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Climate and Transportation Policy Sequencing in California and Quebec

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About the JCCTRP

The Joint Clean Climate Transport Research Partnership (JCCTRP) is a new research partnership that brings together leading universities, private research institutes, businesses and non-profit organizations from Quebec, California, Ontario and Vermont working on transport and climate policy. The JCCTRP Secretariat is based at the *École des sciences de la gestion* at the *Université du Québec à Montréal (ESG-UQÀM)*. The ultimate goal of the JCCTRP is to identify technical, economic and political factors shaping the potential for environmentally effective, economically efficient, and politically viable low-carbon transport and climate mitigation policy, and understand their implications for emissions trading.

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ABSTRACT

In this working paper we discuss the California-Quebec emissions trading system and its relationship with so-called "complementary policies" in the transportation sector. Quebec remains, after the brief involvement of the province of Ontario in 2018, the sole jurisdiction linked to California through an emissions trading system. But questions remain whether the complexities of California's climate policies might limit their effective replication elsewhere. The challenge is that striving for efficient and flexible regulations that account for policy interaction and sequencing requires significant technical resources, as governments often take on a larger role in designing policy components for specific sectors of the economy. While outstanding challenges remain in the transport sector in both jurisdictions, we find that many of the policies observed in California's transportation sector have been adopted by the Quebec and Canadian federal government in a manner that alleviates some concerns about replicability. The sequence by which so-called complementary transport policies have been introduced is also more complex than reported in other studies. At the Quebec and the Canadian federal government, low-carbon transport policies have both preceded and succeeded efforts to put an economy-wide price on GHG emissions. These findings point to the possibility of replicating California's suite of climate policies in a sequential manner that generates political benefits in terms of reduced and distributed costs while alleviating concerns about free-ridership. We conclude with a discussion about coordinating emissions trading and complementary policies amongst linked jurisdictions.

RÉSUMÉ

Dans ce document de travail, nous discutons le système d'échange de droits d'émission entre la Californie et le Québec et sa relation avec les politiques dites " complémentaires " dans le secteur des transports. Le Québec demeure, après la brève participation de l'Ontario en 2018, la seule province liée à la Californie par un système d'échange de droits d'émission. Toutefois, des questions subsistent quant à la complexité des politiques climatiques de la Californie et à la possibilité qu'elles ne soient pas reproduites efficacement ailleurs. Le défi réside dans le fait que la recherche de réglementations efficaces et flexibles tenant compte de l'interaction et de l'enchaînement des politiques nécessite des ressources techniques importantes, car les gouvernements jouent souvent un rôle plus important dans la conception des éléments de politique pour des secteurs spécifiques de l'économie. Bien que des défis demeurent dans le secteur des transports dans les deux juridictions, nous constatons que bon nombre des politiques observées dans le secteur des transports en Californie ont été adoptées par les gouvernements fédéral québécois et canadien, ce qui atténue certaines inquiétudes quant à la reproductibilité. L'ordre dans lequel les politiques de transport, dites complémentaires, ont été introduites est également plus complexe que dans d'autres études. Au Québec et au gouvernement fédéral canadien, des politiques de transport à faible émission de carbone ont précédé ainsi que réussi des efforts pour fixer un prix des émissions de GES pour l'ensemble de l'économie. Ces résultats indiquent la possibilité de reproduire l'ensemble des politiques climatiques de la Californie d'une manière séquentielle qui génère des avantages politiques en termes de réduction et de répartition des coûts tout en atténuant les préoccupations concernant le resquillage. En conclusion, nous discutons de la coordination de l'échange de droits d'émission et des politiques complémentaires entre les juridictions concernées.

INTRODUCTION

In this paper we discuss the California-Quebec emissions trading system and its relationship with so-called "complementary policies" in the transport sector—regulations adopted to deliver a variety of public goods in the transport sector including the reduction of greenhouse gas (GHG) emissions but also air quality, reduced congestion and sustainable communities. Since transport is responsible for 30-50% of GHG emissions in most developed economies, a clear pathway for decreasing emissions requires scaling up actions in the transport sector. Since 2014 Quebec has been, after the brief involvement of the province of Ontario in 2018, the sole jurisdiction linked to California through an emissions trading system under the auspices of the Western Climate Initiative (WCI) (Cloarec and Purdon, 2018; Houle et al., 2015; Roch and Papy, 2019). Yet while the collective GHG emissions of California and Quebec have declined in recent years, transport emissions have been rising and represent the largest share in both jurisdictions (CARB, 2018c: 4; MELCC, 2018: 7).

Comparison of the cap-and-trade and complementary policies in the transport sectors of California and Quebec has implications for climate policy and sequencing more broadly. California has long been a leader in environmental regulation in the United States (Farrell and Hanemann, 2009; Vogel, 2018). In California's transportation sector, important complementary policies now include the vehicle emissions standards, zero emissions vehicle (ZEV) mandates, the low carbon fuel standard (LCFS) as well as regional climate targets to reduce per capita vehicle GHG emissions.

