada. While carbon taxes provide a streamlined approach to pricing carbon emissions, revenue-neutrality is a topic which requires further discussion. The role and results of a revenue-neutral carbon tax are especially important to discuss, due to the fact that the incoming federal carbon tax will be revenue-neutral.

Revenue-Neutrality. Revenue-neutrality is the concept of returning the revenues of a carbon tax in the form of dividends to taxpayers (Government of British Columbia, n.d.-a). This process is considered by many as providing a double-dividend, in which it is able to achieve both economic and environmental benefits (Fullerton & Metcalf, 1997). Revenue-neutral carbon taxes have been proven to be effective at reaching both goals, but opinions on the extent of the environmental benefits has varied widely; some critics argue that given the urgency of reaching emissions reductions, that a more robust approach should be adopted (Partington & Sharpe, 2016). The main criticism attached to revenue-neutrality is the argument that it sacrifices greater environmental gains in order to achieve economic efficiency. It is argued that the use of revenues in direct investment is a more effective method of achieving energy efficiency. The pooling of resources is potentially effective for large-scale investments, which are not obtainable by smaller communities and households. It is important to also note that increasing taxes without revenue-neutrality also creates a considerable setback in the economic sense that others taxes have distortionary effects which should ideally be diminished (Bovenberg & Mooij, 1994). Additionally, there is criticism as to the lack of flexibility of revenue-neutral taxation in regard to trade-sensitive sectors (Wall, 2016).

British Columbia. British Columbia is the prominent Canadian example of a revenue-neutral carbon tax in operation. This tax covers approximately 70 percent of GHG emissions within the province and is revenue-neutral with proceeds returned through reductions in other taxes (Government of British Columbia, 2012). The carbon tax was introduced in 2008, at a price increasing from 10 CAD/tCO_2, up until it reached 30 CAD/tCO_2 in 2012 (Government of British Columbia, 2012). The carbon tax in British Columbia had a noticeable impact on fossil fuel consumption, resulting in a GHG emission reduction of 6% below 2007 levels by 2012 (Government of British Columbia, 2014). In 2012, the BC government put a five year freeze on the price level, with a plan to revisit price consideration at the end (Government of British Columbia, n.d.-a). Following the five year carbon price freeze and an announcement of an impending national carbon tax, the BC government decided to simply leave the carbon tax at 30 CAD/tCO_2 (Bailey, 2016a). The result of the inaction of the BC government on escalating a carbon price means that further emission reductions through pricing will not be achieved until the national carbon price reaches 40 CAD/tCO_2 in 2021. The legislated GHG target for 2020 is 33% below 2007 levels (Government of British Columbia, 2014). The 2020 target will require much stronger regulations and carbon prices in order to be reached, and further insight into the discrepancy can be observed through review of the 2008 Climate Action Plan.

According to the 2008 Climate Action Plan, BC had initially planned to utilize cap-and-trade as a key component of its climate strategy, in addition to the carbon tax (Government of British Columbia, 2008). The intention was to run this system in conjunction with the other regional members of the WCI. The cap-and-trade system was intended to cover emissions from large industrial polluters, which would be relatively unaffected by a carbon tax on fossil fuels, thus covering a wider array of emission types (Government of British Columbia, 2008). The implementation of a cap-and-trade system within BC was not carried out, with a repeal of the cap-and-trade act, citing a lack of participation of other sub-national economies in the WCI cap-and-trade program (Government of British Columbia, n.d.-b; Hunter, 2014).

Alberta. On January 1st, 2017, the Government of Alberta implemented a carbon tax, referred to as a carbon levy, of 20 CAD/tCO_2 (Government of Alberta, n.d.). This carbon tax is also operating alongside an introduced performance-based regulation in order to cover large industrial emitters (Alberta Utilities Commission, n.d.). Based on current emissions, the Government of Alberta estimates that the carbon tax will result in revenue of 9.6 billion CAD in the 5 years following implementation. The revenue from this carbon tax is expected to be used both for direct household rebates and reinvestments into the economy including energy efficient infrastructure and coal transition (Government of Alberta, n.d.). Since portions of the revenue will be used to fund government projects, this is not a revenue-neutral carbon tax. In comparison to the 70% coverage of GHG emissions with the economy of BC, Alberta is expected to cover 78-90% of GHG emissions with their carbon tax (Government of Alberta, n.d.). Additionally, the tax is scheduled to rise to 30 CAD/tCO_2 in 2018, then at inflation plus 2% annually beyond that (Government of Alberta, 2015). In an economic perspective, the carbon tax has progressive qualities such that portions of the revenue will be given in the form of direct rebates to lower and middle income individuals.

Québec. According to a historical overview of carbon pricing in Québec, the province originally introduced a carbon tax, which achieved success by raising 1.2 billion CAD over its duration, earmarked for the province's Green Fund (Government of Québec, 2015a). According to the Government of Québec, the province decided to shift to a cap-and-trade system in order to pursue further GHG emissions using a more robust and flexible mechanism.

Mandatory Carbon Pricing. The federal government plan to implement a minimum carbon tax ensures that not only will every jurisdiction be maintaining a price on carbon, but also that a price floor will be established. This price floor will impact both the operation of carbon taxes and cap-and-trade programs. There is a theoretical overlap, in which this mandatory carbon tax may operate as a bridging measure for cap-and-trade programs with low price signals.

Chapter 5- Discussion

Through the analysis of the policy design choices in the scoping review, there are clear topics of concern to address. Additionally, each design choice of contention will be addressed and explored.

Challenged Narrative

In regard to cap-and-trade design, the non-systematic search for evidence has identified a common but contentious narrative claiming that policy design choices do not impact environmental performance or efficiency.

The contention of this scoping study is that program design, especially allowance allocation, does matter for cap-and-trade program effectiveness; because of the contradiction of this claim, evaluating this competing narrative is important. The contention of this scoping study contradicts the application of the Coase Theorem that many academic articles have utilized. Hahn and Stavins (2011), provide a highly cited journal article which claims that design choices have no impact on environmental outcomes; their article examined the topic and determined that allowance allocation method does not impact environmental performance or efficiency based on an analysis of the Coase Theorem (Hahn & Stavins, 2011).

The independence property of the Coase Theorem, states that in environmental markets (in this case, cap-and-trade programs) efficiency and effectiveness are independent of the method chosen for the initial allocation of the rights (Coase, 1960; Hahn & Stavins, 2011; Medema & Zerbe Jr, 1995). There is a key aspect which is not addressed in articles applying the Coase Theorem, which makes the application problematic. In order for the Coase Theorem to work in practicality there is a requirement for there to be no transaction costs (Medema & Zerbe Jr, 1995); the main evidence against this assumption and application of the Coase Theorem is the function that opportunity costs play in the role of free allocation. The fact that entities are accounting for opportunity costs and passing them to consumers present the existence of transaction costs (Bruyn et al., 2010; European Commission, 2015d). By integrating opportunity costs into the price for consumers, a transaction cost is incurred. While the extent to which this occurs can be debated, it has been shown to occur, and can have strong consequences when the emitting entity is a price setter; the higher product prices impact innovation, competitiveness, and carbon leakage (Bruyn et al., 2010). This implies a negative impact on environmental outcomes, especially in regard to decreased innovation.

Additionally, the referenced cap-and-trade programs and academic articles reviewed in this study provide evidence of a relation between design choices and carbon prices; as has been reviewed in this study, the price on carbon is a fundamental mechanism in carbon pricing instruments which create the incentive to either innovate in regard to efficiency or to reduce GHG emissions (Heinmiller, 2007; Yamin, 2012). Furthermore, without an incentive to reduce emissions the environmental outcome of a program should be expected to suffer.

Auctioning

The process of auctioning allowances has been demonstrated to be a significant contributor of revenue for direct investment in green initiatives. These initiatives can be tailored specifically to the determined needs of the jurisdiction, and include considerations such as infrastructure investment, subsidies, and serving disadvantaged communities.

The joint auctions conducted by California and Québec present the possible variability of auction revenues earned by a jurisdiction each year, showing that inconsistent revenues can be expected (California Air Resources Board, 2016a). Due to the fact that auction revenue can have a wide degree of variation, it is important that projects planned using conservative auction revenue estimations, funded at a variety of revenue points, or using multi-year planning (Institute for Climate Economics, 2015). California's revenue utilization provides strong examples of this approach through the use of multi-year planning as well as conservative revenue estimation.