But questions remain whether the complexities of California's climate policies might limit their effective adoption elsewhere. For example, in a recent study of California's cap-and-trade system, Bang et al. (2017) argued that "For policy entrepreneurs who aim not just to change policies at home, but also to generate followership in other jurisdictions, what can they do to be most effective? Our study suggests that California has, perhaps, not paid enough attention to that question, because it has designed a system that relies almost uniquely on the capabilities of California and will not be easily replicated elsewhere" (p.28). This is amplified by the fact that complementary policies currently play a dominant role in California's plans to reduce emissions through 2030 (CARB, 2008: 17; 2017a: 41). When complementary policies drive the majority of emission reductions, and apply to sources covered by a carbon price, they tend to complicate and often reduce the price signal elicited through cap-and-trade, which could prove counterproductive if improperly implemented (Böhringer and Rosendahl, 2010; Fischer and Preonas, 2010; Fischer et al., 2017; Schatzki and Stavins, 2018a).

Others have pointed out that, historically, the relationship between carbon pricing and complementary policies within jurisdictions evolves over time, with complementary policies generally coming first and generating important political benefits that allow carbon pricing to be more broadly introduced later (Levin et al., 2012; Meckling et al., 2017; Pahle et al., 2018). This is increasingly discussed under the concept of "policy sequencing" which, borrowing from the works cited above, we define as an approach to policymaking that aims to set a jurisdiction (or group of jurisdictions) on a policy pathway whereby each stage of the policy sequence strives to incrementally relax or remove barriers conducive to achieve of a subsequent, more stringent stage that allows significant cumulative increases in policy stringency over time. Policies in this light are expected to produce both measurable policy outcomes (such as emissions reductions) but also generate favourable political conditions for ratcheting up future policy stringency by shaping the economic costs of climate policy, distributing policy costs and benefits across various policy actors, cultivating institutional and governance capacity and addressing free-riding concerns. This "second-best" approach to climate policy contrasts with "first-best" policy, often associated with carbon pricing, where economic efficiency and effectiveness are given more weight in policy design (Bennear and Stavins, 2007; Kalkuhl et al., 2013). The challenge is that striving for efficient and flexible regulations that account for policy interaction and sequencing requires significant technical resources, as governments often take on a larger role in designing policy components for specific sectors of the economy.

In this paper we compare climate and transport policy diffusion and sequencing in California and Quebec in terms of policy instruments, institutions and associated legal frameworks. While outstanding challenges remain in the transport sector in both jurisdictions, we find that many of the institutions observed in California's transport sector have been adopted by the Quebec and Canadian federal governments in a manner that alleviates some concerns about the replicability of a complex suite of climate policies like California's. This includes vehicle emissions standards, low carbon fuel standard (LCFS) and zero emissions vehicle (ZEV) mandates. But there are important differences between California and Quebec's climate and transport policy. Most important are regional climate targets with which regional governing bodies are required to demonstrate compliance through complex transport system modeling efforts.

In the rest of this paper we review the history of cap-and-trade in California and Quebec, a surrogate for first-best climate policy, including examination of performance to date and recent research into the relationship between carbon pricing and complementary policies. We also summarize recent research suggesting that low-carbon prices may well be structural features of emissions trading given significant uncertainties about the amount of future abatement required. This is followed by a comparative review of the evolution of low-carbon transport policies in California and Quebec including discussion of political economy implications of each of the policy instruments. In the conclusion we discuss the implications of our findings for policy sequencing and the possibility of effectively coordinating emissions trading and complementary policies amongst jurisdictions such as California and Quebec.

California and Quebec's Experience with Emissions Trading

History of Cap-and-Trade in California and Quebec

The history of the California-Quebec emissions trading system has been discussed elsewhere, including the evolution of the WCI (Houle et al., 2015) as well as the brief entry and exit of Ontario (Cloarec and Purdon, 2018; Lachapelle and Kiss, 2019). California launched its emissions trading system in late 2012, after passage of The California Global Warming Solutions Act of 2006 (Assembly Bill 32, "AB32"), which required the state to reduce emissions to 1990 levels by 2020—a reduction of approximately 15% below emissions expected under a business as usual (BAU) scenario (CARB 2014a). In 2016, California's legislature set new targets to reduce GHGs to 40% below the 1990 levels by 2030 (CARB, 2017c). California's cap-and-trade system was extended through 2030 by way of adoption of AB398 in July 2017 (Schatzki and Stavins, 2018b). Quebec launched its own independent emissions trading system in 2013 and chose to link its market with California's through the WCI in 2014. Relative to California, Quebec set a more ambitious 2020 emission reduction target, of 20% below 1990 levels, and recently adopted a target of 37.5% below 1990 levels for 2030 (MELCC 2018a). California and Quebec base their linked cap-and-trade on an administrative agreement between the two governments, the Agreement on the Harmonization and Integration of Cap-and-Trade Programs for Reducing Greenhouse Gas Emissions (Roch and Papy, 2019; Trudeau, 2018).