Compliance Complexity

Compliance costs have been considered a problem to be considered within several cap-and-trade programs. Reviewing the complexity issues of compliance within the EU ETS and the NZ ETS, they demonstrate the importance of providing clear, concise, and flexible emissions reporting. In the case of the EU ETS, unnecessary complexity of compliance was found to create undesired transaction costs, especially to small emitters (Dutch Emissions Authority, 2015). The burden on small emitters was made more apparent with the review of the NZ ETS, which also found that they had information and clarity issues (New Zealand Government, 2016). The design of the Tokyo Cap-and-Trade Program provides a set of design solutions for the issue of high administrative costs; clarity could be provided through annual seminars, emissions feedback, and sector leading examples of pollution reduction (ICAP, 2016; World Bank Group, 2016). Additionally, the Tokyo Metropolitan Government calculates emissions based on energy consumption using effective gauges and are verified by energy bills (Rudolph & Kawakatsu, 2012). The KETS compliance system also provides potential solutions to compliance issues, in that it established a market monitoring system and a consultative body to communicate with stakeholders (ICAP, 2016). Additionally, suggestions from the Dutch Emissions Authority (2015) could help streamline the process for small emitters, including the concept that the registry and surrender of allowances could be automated, bypassing registry access requirements and any potential misunderstanding from the emitter.

Sector Coverage and Indirect Emissions

The most common focus of many cap-and-trade programs focus is the production side of emitting, attempting to create incentives for the direct source of emissions. The focus on indirect emissions has proven to result in a significant reduction in emissions in Tokyo, and as such could be considered for the implementation of other carbon markets (ICAP, 2016; World Bank Group, 2016).

Emissions coverage. Comparing the total emissions coverage of each cap-and-trade program, the WCI members are the most aggressive, with cap-and-trade program coverage at 85% of emissions (ICAP, 2016; World Bank Group, 2016). The inclusion of as many sectors and companies as possible is beneficial to the long-term success of a cap-and-trade system, as it holds more emitters responsible and creates a sense of proportional responsibility for emissions. The scoping review indicates that the economic impact of establishing such wide emissions coverage is negligible at contemporary levels of price signals (Ökoinstitut & Ecofys, 2013). In regard to other carbon pricing instruments, Alberta is projected to cover 45% of total emissions outside of cap-and-trade, and British Columbia currently covers 70% of total emissions;

however, the intensity based measures do not provide a hard cap on emissions, and as such do not limit total emissions.

Table 1

Emissions coverage by region

Region	Cap-and-Trade Emissions Coverage	Total Emissions Coverage
European Union	45%	52%
Korea	68%	68%
New Zealand	52%	52%
Tokyo	20%	N/A
California	85%	85%
Québec	85%	85%
Ontario	82%	82%
British Columbia	0%	70%
Alberta	45%	90%
RGGI	21%	21%

Note. Data for cap-and-trade emissions coverage from ICAP (2016) and for Ontario from World Bank (2016). Data for total emissions coverage from World Bank (2016).

Indirect emissions. In the absence of larger regional carbon markets, smaller, local municipal markets can still be effective. Tokyo, in the absence of a Japan-wide carbon market, was still able to reduce municipal emissions by 23% in a short time-frame (ICAP, 2016). Such an approach could be effective for other municipalities outside of wider cap-and-trade systems, especially those with local goals such as lowering smog levels.

Allowance Allocation

Evaluating the allowance allocation choices of international implementations provides considerable insights into specific design choices. Allocation determines the supply side of the economic price equation, and as such, is one of the most important considerations in building an effective cap-and-trade program.

Free allocation. A common design choice during the beginning phases of cap-and-trade systems is to provide most allowances through free allocation, in a process aiming to help emitters acclimate to the program before a transition to a stronger auction component. While the concept of helping emitters transition into an auction-based system is appropriate, the scoping review shows that free allocation has resulted in numerous issues.

Free allocation for electricity producers has been a major issue, as opportunity costs are sometimes passed through into the consumer price, and create windfall profits for the emitter (Bruyn et al., 2010; European Commission, 2015d). Additionally, there is considerable proof that industry can and does pass on varying percentages of opportunity costs to the consumer. This cost pass-through demonstrates that not only is there a detriment to consumers, but also an increase in product price. As mentioned in the scoping review, increased product price has been linked to detriments to innovation, competitiveness, and carbon leakage.

While free allocation can be a useful tool for transitioning emitters, or protecting emitters on the carbon leakage list, it also comes at the unexpected cost pass-through. Alternatives are suggested, such as auctioning a larger share of emissions, and reinvesting revenues to energy saving subsidies (Bruyn et al., 2010). Additionally, allowances provided through free allocation mean a reduction in the potential revenue generated through auctions.

Method choice. The method choice of free allocation has had a considerable impact on the overall success of carbon markets. The two main methods of free allocation used by cap-and-trade systems are grandfathering and benchmarking. The EU ETS, and its initial choice of free allocation through grandfathering, demonstrated that allocation based on historical GHG emissions can have several unintended consequences. The major consequences of grandfathering being that companies who have already innovated are considered at an efficiency level equal to that of less efficient companies; the result is not enough pressure on the less efficient emitter, and too much on the efficient emitter (European Commission, 2015b). In contrast to the method of grandfathering, benchmarking has been viewed as creating more incentives for innovation, and recently even the EU ETS has begun to implement this style of free allocation more broadly (ICAP, 2016; World Bank Group, 2016). There are some important considerations with benchmarking, as even within the same sector, emitters may be using dissimilar processes, and as such would need to be benchmarked based on sub-sector and specific processes used (Ellerman & Buchner, 2007).

There is academic support for the notion that free allocation, especially benchmarking, has significant associated administrative costs (European Commission, 2015b). Following these negative impacts of free allocation, it is my opinion that free allocation only be utilized when necessary, such as a transitory tool for the introduction of a program, or in response to substantiated carbon leakage issues.

Over-allocation. The most significant example of the impact of over-allocation is in the allowance allocation in phase I of the EU ETS. The amount of allowances allocated was so large that it exceeded emissions generated, and as a result the price of carbon dropped to low levels (European Commission, 2015c; Schopp et al., 2015). In an economic perspective, this over-allocation presents a supply-side issue, where supply outpaces demand, and equilibrium prices drop. This example of over-allocation provides an important lesson, being that measurement, forecasting, and proper caps are vital to the efficient operation of a cap-and-trade program. The methods by which the allowances were measured and allocated were flawed, which had a negative cascading effect on the operation of the entire program. The early policy mistakes for the EU ETS were so significant, that the European Commission itself anticipates lasting negatives impacts extending to 2020 (European Commission, 2012). While the bottom-up allocation approach was held partially responsible for inaccurate allocation, the European Commission did have final acceptance of proposals (European Commission, 2015c; Schopp et al., 2015). The fact that allocation was not adequately adjusted from the member-state proposals, NAPs, shows that the policymakers did not possess proper estimates to begin with. These significant issues associated with determining the appropriate allowance allocation highlights the importance of establishing effective and reliable monitoring, reporting, and verification of emissions in order to set a proper allowance cap. Effective forecasting and monitoring is paramount to creating a proper sense of scarcity (Dutch Emissions Authority, 2015; European Commission, 2015c). Additionally, it is important to focus on maintaining a level of scarcity, despite any lobbying from covered sectors. The caution utilized by the KETS in response to emitter complaints of allowance shortages is a good example of this, as without scarcity, there is no incentive to reduce emissions (World Bank Group, 2016).

Allowance Caps

A common occurrence with the implementation of cap-and-trade programs is a tendency to set allowance caps too high, exceeding demand, and thus setting a weak price signal. The setting of an allowance cap is one of the fundamental ways in which a program can establish a strong price signal on emissions, and subsequently create incentives for innovation and emissions reduction (ICAP, 2016; World Bank Group, 2016). In the EU ETS, the first two phases allowed member-states to propose allocation caps and implement their own policies; it is only in phase III that the EU ETS policymakers revised allocation methods, establishing an EU-wide cap (European Commission, 2015b). This example provides a powerful lesson, in that not only are allowance caps key to controlling the supply-side of the price equation, but also that harmonization minimizes the distortion of competition created by allocation method discrepancies.

The allowance cap established in cap-and-trade programs need to be set at a decreasing annual rate in order to gradually reach a region's emission targets (Government of Ontario, 2016b). Establishing the proper allowance cap is vital to creating scarcity and emissions reductions, and this can be observed in the failures of the EU ETS and NZ ETS. The choice of the NZ ETS to not set an allowance cap is incompatible with the ultimate goal of a carbon market, since setting an allowance cap is a main determinant for the reduction of emissions (ICAP, 2016). As a result, the NZ ETS did not effectively reduce emissions, rather, it was a private reforestation project, funded separately, which brought net emissions into compliance with the first phase of the Kyoto Protocol. In the EU ETS, the allowance cap was set at such a high level that they were above actual emissions, creating long-term supply-side repercussions (European Commission, 2015c).

Measurement, reporting, and verification. The review of the EU ETS provided an example of the results of improper tracking of emissions, and the resulting repercussions of incorrect allowance caps and market failure. In sharp contrast, the Québec Cap-and-Trade System is based on rigorous protocols utilized by the province, with mandatory emissions reporting, and verification using ISO standards (Government of Québec, 2015b). The proper tracking and verification of emissions is paramount in the process of determining an effective allowance cap to incentivize innovation.

Geographic Scale and Harmonization

The scoping review of the Tokyo Cap-and-Trade Program provides an interesting example of the potential efficacy of municipal level cap-and-trade systems and a price being set on indirect emissions. Since the implementation of the program, Tokyo has managed to achieve a 23% reduction of gross emissions, which is a significant achievement (ICAP, 2016). There is an apparent association between the scale of a carbon market and the obstacles in the path towards harmonization. Large-scale and multinational programs are faced with greater complexity, with issues including multiple approaches to allocation methods, greater diversity of political opinions, and more competitive considerations.

The multinational program of the EU ETS provides a cautionary example of the issues involving integration of numerous member-states into one overarching policy design (European Commission, 2015c). With 31 member states, and a wide range of sector compositions and economic positions, it is evident that fractured policies are the result of attempts to cater to individual member-states. There is academic support for the idea of instituting policy harmonization; the advantages of a single harmonized policy are numerous, including avoiding distortion of program incentives and competition, as well as assigning proportional responsibility to emissions generating regions (European Commission, 2015b).

The partnership of North American sub-national entities under the WCI cap-and-trade framework presents a parallel to the EU ETS, in that multiple nation-states are operating under the same program. The consideration of harmonization will be an important one, in order to avoid the negative impacts that accompany instituting fractured policies. Québec and California will have to ensure they continue to have harmonized policies, especially if California proceeds with their proposed changed to the minimum settlement price (Mcmahon & Mccarthy, 2017).

The lessons of a lack of harmonization apply directly to Canada given the initial patchwork application of carbon pricing, and the later application of a national scheme. It is important to note that with differing carbon pricing instruments and designs between the provinces and territories, that there will also be competitive distortions. As an example, different instruments and designs have varying levels of total emissions coverage, and some cover processes that others do not (World Bank Group, 2016). While distortions of competition may be subtle under current pricing levels, both pricing mechanisms will have their own distinct rates of emission price progression, and as such price differentials may increase along with the maturity of the markets. In my opinion, the competitive distortions among the provinces and territories could increase unless greater consideration is given toward the issue of hybridization.

Offsets and Benefits of Localization

While Kyoto Protocol offsets provide funding for projects in developing countries aiming to reduce emissions, they can be viewed as being counterproductive to the specific country-based emission reduction targets, which were established through INDCs and the Paris Agreement. The cost of purchasing Kyoto Protocol units, CERs and ERUs, has plummeted relative to other units due to over-allocation, and as such they have a competitive advantage, being the least-cost option (Newell et al., 2012; The Economist, 2012). The inclusion of international offsets, using mechanisms such as the JI and CDM, provides significant disincentives to focus on localized carbon markets. The depressed price of emissions of both the EU ETS and NZ ETS markets have been associated to the inclusion of units from the JI and CDM; international units have had a trend in out-competing local market units (Shaw, 2007).

While emission reductions anywhere on the planet result in a mitigation to climate change, there are distinct benefits to limit offset projects to local jurisdictions. These local benefits are due to the impacts of air contaminants, highly toxic, low atmospheric pollution which is derived from emissions by local and neighbouring jurisdictions (City of Toronto, 2014). According to Toronto Public Health, in 2014 air pollution in the region resulted in the premature deaths of 1,300 individuals and resulted in the hospitalization of an addition 3,550 individuals; additionally, air pollution results in hundreds of thousands of asthma symptom expressions, respiratory problems, and reduced life expectancy (City of Toronto, 2014). There is no critical mass for air contaminants, in fact, any level of ground-level ozone is harmful to plants and animals (City of Toronto, 2014). If left unchecked, large urban centers can experience smog events so severe that drastic action needs to be taken. In 2015, Beijing experienced smog levels so severe that a red alert for air quality was issued, cutting the traffic levels in half and halting schools and construction work (Vanderklippe, 2015). Following the negative impact from any level of smog, there is an economic incentive to focus offsets to local jurisdictions in order to lower the overall cost on health, as well as minimize impacts on gross domestic product. These negative externalities highlight a benefit of focusing on local offsets, while creating additional political capital for the case to implement stronger carbon pricing.

International offsets also have additional costs associated with them, including screening and regulation which needs to be applied to evaluate international projects (Newell et al., 2012). Newell et al. further on concerns regarding CDM, highlighting the fact that unintended consequences arise from international offsets, such as funding temporary forestry projects and the creation of harmful compounds simply to provide offsets for their own subsequent destruction.

If in addition to local emissions reduction projects, international offset inclusion is still deemed desirable, a balance must be struck. In this scenario, it would be advisable to provide them as an option, but at a limited quantity in order to maintain local market participation, as well as the incentives of localized cap-and-trade programs. KETS, for example, is planning on applying a 10% limit on the use of international credits for an emitter's surrender requirements

(ICAP, 2016). Due to the IDNC focus of WCI cap-and-trade systems, it will be important to maintain a limitation on international credits. It is a vital variable in the process of establishing a higher price on emissions, greater innovation in energy efficiency, and reaching emissions targets. Additionally, the purchase and surrender of Kyoto Protocol emissions units represents a flow of funds offshore, which is technically an economic drain for the localized program's regions.

Currently active WCI cap-and-trade programs have a stance on international offsets which insulate them from these concerns regarding JI and CDM. California and Québec do not currently allow the use of Kyoto Protocol units, and only allow domestic offsets to be used for 8% of surrender obligations (ICAP, 2016).

Price Volatility

The issue of price volatility and the unintended impact of policy design is a common theme in the review of the international experiences of cap-and-trade programs. In a carbon market, the price set on emissions is vital to the creation of incentives to innovate and reduce emissions. If a price is set too low, the relative cost of researching, developing, and implementing local technology to mitigate emissions becomes too high. Additionally, vulnerability through shocks and surges in prices are also seen as detrimental to long-term predictability and possible investment return for innovation (European Commission, 2015c). Beyond market shocks, there are multiple variables which set the price of emissions, and the scoping review of programs provides clarity on which variables play key roles. The scoping review demonstrates the key endogenous variables that establish the price on emissions are allowance allocation, international offset availability, and long-term predictability.

In my opinion, the use of external offset credits, while in line with the goal of preventing global climate change, does not meet the goal of reaching the INDC emission targets set in accordance with the Paris Agreement. The inclusion of international offset credits within a cap-and-trade system creates price competition and thus potential price depression in localized carbon markets.

Stability Mechanisms. While carbon markets should be mostly left alone to create incentives for emissions reductions and innovation, there should also be safeguards provided to make sure unexpected shocks don't make emissions excessively cheap or expensive. In order to ensure the dynamic efficiency of the market, and safeguard the incentives of a carbon market, economic mechanisms such as auction price floors and market stability reserves need to be considered (European Commission, 2015c; World Bank Group, 2016). In theory, in an effective cap-and-trade system, a price drop to near zero would indicate that innovations, creating emission reductions, are so extensive that GHG targets can easily be met; however, this has not been the case in practice, as the scoping review shows that actual emission reductions have been low. Stability mechanisms provide regulatory balances to ensure a cap-and-trade program against these market failures, which render the program ineffectual. In practice, price drops to near-zero have indicated such a market failure, as emissions reduction targets are ambitious, and assuming proper allowance caps, allowances should be in demand for the foreseeable future; therefore, effective markets should still be setting a reasonable price on carbon.