Significantly, the Quebec emissions trading system preceded the Canadian federal government's Pan-Canadian Framework on Clean Growth and Climate Change (Government of Canada, 2016). While encouraging provinces to take the lead in carbon pricing, the federal carbon price is intended as a "backstop" for provinces unwilling or unable to implement a carbon pricing policy of their own; it is currently not being applied in Quebec. An official review in 2022 will confirm whether Quebec's system is equivalent to federal criteria, though questions remain regarding how equivalency will be measured (Kyriazis, 2017; Mascher, 2018).

A review of policy performance to date suggests that there are considerable benefits for Quebec from linking its emissions trading system with California in terms of reducing costs faced by Quebec firms for abatement. However, before going further, it should also be noted that the California and Quebec emission trading systems are also tools for generating government revenues. In California, a portion of auction proceedings is allocated to the Greenhouse Gas Reduction Fund (GGGF), which has received about $8.5 billion dollars to date (CARB, 2019b). In Quebec, revenue generated from auction allowances have been deposited in a Green Fund, which is to be used towards combatting climate change, waste and management or water governance (CGFV, 2018b). Over $3.7 billion CDN of funding has been sourced from the Green Fund for climate actions under the 2013-2020 Climate Change Action Plan (MDDELCC, 2018: 9).

Emission Trends, Prices and Emissions Trading on the California-Quebec Carbon Market to Date

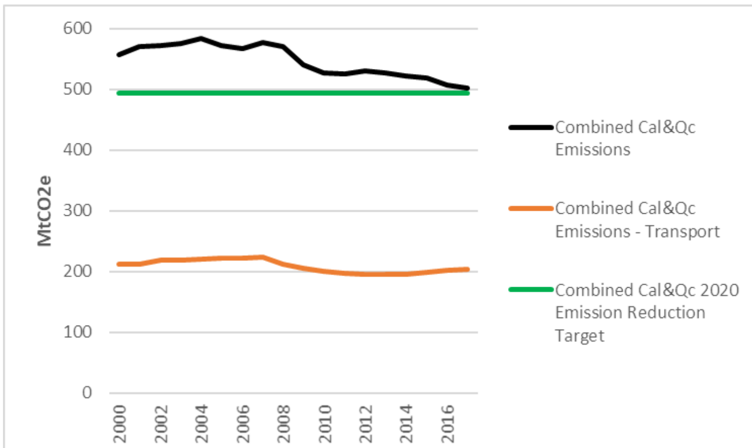
To investigate the performance of the California-Quebec carbon market we first examine trends in their combined emissions before turning to observed market prices and insights from economic modeling of emissions trading. An important insight here is that observed market prices remain well beneath market prices estimated a priori through many economic models and have not significantly departed from the carbon price floor. This discrepancy has raised concerns about the performance of the carbon market.

First, drawing on information reported in annual emission inventories for each jurisdiction, we find total emissions between California and Quebec to be declining despite a slight increase in transport emissions since 2010 (Figure 1). Due to significant emission reductions in California's power sector, by 2017 total emissions between the two jurisdictions were just 8 MtCO2e (million tonne carbon dioxide equivalent) shy of their collective 2020 emission reduction target of 494 MtCO2e. Breaking down reductions by jurisdiction, California surpassed its 1990-level emissions target by reducing emissions 0.7% below that (CARB, 2019a); Quebec reduced emissions on its territory 9.4% below 1990 levels (ECCC, 2019b).

It is important to stress that the trends above do not account for emissions trading but only report changes in each jurisdictions emission inventories. For example, Quebec's emission inventory does not account for emission reductions in California attributable to the purchase of emission allowances by Quebec firms via the carbon market.

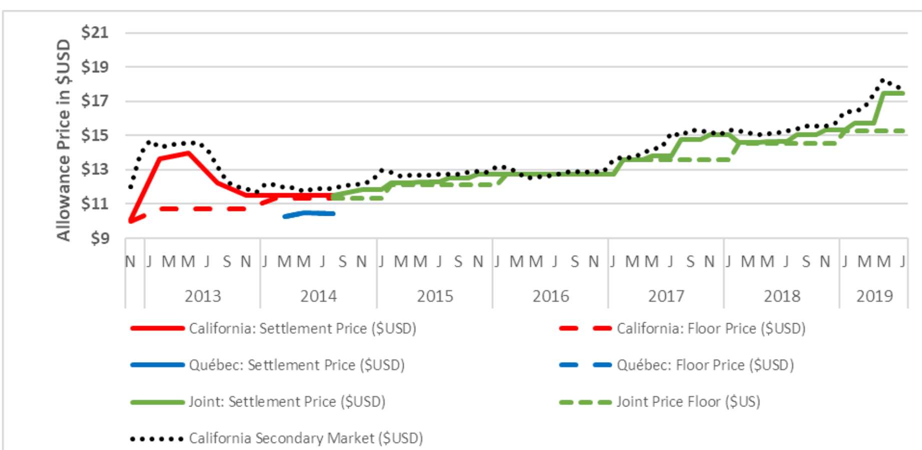
In terms of carbon market prices, we consider trends in the carbon price floor, allowance prices from quarterly auctions, known as the primary market, as well as secondary market prices, which are based on firm-to-firm trades. The carbon price floor was one of the key innovations introduce through the WCI to ensure a minimum price for auctioned allowances and preempt oversupply issues. In 2013, California and Quebec agreed to set an auction floor price of $10 USD per tCO2e which increases by 5% annually plus the rate of inflation (Purdon et al., 2014: 27), reaching $15.30 USD in 2019. As can be seen in Figure 2, primary and secondary market prices have generally hugged the price floor. At the most recent joint auction in August 2019, the primary market price stood at $17.16 USD (CARB & MELCC, 2019) while prices on the secondary market reached nearly $18 in summer 2019 (Figure 2). As we discuss below, such prices are unlikely to incentivize significant emission reductions in either jurisdiction and have generated considerable critical debate. We also note that Canadian federal carbon backstop prices are slated to rise from $20 CDN to $50 CDN (approximately $15-$38 USD) by 2022. However, the Canadian federal government recently announced it has no plans to raise prices beyond this (McCarthy and Giovannetti, 2019).