Both California and Québec implemented cap-and-trade programs with auction reserve floors, which together increase at a set amount annually (California Air Resources Board, 2017c). The annual increase in the price floor is in line with the perspective that emission reductions should be incrementally increased over time in order to gradually meet national targets. The implementation of a price floor helps maintain a base level to maintain the incentives for energy-efficient innovation. While the scoping review shows that over-allocation has been a trend appearing in many implementations of carbon markets, it is reasonable to believe that in future iterations under-allocation could also become an issue. If allowance allocations are too scarce, set prices could become excessively high, and result in a depression of overall economic production. The mechanism of allowance price containment reserve does serve as a form of ceiling; however, reserves have limited supplies, and as such may not be fully deter excessive prices (European Commission, 2015c). Following this consideration, the implementation of an absolute price ceiling, using a specific upper threshold, would be more effective at limiting prices. While price floors and ceilings would be effective at maintaining desirable incentives, they should only be set at extremes on both ends, in order to allow the market to establish its own equilibrium price within a range based on supply and demand.

Carbon Leakage

Carbon leakage is a complicated consideration, as the balance between excluding trade-sensitive and emissions-intensive sectors, and establishing wide emissions coverage, is difficult. According to the European Commission, there has been a lack of evidence, after review of empirical studies, that carbon leakage has created a distinct disadvantage in regard to competition (European Commission, 2015b). Following the insufficient evidence among their data and academic studies as to the significance of carbon leakage, the European Commission has committed to efforts of reducing the list of emitters excluded from auctions and provided free allocation. The more narrow and efficient the carbon leakage list is, the wider the emissions coverage will become, and the more revenue can be generated through auctioning.

While there is a lack of evidence, it is important to note that historical prices on emissions have been low, and as such, do not provide valuable research for more effective carbon markets with higher price signals. There is little relevant data available in which a cap-and-trade program manages to establish higher prices on emissions. It may potentially be the case that research conducted on carbon leakage has been inconclusive because prices are not yet high enough to significantly impact competition (European Commission, 2015c). In reflection of this possibility, caution should still be employed in regard to carbon leakage and sensitivity to competition. Due to the lack of data regarding the competitive effects of carbon leakage under pressure from a high carbon prices, this topic should be monitored closely, assessment strategies should be refined, and data should be collected and reviewed for policy revisions as carbon prices begin to rise.

Cost pass through. Another important consideration in regard to carbon leakage is the extent to which emitters, when assigned free allocation, inflate prices for the end consumer (European Commission, 2015b). There are two factors which lead to this, the first, that industry emitters are included on the carbon leakage list and provided a large portion of free allowances. The second factor is the perception behind free allocation in that industry is unable to pass through the cost of emission, and thus have a competitive disadvantage. Not only has carbon leakage been proven to be essentially a non-issue at contemporary carbon price levels, but research conducted for the European Commission has fully demonstrated that industry can, in fact, pass through the opportunity cost of emitting (European Commission, 2015b, 2015c). Bruyn et al. (2010) provided three ways in which carbon costs can be passed into the product price; these three ways are pricing being based on opportunity cost of allowances rather than expenditure-based, firms engaging in marginal cost pricing rather than average cost pricing, and firms being price setters rather than price takers (Bruyn et al., 2010). The entities passing on carbon costs to consumers would need to have definitive standards which mitigate these possibilities. The result of these factors is that some industry sub-sectors have been benefiting from profits in a method similar to that previously recognized and corrected for electricity producers.

Additionally, it is important to realize that carbon leakage and the subsequent allocation of allowances is a political issue, just as much as it is an economic issue. In review of the EU ETS, it is evident that both political difficulties and member-state determined free allowances had a considerable effect on raising the total allocation of free allowances in the first two phases of the program (European Commission, 2015c).

Carbon Taxes

As is demonstrated by the implementations of carbon taxes in Québec and British Columbia, carbon taxes can also be an effective carbon pricing mechanism, while maintaining economic efficiency. The carbon tax within BC has set a relatively high price signal with the price of 30 CAD/tCO_2 , and achieved noticeable beneficial results; however, concerns still exist in regard to its long-term efficacy due to lack of consistent price growth, as well as discussions regarding financing of green initiatives (Government of British Columbia, 2012, 2014). Rather than gradually increasing the price on carbon in order to reach emission reduction goals, the price has actually been decreasing due to inflation under the price freeze (Bailey, 2016b). Alberta provides a more stable approach to carbon pricing through carbon taxes, as it applies a consistent long-term growth pattern (Government of Alberta, 2015). The carbon levy growth rate of 2% plus inflation provides a reliable downward pressure on emissions. Regardless of the choice of carbon pricing, in order to gradually reach emission reduction targets, incremental reductions will be vital for a smooth transition.

Carbon Pricing Variation

Review of the implemented carbon pricing instruments within Canada provides a clear perspective of the inherent variation of carbon pricing preference throughout different jurisdictions. While it is clear that each jurisdiction implementing carbon pricing has a desire to lower GHG emissions, the reason for choosing an instrument to carry out the task is less obvious. The scoping review provides some insight, as cap-and-trade systems demonstrate the wide spectrum of policy design options and potential flexibility of that instrument, while the simplicity of administration given the scope of carbon taxes present it as an efficient choice. These main considerations of the two instruments appear to be reflected by official justifications by the jurisdictions implementing them.

In regard to documented first-hand explanations of instrument choice, several official justifications exist for the implementation of cap-and-trade programs. In its 2016 *Climate Change Action Plan* the Government of Ontario explains that cap-and-trade was chosen due to the fact that it is more flexible, and allows companies to have more options (Government of Ontario, 2016a). The specific examples given are the possibility of offsets, and that cap-and-trade allows for multi-year compliance periods, with compliance paths that operate in conjunction with business plans and investments.

Similar to the official stance presented by the Government of Ontario, the Government of Québec states that it decided to shift to a cap-and-trade system in order to pursue GHG emission reductions using a more robust and flexible mechanism (Government of Québec, 2015a).

In regard to official explanations of the implementation of carbon taxes, in its 2008 Climate Action Plan, the Government of British Columbia highlights the importance of reinvesting all carbon tax revenue into tax cuts for individuals and businesses (Government of British Columbia, 2008). The fact that carbon taxes require less administration and associated costs enables revenue-neutrality, as higher levels of spending on administration and monitoring would either require a retention of a portion of revenues, or a budget deficit.

Bridging the Sub-National Economies

Province-based policy in Canada has resulted in a variation of implemented policy instruments, and has stratified national carbon pricing. Not only do Canadian jurisdictions vary among instruments, but the variation is extended further by the fact that each has an unique policy design.

With additional sub-national economies having implemented cap-and trade programs, the original justification for the exclusion of a cap-and-trade program within BC is waning. In fact, the 2008 climate action plan, with its intended dual instrument implementation, provides a compelling template for the bridging of Canadian carbon policies (Government of British Columbia, 2008). The concept of embracing the strengths of both policy instruments provides a potential option for further design harmonization among Canadian jurisdictions, as varying degrees of hybridization are an option (Goulder & Schein, 2013). Among other factors, carbon taxes have the capability of providing a low administration cost for a baseline carbon price, while cap-and-trade provides a highly malleable instrument for flexible solutions in each jurisdiction.

In lieu of a nation-wide combination of instruments, jurisdictions utilizing cap-and-trade programs have several options in regard to the coming national carbon tax. Three potential strategies for price equalization among cap-and-trade economies include using the national carbon tax as a topping-up of carbon prices, using cap-and-trade only for industrial processes which would not be impacted by the carbon tax, or completely switching their policy instruments to a carbon tax. In reflection of the justifications of policy instrument choice, it is unlikely that a jurisdiction with a cap-and-trade program would switch instruments, due to the relative difference of policy flexibility.

In regard to the incoming national carbon tax, the initial price will be 10 CAD/tCO_2 in 2018, and will be rising to 50 CAD/tCO_2 in 2022, meaning that it will only impact jurisdictions without any region-wide carbon pricing at first (Government of Canada, 2016a). The national carbon tax will potentially have an impact on jurisdictions utilizing cap-and-trade systems in the second or third year of operation, dependent on whether the WCI allowance price exceeds 20 CAD/tCO_2 in 2019. Plans for practical hybridization through Canadian jurisdictions will need to be further researched and designed to meet that date in order to ensure effective carbon pricing equalization.

Failing to ensure proper price interaction and equalization after the national carbon tax is introduced may result in significant competitive distortions, higher compliance costs for many businesses, and political turmoil among Canadian jurisdictions.

Comparable Studies

In order to evaluate knowledge gained from this scoping review it is beneficial to compare it to similar studies. A significant amount of policy parameter research is reviewed within this study, providing an aggregation of recent lessons learned regarding carbon pricing. While there are numerous studies on individual parameters of carbon markets, or of single market analyses, there are fewer which use a scoping review to aggregate data regarding lessons learned across multiple markets and how they may be applied to another economy. Due to the recency of large-scale carbon markets, gaps of knowledge and application still exist, including for Canada. In regard to applying lessons learned, a similar approach has been used in several studies, including in regard to the European carbon market.

Boemare and Quirion (2002). Boemare and Quirion evaluated the directive proposal from the European Commission which outlined the tradeable permit scheme prior to its implementation as the EU ETS (Boemare & Quirion, 2002). Similar to this scoping review, they reviewed lessons learned from several trading programs, and highlighted several key parameters.

While they cover fewer parameters, they similarly highlight the importance of scale, allocation, monitoring, compliance, and harmonization. Among the similar parameters, they also found that continuous or automated monitoring and reporting would provide much more accurate data. They also highlight a concern regarding the initial large degree of freedom of allocation in the EU ETS, which as this scoping review covers, led to over-allocation issues. Additionally, they found that grandfathering as a method of allocation is less effective with the goal of reducing emissions.

A key difference between the two studies is that due to the fact the EU ETS had not been implemented yet, it could not itself be used as a guideline for lessons learned. This scoping review is able to take advantage of the status of EU ETS as the largest cap-and-trade system globally, in addition to other recent programs, and addresses the many issues which appeared during the duration of several recent phases of operation. Another difference between the studies is that their study incorporates adhering to the Kyoto Protocol, which includes international offset credits such as JI and CDM; this study on the other hand notes the counterproductive impacts of lower cost allowances, and highlights the advantage of localized offsets. Their study led to recommendations for the following implementation of the EU ETS, and this study differs as it covers significant amounts of more recent data, evaluates the current status of Canada's varied carbon policies, and provides recommendations to strengthen them.

Newell, Pizer, and Raimi (2012). Their study also aggregates information from various international programs, and outlines several aspects that it deems important. It highlights the fact that the world is diverging from a top-down perspective on carbon markets, and has become more focused on, and inclusive to, specific jurisdictions (Newell et al., 2012).

Similar to this scoping review, their study also includes the EU ETS, the Kyoto Protocol, and New Zealand's carbon market. It also addresses the issue of over-allocation of allowances within the EU ETS, the subsequent drop in the price of emissions, and the role of harmonization and monitoring in alleviating these issues. Their study also notes a lack of definitive information on the effects of carbon pricing on competitiveness and carbon leakage. Their study supports strong criticism of international offsets such as the CDM, including market collapse, increased screening costs and dubious results in forestry sectors and dangerous compound elimination. Additionally, this study discusses price volatility and stabilization methods, although lacks more current information on implemented mechanisms. Their study also briefly reviews the carbon market known as the Regional Greenhouse Gas Initiative, which had notable successes for large electricity generators in select jurisdictions in the United States.

Due to the date of their study, limited auctioning data existed to analyse, especially in regard to linked auctions in North America. Also, while this study does aggregate lessons learned from multiple systems, it does not apply them to a specific economy or program. Additionally, significant amounts of information has been published since the date of this study, including redesign of the EU ETS, as well as the introduction of carbon markets to Canada, Japan, South Korea, and California.

Chapter 6- Recommendations

The active regions operating under the WCI have instituted numerous ambitious policies, including a global leading emissions coverage percentage; however, the scoping review and subsequent discussion highlight some significant areas of concern for Canadian carbon pricing. In order to improve upon the efficacy of the markets linked under the WCI, and subsequently future Canadian market linkage, it will be beneficial to institute several policy revisions.

Cap-and-Trade Optimization

Cost pass-through. As discussed in the narrative section, Coase Theorem does not apply, as transaction costs need to be minimized, and the accounting methods of emitting entities must be regulated. The entities valuing allowances based on opportunity cost need to have definitive standards which require them to account on an expenditure basis. Additionally, in regard to accounting of free allowances the use of marginal cost pricing and price setting need to be addressed. Inflation of product prices negatively impacts innovation, competitiveness, and carbon leakage. The Coase Theorem does not hold in regard to the independence property, and policy design choices play a considerable role in the operation of the program and subsequent environmental outcomes.

The allocation of free allowances to industry should be decreased dependent on the level of cost pass-through for each unique sub-sector. These increases in product price may have a negative impact on market share, and subsequently result in carbon leakage. Further research needs to be conducted on the extent to which cost pass-through impacts market share for each industry, in order to fully evaluate the carbon leakage risk created by free allocation. Once research under these conditions is adequate, then usage of free allocation can be revaluated.

Compliance. The scoping review indicates that there are compliance concerns in several programs, including the EU ETS, NZ ETs, and Québec. Administrative costs are higher due to unnecessary complexity, lack of education, and lack of automation. Compliance is more important than initially considered; greater efforts need to be made to make compliance less costly. It is especially important in regard to small emitters that the transaction costs of participating in the market are kept as low as possible; any barriers incurred by emitters reduces the efficiency of the market. Following the example set by the Tokyo Cap-and-Trade Program and KETS, it would be advantageous to provide compliance education through stakeholder dialogue, annual seminars, emissions feedback, and sector leading examples of pollution reduction. Additionally, in order to provide greater efficiency of obligation surrenders, automated reporting and surrender mechanisms should be developed for small emitters.

Measurement, reporting, and verification. Allowance caps establish market scarcity, which drives the main incentive for energy-efficient innovation, and should be based on accurate data, ensuring incremental downward-trends in emissions. Associations between carbon pricing and emissions reductions can be more firmly tracked if the WCI and other Canadian jurisdictions produce more frequent greenhouse gas inventories. Additionally, Tokyo provides a strong example for future programs, through its comprehensive standards for measurement, reporting, and verification. In regard to high density cities Tokyo is an example of effective emission reduction measures, which can potentially be implemented to reduce smog concerns and have a positive impact on healthcare costs.

Reconsidering free allocation. Based on the unintended consequences, incentives, and cost pass-through of free allocation, more efforts should be made in limiting the practice of passing carbon prices on to consumers. As is shown in the scoping review, free allocation is often used as a transition tool into auctioning, and in these scenarios the method of transition should be further researched and scrutinized. Studies suggest the possibility of switching a portion of free allowances to an auction which recycles profits back to emitters for innovation. As demonstrated by the EU ETS grandfathering as a method should be avoided due to the undesirable incentives associated with that method. Benchmarking should be used to ensure emitters are competing based on sector averages rather than individual history, and benchmarks should be updated on a regular basis to maintain incentives to innovate.

Carbon leakage. The effect of carbon leakage under higher carbon prices is still unknown, and as such, it may be necessary to be cautious in exposing potentially trade-sensitive emitters to the cost of trading. The effect of carbon leakage on competition is an issue which will still need to be addressed by future research, especially under the condition of higher carbon prices. The impact of higher carbon prices on competition will only be revealed as Canada progresses toward higher price signals, and as such, adaptive management strategies should be utilized with this as a consideration.

Market stability. Currently, the main stability mechanisms used by WCI members are price reserve floors and price containment reserves. These reserve based mechanisms provide upper and lower thresholds which create a buffer against shocks, but further research should be conducted into a potential price ceiling. A price ceiling would provide an absolute upper threshold, rather than a threshold based on a reserve, which can be depleted. It is important to note that such mechanisms should be designed solely for the purpose of stabilizing against price shocks, rather than being the main method of establishing an equilibrium price, which is the primary goal of the carbon market itself.

Auction revenue. Auction revenues have proven to be inconsistent despite stability mechanisms, and as a result, it is vital to climate action plans that any projected funding and planned investments be based on conservative revenue estimates, multiple revenue points, or flexible timelines. Flexible project planning will ensure that projects can proceed regardless of the volume of funding obtained through auctioning in any given quarter.