FIGURE 1: TOTAL COMBINED EMISSIONS AND EMISSIONS IN THE TRANSPORT SECTOR IN CALIFORNIA AND QUEBEC, 2000-2017



Sources: (CARB, 2019c; ECCC, 2019b)

FIGURE 2 : EVOLUTION IN ALLOWANCE PRICE FLOOR AS WELL AS PRIMARY AND SECONDARY MARKET ALLOWANCE PRICES, 2012-2019



Sources: Data concerning prices floors and primary market prices are derived from quarterly auction reports of CARB and MELCC. Price data for the secondary market comes from "California Carbon Dashboard" (calcarbondash.org) for 2012-2017 and "California Carbon Info" (californiacarbon.info) for 2018-2019.

What about actual emissions trading between California and Quebec? There is considerable uncertainty about emission trading flows between the two jurisdictions because, under current rules, reporting on allowance holdings between jurisdictions will not be made available until the close of the 2013-2020 carbon market commitment period. This issue has raised concerns about market transparency (IEMAC, 2018: 54). Yet we can gain insights into how trade flows are likely occurring by considering other evidence.

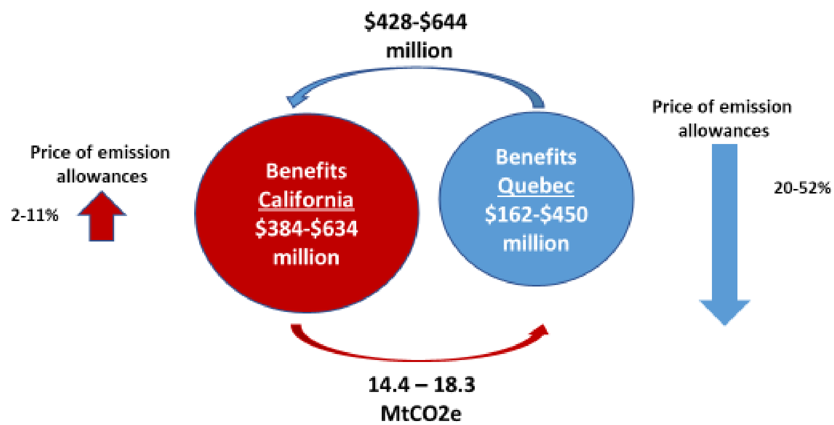
As a preliminary matter, the cost of reducing emissions varies considerably between California and Quebec. Quebec's energy sector is one of the more clean in North America, with hydroelectricity currently meeting 36% of the province's total energy demand (Whitmore and Pineau, 2018: 29). Quebec possesses the lowest electricity prices anywhere in North America due to massive hydroelectric dams (Hydro-Québec, 2018). In 2017, emissions per capita in Quebec stood at 9.4 tCO_2e, slightly cleaner compared to 10.8 tCO_2e in California (CARB, 2019a; ECCC, 2019b).

Economic models have consistently indicated that it is more expensive to reduce emissions in Quebec than California because California's energy sector has lower cost abatement opportunities. For example, previous economic modeling efforts have estimated that on average, over 2013-2020 the Quebec-California market would see Quebec firms purchase between 14.8 to 18.3 $MtCO_2e$ of emission allowances from California counterparts; this would reduce Quebec compliance costs by 20%-52% compared to the costs of reducing emissions on Quebec territory alone (Figure 3). For Quebec to reach its emission reduction goal without linking its carbon market with California's, market prices would average \$48-\$56 per tCO_2e in contrast to a linked scenario where allowance prices would average \$23-\$45 per tCO_2e. While there is a slight increase in carbon prices in California due to increased demand from Quebec firms, California is estimated to gain on average \$384-\$634 million in emissions trading inflows. Despite transfers to California, Quebec saves \$162-\$450 million in compliance costs relative to an unlinked market. We note in passing that estimated average carbon prices of the linked California-Quebec obtained from modeling efforts discussed here are well above secondary market prices of \$18 per tCO_2e observed in 2019.

Looking towards 2030, the Quebec government has modeled two carbon pricing scenarios for a carbon market linked with California (MFQ, 2017: 6 & 23). In the first scenario, prices would rise from approximately \$21 CDN per tCO_2e in 2020 to \$59 CDN per tCO_2e in 2030. In a second scenario, where prices rise more rapidly, the price of emission allowances would increase from approximately \$22 CDN (~\$16 USD) in 2020 to \$93 CDN (~\$70 USD) in 2030. From 2023 through 2030, the two scenarios were estimated to lead to a reduction of 3.6-5.3 $MtCO_2e$ on Quebec territory by 2030 and 13.8-22.8 $MtCO_2e$ due to combination of measures and purchases of emission allowances outside Quebec.

Our above discussion has demonstrated that observed carbon prices have remained much lower than anticipated in economic models prior to the implementation of emissions trading. This has raised concerns about the ability of the carbon market to deliver on both California and Quebec's emission reduction targets. One explanation for low carbon prices has been structural oversupply whereby more allowances have been issued for the carbon market than are required by firms for compliance (Cullenward and Coghlan, 2016; IEMAC, 2018). Adding to oversupply concerns, changes to the rules surrounding electricity imports and associated emissions have led to an important degree "resource shuffling" whereby California imports more low-carbon electricity from firms who continue to sell dirty electricity to consumers in other states (Cullenward, 2014; Cullenward and Coghlan, 2016). While we believe concerns about oversupply and resource shuffling deserve to be further explored, these are not the only factors contributing to low prices observed on the California-Quebec carbon market. Rules addressing oversupply have also been tightened up (Schatzki and Stavins, 2018b: 18-19), though more might still be done particularly to address oversupply allowances held in private accounts.

FIGURE 3 : CARBON PRICES AND EXPECTED BENEFITS OF TRADE BETWEEN CALIFORNIA AND QUEBEC OVER THE PERIOD 2013-2020 RELATIVE TO AN UNLINKED SCENARIO



	Prices California Unlinked \$/tCO2e	Prices Quebec Unlinked \$/tCO2e	Prices Cal-Qc Linked \$/tCO2e
Price 2013	\$15 - 34	\$37 - 43	\$16 - 35
Price 2020	\$27 - 54	\$59 - 69	\$31 -55
Average 2013-2020	\$21 - 44	\$48 - 56	\$23 - 45

Source : Purdon and Sinclair-Desgagné (2015: 13) adapted from CARB (2012: 84-86, 91-93); WCI Economic Modeling Team (2012: 7).

Relationship between Cap-and-Trade, Uncertainty about BAU Emissions and Complementary Policies in California

Recent research suggests that low carbon prices observed on the California carbon market are also a by-product of a structural characteristic of the market that make carbon prices at the price floor or price ceiling more likely than prices in between, and carbon floor prices more likely than carbon ceiling prices in the California case. As demonstrated by Borenstein et al. (2018), at root are extensive levels of uncertainty about future emissions in the absence of carbon pricing under BAU conditions and the relationship between emissions trading and complementary climate policies. Their research is unique in attempting to empirically model not only carbon pricing but also incorporate the impact of complementary policies on carbon pricing in California. We note also that their analysis assumes various degrees of effectiveness of complementary policies hitting the targets the regulator set for them, rather than directly modeling them.

Three inter-related factors drive the above dynamics. First is the large degree of uncertainty about the amount of emission reduction necessary for California to meet its economy-wide emission reduction targets. This is due both to uncertainty associated with California's BAU emissions but also to uncertainty associated with the amount of emission reductions that might be achieved through complementary policies. As Borenstein et al. (2018) demonstrate, regardless of the stringency of the cap, uncertainty about the amount of emission reductions necessary to meet it inhibits carbon market prices from equilibrating to the level of abatement necessary.

Second, relative to uncertainty about the amount of abatement required, the price responsiveness of emission reductions to current and expected prices on the California carbon market is low. Emission reductions, at least at relatively low prices investigated by Borenstein et al. (2018) in California, are fairly inelastic to carbon pricing, dampening the ability of actual carbon market prices to drive significant emission reductions. Under these conditions, complementary policies play a larger role by driving emission reductions through non-price regulations at higher implicit cost. For example, at carbon floor prices emission trading is expected to result in 18 MtCO2e of reductions over the 2013-2020 period across sectors whereas, at an administratively set price ceiling, they would only increase to about 53 MtCO2e (Table 1). In contrast, complementary policies including vehicle emission standards, LCFS and California's renewable portfolio standard would reduce 141 MtCO2e.

TABLE 1: EMISSION REDUCTIONS VIA CARBON MARKET ALLOWANCE PRICING, COMPLEMENTARY POLICIES AND OTHER NON-PRICES FACTORS

Source of Abatement Supply	Average Modeled Reductions over 2013-2020	
	MtCO2e	MtCO2e
Emission Reductions Response to Allowance Prices	Floor	Ceiling
Electricity	3.4	9.7
Transport	3.6	12.2
Natural Gas	11.0	31.2
Emission Reductions Resulting from Complementary Policies		
Vehicle Emission Standards & LCFS	78.3	78.3
Renewable Portfolio Standard	63.1	63.1
Emission Reductions Resulting from Other Non-Price Factors		
Exogenous Electricity Rate Effects	9.6	9.6
Electricity Imports	64.0	64.0
Offsets	97.7	97.7
Total	**330.8**	**365.9**