Nation-Wide Carbon Pricing

While there are other important considerations in regard to reaching climate change mitigation goals, such as improvement of regulations, carbon pricing remains a vital component. Not only does a higher price signal need to be reached, but there are also inefficiencies tied several implemented program designs. It is also important to note that with the federal plan to implement a minimum carbon price through a carbon tax, a combination of the two carbon pricing approaches is likely to be a mainstay in the Canadian future.

Cap-and-Trade Harmonization. Fractured policy application is a significant issue within the EU ETS, and has occurred in regard to allocation, allowance caps, and attempts to minimize carbon leakage. Applying different policies to various members has been viewed as a detrimental design according to numerous academic studies. Being the first three operating members of the WCI carbon market, California, Québec, and Ontario need to further their efforts to harmonize; Canadian jurisdictions will need to attempt to harmonize minimum settlement prices with California in the event that it proceeds with current redesign proposals.

Hybridization. The future of carbon pricing in Canada appears to be divided, with cap-and-trade programs and carbon taxes both proving to have significant momentum. Conversations regarding policy implementation often consider the comparative advantages of either system, without examining the possible synergies. Cap-and-trade systems, with proper policy design, can provide flexible and tailored pricing mechanisms; the tradeoff with this policy choice is variability in auction prices and a higher administration cost. The benefits of cap-and-trade systems on municipal levels are also evident, in regard to the example of the Tokyo Metropolitan Area and their significant emissions reductions through focused targeting. Additionally, carbon taxes can create a national base-line for carbon prices while having relatively low administration costs; however, carbon taxes are less likely to be approved without an element of revenue-neutrality, or at price levels sufficient to reach Canadian climate change targets alone. Embracing the duality of policy mechanisms, in addition to improved regulations, on a national scope is pragmatic, and may prove to have considerable benefits in the path towards reaching the Canadian INDC. Further encouragement should be made to research and utilize a combined approach across all sub-national economies, in order to not only ensure a stable and incrementally increasing baseline price, but also to encourage funding for green initiatives, innovations, and offset projects. Debate should not be focused on which of the two policies is superior, rather it should focus on how to bridge designs to achieve an equal price and emissions coverage among the sub-national economies.

References

Alberta Utilities Commission. (n.d.). Performance-Based Regulation. Retrieved from http://www.auc.ab.ca/items-of-interest/Performance-BasedRegulation/Pages/default.aspx

Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19–32.

Bailey, I. (2016a). B.C. government rules out increase to carbon tax. *The Globe and Mail*. Retrieved from http://www.theglobeandmail.com/news/british-columbia/bc-releases-climate-plan/article31469785/

Bailey, I. (2016b). B.C. government rules out increase to carbon tax. Retrieved from https://www.theglobeandmail.com/news/british-columbia/bc-releases-climate-plan/article31469785/

Bessembinder, H. (1992). Systematic risk, hedging pressure, and risk premiums in futures markets. *Review of Financial Studies*, *5*, 637–667.

Boemare, C., & Quirion, P. (2002). Implementing greenhouse gas trading in Europe: lessons from economic literature and international experiences. *Ecological Economics*, *43*(2-3), 213–230.

Bovenberg, A. L., & Mooij, R. (1994). Environmental Levies and Distortionary Taxation. *The American Economic Review*, *84*(4), 1085–1089.

Bruyn, S. D., Markowska, A., & Nelissen, D. (2010). *Will the energy-intensive industry profit from EU ETS under Phase 3? Impacts of EU ETS on profits, competitiveness and innovation*. CE Delf. Retrieved from http://ec.europa.eu/competition/consultations/2011_questionnaire_emissions_trading/nederlandse_overheid_annex1_en.pdf

Bureau of the Environment: Tokyo Metropolian Government. (2010). *Tokyo Cap-and-Trade Program: Japan's first mandatory emissions trading scheme*. Retrieved from http://www.kankyo.metro.tokyo.jp/en/attachement/Tokyo-cap_and_trade_program-march_2010_TMG.pdf

California Air Resources Board. (2012). *CHAPTER 5: HOW DO I BUY, SELL, AND TRADE COMPLIANCE INSTRUMENTS?* Retrieved from https://www.arb.ca.gov/cc/capandtrade/guidance/chapter5.pdf

California Air Resources Board. (2016a). *CALIFORNIA CAP-AND-TRADE PROGRAM SUMMARY OF JOINT AUCTION SETTLEMENT PRICES AND RESULTS*. Retrieved from https://www.arb.ca.gov/cc/capandtrade/auction/results_summary.pdf

California Air Resources Board. (2016b). *Update on the Potential for Linkage of California's Cap-and Trade Program With Ontario*. Retrieved from https://www.arb.ca.gov/cc/capandtrade/meetings/042816/linkage_ontario_presentation_042816.pdf

California Air Resources Board. (2017a). California Cap-and-Trade Program and Québec Cap-and-Trade System February 2017 Joint Auction #10. Retrieved from https://www.arb.ca.gov/cc/capandtrade/auction/feb-2017/summary_results_report.pdf

California Air Resources Board. (2017b). *California Cap-and-Trade Program and Québec Cap-and-Trade System May 2017 Joint Auction #11*. Retrieved from https://www.arb.ca.gov/cc/capandtrade/auction/may-2017/summary_results_report.pdf

California Air Resources Board. (2017c). Cap-and-Trade Program. Retrieved from https://www.arb.ca.gov/cc/capandtrade/capandtrade.htm

California Environmental Protection Agency. (2015). *Overview of ARB Emissions Trading Program*. Retrieved from https://www.arb.ca.gov/cc/capandtrade/guidance/cap_trade_overview.pdf

California Environmental Protection Agency. (2016). *California Greenhouse Gas Emissions for 2000 to 2014*. Retrieved from https://www.arb.ca.gov/cc/inventory/pubs/reports/2000_2014/ghg_inventory_trends_00-14_20160617.pdf

City of Toronto. (2014). *Path to Healthier Air: Toronto Air Pollution Burden of Illness Update*. Retrieved from http://www1.toronto.ca/City Of Toronto/Toronto Public Health/Healthy Public Policy/Report Library/PDF Reports Repository/2014 Air Pollution Burden of Illness Tech RPT final.pdf

Clò, S. (2010). Grandfathering, auctioning and Carbon Leakage: Assessing the inconsistencies of the new ETS Directive. *Energy Policy*, *38*(5), 2420–2430.

Coase, R. H. (1960). The Problem of Social Cost. *Journal of Law and Economics*, *3*, 1–44.

Colquhoun, H. L., Levac, D., O'Brien, K. K., Straus, S., Tricco, A. C., Perrier, L., & Moher, D. (2014). Scoping reviews: time for clarity in definition, methods, and reporting. *Journal of Clinical Epidemiology*, *67*(12), 1291–1294.

Department of Energy & Climate Change. (2014). *UK Vision for Phase IV of the EU ETS*.

Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/329841/EU_ETS_vision_for_phase_IV_final_version.pdf

Dijkers, M. (2015). *What is a Scoping Review?* Retrieved from http://ktdrr.org/products/update/v4n1/dijkers_ktupdate_v4n1_12-15.pdf

Drost, P. (2015). Serge Rousselle vows carbon pricing system will be "revenue neutral." Retrieved from http://www.cbc.ca/news/canada/new-brunswick/rurge-

Dutch Emissions Authority. (2015). *A simple and effective EU ETS*. Retrieved from http://www.emissieautoriteit.nl/documenten/publicatie/2015/06/23/dutch-report---asimple-

Ellerman, A. D., & Buchner, B. K. (2007). The European Union emissions trading scheme: origins, allocation, and early results. *Review of Environmental Economics and Policy*, *1*(1), 66–87.