Source: (Borenstein et al., 2018: 18-19)

This brings us to the third issue: higher carbon prices necessary to achieve the necessary emission reductions may not be politically feasible. The study of Borenstein et al. (2018) is limited to "the range of GHG prices generally deemed political acceptable" (p. 3), which is between the price floor and price ceiling. Specifically, carbon prices for the California-Quebec carbon market over 2013-2020 considered in their study range from about $15 to $60 per tCO2e. Recently established a special price ceiling account at $65 per tCO2e beginning in 2021 and which will increase annually by 5% plus the rate of inflation (CARB, 2019h: §95915(f)). We note however that meeting California's 2050 climate goal is estimated to cost between $9-$124 per tCO2e and for Canada to meet its 2030 commitments under the Paris agreement could see carbon prices rise to approximately $200 CDN (~$150 USD) per tCO2e (Jaccard et al., 2016; Yang et al., 2015).

In a bid to improve the efficiency of California's climate mitigation efforts, should complementary policies be removed? Not all complementary policies may be economically efficient. First, from a political point of view, complementary policies have clear advantages. Figure 4 below reproduces modeling results from Borenstein et al. (2018) depicting emission reductions and associated prices (the emission abatement supply curve) for California, with and without complementary policies. When complementary policies are retained, the price of emission reductions remains low at approximately $15 per tCO2e until 300 MtCO2e of emission reductions are achieved, after which the price rises abruptly. In contrast, when complementary policies are removed prices begin to climb at 200 MtCO2e though in a manner that is slightly less steep. Note that, it is precisely the economic inefficiency of the complementary policies modeled in Borenstein et al. (2018) that lead to this result. Policies addressing additional market failures, including those that could enable additional emission reduction rather than directly inducing emission reduction in covered sectors, would be economically efficient and not impose higher cost emission reductions in the same way.

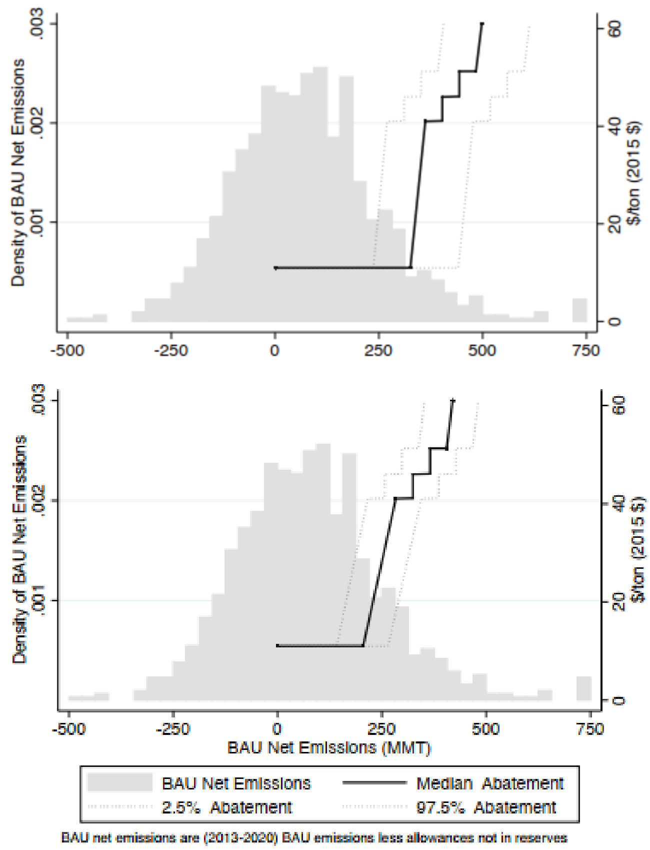
Second, let us consider the probability of improving the efficiency of the system by relying exclusively on carbon market prices to achieve required emission reductions is low. Borenstein et al. (2018) show that removing complementary policies would increase the probability of the carbon market achieving reductions sufficient for reaching California's emission target at a price between the price floor and price ceiling from only 1.2% to 8.3% (p.23). With or without complementary policies, carbon market prices are likely to be at either the price floor or ceiling over 90% of the time observed. Potential gains in economic efficiency must thus be weighed against political benefits and additional costs of maintaining complementary policies.

To summarize, until the emission reductions resulting from complementary policies are exhausted, market forces are unable to induce carbon prices to rise significantly and, as a result, they will remain close to the carbon price floor. Absent significant structural reforms and assuming significant oversupply in the form of private banked allowances does not exist, carbon market prices are likely to remain close to the floor until a threshold is crossed beyond which complementary policies are unable to deliver the required emission reductions; in that case either market prices jump. The combination of uncertainty about the level of abatement required to meet the cap and the relatively modest price-responsiveness of emissions at politically acceptable prices results in outcomes skewed towards either very high or very low prices—providing justification for both a price floor and ceiling. Overall, California's complex suite of policy instruments may be less economically efficient in aggregate than if carbon pricing were to play a larger role, but with the political advantage of reducing and distributing policy costs and benefits.

FIGURE 4: MODEL ESTIMATES OF NET EMISSIONS, EMISSION ABATEMENT SUPPLY AND CARBON PRICES IN CALIFORNIA'S CAP-AND-TRADE SYSTEM FOR THE PERIOD 2013-2020 WITH AND WITHOUT COMPLEMENTARY POLICIES

A) Abatement supply with Complementary Pocies

B) Abatement supply without Complementary Pocies



Source: (Borenstein et al., 2018: 21, 32)

COMPARING LOW-CARBON TRANSPORTATION POLICIES IN CALIFORNIA AND QUEBEC

Having discussed the general role about the relationship between the carbon market and complementary policies in California and Quebec we now turn our attention to more detailed discussion of low-carbon transport policies in the two jurisdictions. We discuss the evolution of vehicle emission standards, ZEV mandates and low carbon fuel standard (LCFS) as well as regional climate targets, notably *The Sustainable Communities and Climate Protection Act of California*, which currently has no counterpart in Quebec or Canada. We also conclude discussion of each different type of transport policy in terms of its political economy implications, significantly about how it conveys and distributes the cost of the regulation. However, the adoption of comparable low-carbon transport policies in another jurisdiction also addresses free-riding concerns that might be confronting California's policy makers. Table 2 summarizes complementary transport policies discussed in the sections below, including low-carbon transportation policies of the California, Quebec and Canadian federal governments.

TABLE 2: TIMELINE OF EMISSIONS TRADING AND LOW-CARBON TRANSPORT POLICY IN CALIFORNIA, QUEBEC AND CANADIAN FEDERAL GOVERNMENT

YEAR	CALIFORNIA		QUEBEC		CANADIAN FEDERAL GOVT	
	Emission Trading	Transport Policy	Emissions Trading	Transport Policy	Carbon Pricing	Transport Policy
1976						CAFC
1982						MVFCSA Adoption
1990		LEV I & ZEV 1				
1998		LEV II				
2002		AB1493 (Pavley 1)				
2004		ZEV 2				
2006				Link to Pavley 1		
2007		Waiver Denial & LCFS 1				MVFCSA Proclaimed
2010						GHG Emission Regulations
2012	Cap-and-Trade	ACC				
2013		LCFS Legal Challenge	Cap-and-Trade			
2014		LCFS Legal Challenge	Linking Cap-and-Trade			Link to EPA Standards
2015		LCFS 2				
2016		ZEV 4 & Sustain. Freight AP		Replicate California ZEV	Backstop Carbon Pricing	
2017						ZEV Announcement
2018						Clean Fuel Stand. Announcement
2019					Backstop CP Implemented	Link to Cal. Standards

VEHICLE EMISSION STANDARDS IN CALIFORNIA AND QUEBEC

California Vehicle Emission Standards in California

California's early efforts to address vehicle air quality established significant technical and institutional capacity in this area before the US federal government. In 1967, the California Air Resources Board (CARB) was established as the state's main air quality regulatory institution (CARB, 2019e). The status of California as the national leader of air quality regulation was subsequently cemented through Section 177 under the Federal Air Quality Act of 1967, which granted California a federal exemption to pursue stricter standards than held at a national level (Fern, 1997; Peesapati, 2018).

Since 1967, California has made use of its federal exemption on various occasions including, significant for our purposes, the low-emission vehicles (LEV) program in 1990. LEV called for phased emission standards to reduce local air pollution and also included a Zero Emissions Vehicle (ZEV) mandate, which we address in a separate section below. The LEV program was a turning pointing California environmental policy, originating out of the *California Clean Air Act* of 1988 which instructed CARB to “achieve the maximum degree of emission reduction possible from vehicular and other mobile sources” (Hanemann, 2007). In 1998, more stringent LEV II regulations were adopted to reduce criteria pollutant emissions from vehicles (CARB, 2019f).

By the 2000s, California added GHG reductions to its goal of air quality. This change formally began in 2002 with passage of the Clean Car Standards (Assembly Bill 1493, “AB1493”). AB1493 explicitly sought to modify vehicle emission standards towards the reduction of GHG emissions. The first California Assembly Bill to designate CO2 as a pollutant (CARB, 2017c), AB1493 directed CARB to adopt the maximum feasible and cost-effective reduction for major GHG emissions for all vehicles beginning with the 2009-2016 vehicle model years (CARB, 2004). For a time the standards were caught in legal incertitude. In 2007, the Bush Administration denied an EPA waiver for California—a first for the EPA—and adopted less-rigorous standards under the EISA amendments (Berck et al., 2010: 50-52). However, the Obama administration granted a waiver in 2009, allowing California to move ahead with the implementation.

In January 2012, the California government adopted additional requirements for vehicle model years 2017-2025, which were developed in a joint effort with EPA and NHTSA. Later that same year, California introduced the Advanced Clean Cars program which included updated LEV III regulations, ZEV mandate and GHG reduction rules for 2025 (CARB, 2018b). These include reducing criteria pollutant emissions from mobile sources by 75%, total 34% GHG reduction (or 4.6% reduction per year) and ensuring that 1 out of 7 new vehicles sold in the state is a ZEV (CARB, 2017b).