European Commission. (n.d.). Auctioning. Retrieved from https://ec.europa.eu/clima/policies/ets/auctioning_en

European Commission. (2012). *REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL The state of the European carbon market in 2012*. Retrieved from https://ec.europa.eu/clima/sites/clima/files/ets/reform/docs/com_2012_652_en.pdf

European Commission. (2015a). DECISION (EU) 2015/1814 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 6 October 2015. *Official Journal of the European Union*. Retrieved from http://eur-lex.europa.eu/legalcontent/EN/TXT/PDF/?uri=CELEX:32015D1814&from=EN

European Commission. (2015b). *EU ETS Handbook*. Retrieved from https://ec.europa.eu/clima/sites/clima/files/docs/ets_handbook_en.pdf

European Commission. (2015c). *EVALUATION OF THE EU ETS DIRECTIVE*. Retrieved from https://ec.europa.eu/clima/sites/clima/files/ets/revision/docs/review_of_eu_ets_en.pdf

European Commission. (2015d). *Ex-post investigation of cost pass-through in the EU ETS*. Retrieved from https://ec.europa.eu/clima/sites/clima/files/ets/revision/docs/cost_pass_through_en.pdf

European Commission. (2015e). *Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC to enhance cost-effective emission reductions and low-carbon investments*. Retrieved from http://data.consilium.europa.eu/doc/document/ST-11065-2015-INIT/en/pdf

European Energy Exchange. (2017). EEX. Retrieved from https://www.eex.com/en/

Fullerton, D., & Metcalf, G. (1997). Environmental Taxes and the Double-Dividend Hypothesis: Did You Really Expect Something for Nothing. *Chicago-Kent Law Review*, *73*(1). Retrieved from http://scholarship.kentlaw.iit.edu/cgi/viewcontent.cgi?article=3112&context=cklawreview

Germanwatch. (2013). *USING EU ETS AUCTIONING REVENUES FOR CLIMATE ACTION*. Retrieved from https://germanwatch.org/en/download/7749.pdf

Goulder, L. H., & Schein, A. (2013). *CARBON TAXES VS. CAP AND TRADE: A CRITICAL REVIEW*. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.692.7598&rep=rep1&type=pdf

Government of Alberta. (n.d.). Carbon levy and rebates. Retrieved from http://www.alberta.ca/climate-carbon-pricing.aspx

Government of Alberta. (2015). *CLIMATE LEADERSHIP Report to Minister*. Retrieved from https://www.alberta.ca/documents/climate/climate-leadership-report-to-minister.pdf

Government of Alberta. (2017). Output-based Allocation System Engagement. Retrieved from https://www.alberta.ca/output-based-allocation-engagement.aspx

Government of British Columbia. (n.d.-a). Carbon Tax: Overview of the revenue-neutral carbon tax. Retrieved from http://www.fin.gov.bc.ca/tbs/tp/climate/carbon_tax.htm

Government of British Columbia. (n.d.-b). Climate Action Legislation. Retrieved from http://www2.gov.bc.ca/gov/content/environment/climate-change/planning-and-action/legislation

Government of British Columbia. (2008). *Climate Action Plan*. Retrieved from http://www.gov.bc.ca/premier/attachments/climate_action_plan.pdf

Government of British Columbia. (2012). *Making Progress on B.C.'s Climate Action Plan*. Retrieved from http://www2.gov.bc.ca/assets/gov/environment/climate-change/action/progress-to-targets/2012-progress-to-targets.pdf

Government of British Columbia. (2014). *CLIMATE ACTION IN BRITISH COLUMBIA*. Retrieved from http://www2.gov.bc.ca/assets/gov/environment/climate-change/action/progress-to-targets/2014-progress-to-targets.pdf

Government of British Columbia. (2016). New GHG reporting and compliance act comes into force. Retrieved from https://news.gov.bc.ca/releases/2015ENV0087-002158

Government of Canada. (2016a). Annex I: Federal investments and measures to support the transition to a low-carbon economy. Retrieved from https://www.canada.ca/en/services/environment/weather/climatechange/pan-canadian-framework/annex-federal-investments-measures.html

Government of Canada. (2016b). Canada’s Way Forward on Climate Change. Retrieved from http://www.climatechange.gc.ca/default.asp?lang=En&n=72F16A84-0

Government of Canada. (2017). National Inventory Report 1990-2015: Greenhouse Gas Sources and Sinks in Canada - Executive Summary. Retrieved from https://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=662F9C56-1

Government of Manitoba. (2015a). MANITOBA INTRODUCES COMPREHENSIVE PLAN TO ADDRESS CLIMATE CHANGE, CREATE GREEN JOBS. Retrieved from http://news.gov.mb.ca/news/index.html?item=36950

Government of Manitoba. (2015b). *Manitoba’s Climate Change and Green Economy Action Plan*. Retrieved from https://www.gov.mb.ca/conservation/climate/pdf/mb-climate-change-green-economy-action-plan.pdf

Government of Ontario. (2016a). Climate Change Action Plan. Retrieved from https://www.ontario.ca/page/climate-change-action-plan?_ga=1.189759915.1204479281.1485508584

Government of Ontario. (2016b). Investing in the Low-Carbon Economy. Retrieved from http://www.fin.gov.on.ca/en/budget/ontariobudgets/2016/bk4.html

Government of Ontario. (2017). Ontario Announces Results of June Cap and Trade Program Auction. Retrieved from https://news.ontario.ca/ene/en/2017/06/ontario-announces-results-of-june-cap-and-trade-program-auction.html

Government of Québec. (2012). *2013-2020 Climate Change Action plan*. Retrieved from http://www.mddelcc.gouv.qc.ca/changements/plan_action/pacc2020-en.pdf

Government of Québec. (2014). *Québec's Cap-and-Trade System for Greenhouse Gas Emission Allowances: Technical Overview*. Retrieved from http://www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/technical-overview.pdf

Government of Québec. (2015a). *The Québec cap-and-trade system and the WCI regional carbon market: A Historical Overview*. Retrieved from http://www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/historical-overview.pdf

Government of Québec. (2015b). *The Québec cap-and-trade system: Strengths and Advantages*. Retrieved from http://www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/strengths-advantages.pdf

Government of Québec. (2016). *EXPANDING THE QUÉBEC-CALIFORNIA CARBON MARKET*. Retrieved from http://www.mddelcc.gouv.qc.ca/changements/carbone/documents-spede/linking-quebec-california.pdf

Government of Québec. (2017). Auction Proceeds Allocated to the Green Fund. Retrieved from http://www.mddelcc.gouv.qc.ca/changements/carbone/revenus-en.htm

Groenenberg, H., & Blok, K. (2002). Benchmark-based emission allocation in a capand-trade system. *Climate Policy*, *2*(1), 105–109.

Grubb, M., Azar, C. A., & Persson, U. M. (2005). Allowance allocation in the European emissions trading system: A commentary. *Climate Policy*, *5*(1), 127–136.

Hahn, R. W., & Stavins, R. N. (2011). The Effect of Allowance Allocations on Cap-and-Trade System Performance. *Journal of Law and Economics*, *54*(4), S267–S294.

Heindl, P. (2012). *Transaction Costs and Tradable Permits: Empirical Evidence from the EU Emissions Trading Scheme*. Retrieved from http://ftp.zew.de/pub/zew-docs/dp/dp12021.pdf

Heinmiller, B. (2007). Politics of Cap and Trade Policies. *Natural Resources Journal*, *47*, 445–467.

Hunter, J. (2014). B.C. Liberals pull plug on key part of climate-change strategy. *The Globe and Mail*. Retrieved from http://www.theglobeandmail.com/news/british-columbia/bc-liberals-pull-plug-on-key-part-of-climate-change-strategy/article21250599/

ICAP. (2016). *Emissions Trading Worldwide: International Carbon Action Partnership (ICAP) Status Report 2016*. Berlin: ICAP.

Institute for Climate Economics. (2015). *Recycling EU ETS carbon revenues for further emissions reductions*. Retrieved from http://www.i4ce.org/

Jaccard, M., Hein, M., & Vass, T. (2016). *Is Win-Win Possible?* Retrieved from http://rem-main.rem.sfu.ca/papers/jaccard/Jaccard-Hein-Vass CdnClimatePol EMRG-REM-SFU Sep 20 2016.pdf

Koch, M., Fuss, S., Grosjean, G., & Edenhofer, O. (2014). Causes of the EU ETS price drop: recession, CDM, renewable policies or a bit of everything? – New evidence. *Energy Policy*, *73*, 676–685.

Kreiser, L., Duff, D., Milne, J. E., & Ashiabor, H. (2013). *Market Based Instruments: National Experiences in Environmental Sustainability*. Edward Elgar Publishing.

Lachapelle, É., Papy, J., Pineau, P.-O., & Trudeau, H. (2017). *Enquête sur les entreprises touchées par le système de plafonnement et d'échange de droits d'émission de gaz à effet de serre au Québec (SPEDE)*. Retrieved from https://www.cirano.qc.ca/files/publications/2017RB-01.pdf

Levac, D., Colquhoun, H., & O'Brien, K. K. (2010). Scoping studies: advancing the methodology. *Implementation Science*, *5*(1), 69.

Lupick, T. (2014). Environmentalists deconstruct B.C. Liberals' new rules for LNG emissions, argue it's all about optics. Retrieved from http://www.straight.com/news/761906/environmentalists-deconstruct-bc-liberals-new-rules-lng-emissions-argue-its-all-about-optics

McCarthy, S. (2016). Uncertainty over California cap-and-trade program could impact Ontario. Retrieved from http://www.theglobeandmail.com/report-on-business/industry-news/energy-and-resources/uncertainty-over-california-climate-plan-puts-ontario-in-precarious-position/article32152108/

Mcmahon, T., & Mccarthy, S. (2017). California weighs cap-and-trade change poised to raise costs in Quebec, Ontario. *The Globe and Mail*. Retrieved from http://www.theglobeandmail.com/report-on-business/industry-news/energy-and-resources/california-weighs-cap-and-trade-change-poised-to-raise-costs-in-quebec-ontario/article34903134/

Medema, S. G., & Zerbe Jr, R. O. (1995). *The Coase Theorem*. University of Colorado at Denver. Retrieved from https://pdfs.semanticscholar.org/7c0c/dc0b82cc2b3eabd1a2750418ef110b3ef6de.pdf

Merriam, S. B. (1988). *Case study research in education: A qualitative approach*. Jossey-Bass.

Ministry for the Environment: New Zealand. (n.d.). New Zealand's 2020 Emissions Target.

Ministry for the Environment: New Zealand. (2016). *NEW ZEALAND'S GREENHOUSE GAS INVENTORY 1990–2014*. Retrieved from http://www.mfe.govt.nz/sites/default/files/media/Climate Change/greenhouse-gas-inventory-snapshot-2016.pdf

New Zealand Government. (2016). *The New Zealand Emissions Trading Scheme Evaluation 2016*. Retrieved from http://www.mfe.govt.nz/sites/default/files/media/Climate Change/ets-evaluation-report.pdf

Newell, R., Pizer, W., & Raimi, D. (2012). Carbon Markets 15 Years after Kyoto: Lessons Learned, New Challenges. *The Journal of Economic Perspectives*, *27*(1), 123–146.

Nordhaus, W. D., & Boyer, J. G. (1999). Requiem for Kyoto: An Economic Analysis of the Kyoto Protocol. *The Energy Journal*, *20*(Special Issue: The Costs of the Kyoto Protocol), 93–130.

Ökoinstitut & Ecofys. (2013). *Support to the Commission for the determination of the list of* *sectors and subsectors deemed to be exposed to a significant risk of carbon leakage for the years 2015-2019 (EU Emission Trading System)*. Retrieved from http://ec.europa.eu/clima/policies/ets/cap/leakage/docs/carbon_leakage_list_en.pdf 242

Olson, M. (2015). *Cap-and-Trade Auction Design*. George Mason University.

Ontario Ministry of Environment and Climate Change. (2016). Cap and trade: program overview. Retrieved from https://www.ontario.ca/page/cap-and-trade-program-overview

Park, H., & Hong, W. K. (2014). Korea′s emission trading scheme and policy design issues to achieve market-efficiency and abatement targets. *Energy Policy*, *75*.

Partington, P., & Sharpe, V. (2016). How to price carbon so that emissions go down and citizens don't go crazy. Retrieved from https://ecofiscal.ca/2016/03/24/price-carbon-emissions-citizens-dont-go-crazy/

Patton, M. Q. (1999). Enhancing the quality and credibility of qualitative analysis. *Health Services Research*, *34*(5), 1189.

Pham, M. T., Rajić, A., Greig, J. D., Sargeant, J. M., Papadopoulos, A., & McEwen, S. A. (2014). A scoping review of scoping reviews: advancing the approach and enhancing the consistency. *Research Synthesis Methods*, *5*(4), 371–385.

Ragin, C. C. (2000). *Fuzzy-set Social Science.* Chicago: University of Chicago Press.

Ragin, C. C. (2008). *Redesigning social inquiry: fuzzy sets and beyond*. Chicago: University of Chicago Press.

Ragin, C. C. (2014). *The comparative method: Moving beyond qualitative and quantitative strategies*. University of California Press.

RGGI. (2017). Regional Greenhouse Gas Initiative. Retrieved from https://www.rggi.org/

Rihoux, B. T., & Ragin, C. C. (2009). *Configurational comparative methods: qualitative comparative analysis (QCA) and related techniques*. Thousand Oaks: Sage.

Rudolph, S., & Kawakatsu, T. (2012). *Tokyo's Greenhouse Gas Emissions Trading Scheme: A Model for Sustainable Megacity Carbon Markets?*

Sato, M., & Dechezleprêtre, A. (2015). Asymmetric industrial energy prices and international trade. *Energy Economics*, *52*(Supplement 1), S130–S141.

Schopp, A., Acworth, W. W., Huppmann, D., & Neuhoff, K. (2015). *Modelling a Market Stability Reserve in Carbon Markets*. Retrieved from http://dx.doi.org/10.2139/ssrn.2616333

Shaw, D. (2007). How projects from beyond the EU will affect carbon trading?

Sijm, J., Neuhoff, K., & Chen, Y. (2006). CO2 cost pass-through and windfall profits in the power sector. *Climate Policy*, *6*(1).

The Economist. (2012). Complete Disaster in the Making. Retrieved from http://www.economist.com/node/21562961

UNFCCC. (n.d.). Joint Implementation (JI). Retrieved from http://unfccc.int/kyoto_protocol/mechanisms/joint_implementation/items/1674.php

UNFCCC. (2015a). Background on the UNFCCC: The international response to climate change. Retrieved from http://unfccc.int/essential_background/items/6031.php

UNFCCC. (2015b). *CANADA'S INDC SUBMISSION TO THE UNFCCC*. Retrieved from file:///C:/Users/Jasus/Desktop/INDC - Canada - English.pdf

UNFCCC. (2016a). First Long-Term Climate Strategies Submitted to UN Under Paris Agreement.

UNFCCC. (2016b). Paris Climate Change Conference - November 2015. Retrieved from http://unfccc.int/meetings/paris_nov_2015/meeting/8926.php

UNFCCC. (2016c). *Report of the Conference of the Parties on its twenty-first session, held in Paris from 30 November to 13 December 2015*. Retrieved from http://unfccc.int/resource/docs/2015/cop21/eng/10a01.pdf

UNFCCC. (2016d). Summary of the Paris Agreement. Retrieved from http://bigpicture.unfccc.int/#content-the-paris-agreemen

United Nations. (1992). *UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE*. Retrieved from http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf

United States Environmental Protection Agency. (2013). *2013 Program Progress – Clean Air Interstate Rule, Acid Rain Program, and Former NOx Budget Trading Program*. Retrieved from https://www3.epa.gov/airmarkets/progress/reports/pdfs/2013_full_report.pdf

Vanderklippe, N. (2015). The cost of living in smog-choked Beijing. *The Globe and Mail*. Retrieved from http://www.theglobeandmail.com/news/world/the-cost-of-living-in-smog-infested-beijing/article27640018/

Wall, B. (2016). A better emissions solution than a revenue-neutral carbon tax. *The Globe and Mail*. Retrieved from http://www.theglobeandmail.com/report-on-business/robcommentary/a-better-emissions-solution-than-a-revenue-neutral-carbon-tax/article32352958/

Wang, C. (2001). Investor sentiment and return predictability in agricultural futures markets. *Journal of Futures Markets*, *21*, 929–952.

Western Climate Initiative. (2010). *Design for the WCI Regional Program*. Retrieved from http://www.westernclimateinitiative.org/document-archives/general/program-design/Design-for-the-WCI-Regional-Program/

Western Climate Initiative. (2016). Western Climate Initiative, Inc. Retrieved from http://www.wci-inc.org/

Woerdman, E., Arcuri, A., & Clò, S. (2008). Emissions trading and the polluter-pays principle: do polluters pay under grandfathering? *Review of Law & Economics*, *4*(2), 565–590.

World Bank Group. (2016). *State and Trends of Carbon Pricing 2016*. Retrieved from http://documents.worldbank.org/curated/en/598811476464765822/pdf/109157-REVISED-PUBLIC-wb-report-2016-complete-161214-cc2015-screen.pdf

Yamin, F. (2012). *Climate change and carbon markets: A handbook of emissions reduction mechanisms*. Routledge.

Yin, R. K. (2013). *Case study research: Design and methods*. Sage.