Vehicle Emission Standards in Canada and Quebec

Relative to California, vehicle air quality and GHG regulations arrived in Canada and Quebec later. Much of this policy innovation has been led by the Canadian federal government, rather than provincial governments. Federal government interests in early policy innovations grew out of the effects of the 1973 oil crisis and efforts to integrate the Canada-US auto market. Quebec would however push to adopt California’s Clean Car Standards in 2006 and, in 2016, adopted Canada’s first ZEV mandate which also draws on California’s experiences.

Initial federal efforts to integrate Canada-US automobile markets began with the 1965 Canada-US Auto Pact, which was only superseded by the 1989 Canada-US Free Trade Agreement and later by NAFTA (Carrillo, 2004). By many measures the Auto Pact increased productivity and regional trade (Holmes, 1992: 98); with NAFTA, cross-border trade in the auto sector has deepened (Hufbauer, 2005: 21).

Integration with the US would require adoption of US Corporate Average Fuel Economy (CAFE) (CAA & Pollution Probe, 2009; TransportPolicy.Net, 2018). In 1976, the Canadian federal government established Company Average Fuel Consumption (CAFC) targets under the authority of Transport Canada and harmonized them with the just released CAFE standards. However, attempts to make CAFC targets mandatory were not fulfilled, despite passage of the Motor Vehicle Fuel Consumption Standards Act (MVFCSA) in 1982. While it set legally binding standards similar to CAFE regulations, because US auto manufacturers with operations in Canada were already striving to meet American CAFE standards, they agreed to meet the Canadian CAFC standards voluntarily. CAFC fuel economy standards only became mandatory in 2007, when the Canadian federal government officially proclaimed the 1982 MVFCSA.

The Canadian federal government replaced the CAFC in October 2010 with the *Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations* for vehicle model years 2011-2016. These new regulations also constituted the first time the Canadian federal government sought to limit GHG emissions from the automotive sector. After their publication, the federal government announced its intention to pursue even higher standards for future model years. Regulations linking Canadian federal emission standards to US federal standards were first proposed in 2012 for MYs 2017-2025 and subsequently adopted in 2014 (Posada et al., 2018). Given the Trump administration's intention to freeze low-emission vehicle regulations in the US auto industry, the Canadian federal government in 2019 has instead chose to delink from US federal standards and align with Californian ones (Weikle, 2019).

Quebec, meanwhile, had taken action to accelerate the adoption of progressive vehicle fuel standards in Canada. In its *2006-2012 Climate Change Action Plan*, the Government of Quebec announced that it would pursue the adopt of California's Clean Car Standards beginning with model year 2009 (MDDELCC, 2008: 25-26). In 2009, the *Regulation Respecting Greenhouse Gas Emissions from Motor Vehicles* was adopted and came into force in early 2010—a few months prior to Canadian federal government standards discussed above (CCA-Quebec, 2008). However, in 2011, Quebec officially amended its vehicle emission standards to harmonized with new, more stringent Obama-era vehicle emission standards of the US and Canadian federal governments (MELCC, 2019).

Political Economy of Vehicle Emission Standards

Relative to carbon pricing, there are three political advantages for California and Quebec in adopting more stringent vehicle emission standards. First, the actual costs of the standards on consumers are indirect, conveyed through vehicle sticker prices and generally low enough to be repaid by fuel savings. Consumers are often unable to differentiate the costs of improved fuel standards from other distinguishing features of vehicles (Allcott and Knittel, 2019). Second, while the standards may have initially been focused on California, given its significant share of the US automarket, California standards oblige car manufacturers to produce cars meeting California standards rather than risk producing vehicles adhering to different standards for different markets. This is the famous "California effect" (Vogel, 1995). The upshot is that increases in vehicle costs resulting from California's policy are distributed across of North America rather than concentrated in California and other jurisdictions adopting its standards. Third, California's vehicle emission standards have been taken up by other US states and Canadian provinces, alleviating free-rider concerns. As of 2019, fourteen states have followed California's lead, evoking Section 177 and establishing vehicle GHG emission standards (CARB, 2019i); these constituted approximately 36% of all new light-duty vehicle sales in the US.

ZEV MANDATES IN CALIFORNIA AND QUEBEC

California's ZEV Mandate

Recall that California included a ZEV mandate with the introduction of its LEV regulations in the 1990s, as the ZEVs were initially viewed from the perspective of vehicle air quality (Collantes and Sperling, 2008). The ZEV mandate initially required a minimum share of new car sales to be ZEV: 2% in 1998, 5% in 2001, and 10% in 2003 (CARB, 1998). The mandate also had features to provide flexibility to automobile makers, for example, a crediting system with provisions for banking and pooling ZEV credits to grant manufacturers more flexibly manage their production schedules (CARB, 2018e). CARB also set up the Battery Technology Advisory Panel (BTAP) in 1995 (CARB, 1998). Observing sluggish progress in battery innovation, the BTAP recommended replacing the percentage quota requirement with fixed quantity quota and expanding the ZEV mandate to include hybrid-electric vehicles (CARB, 2000).

Overall, the initial phase of California's ZEV mandate, which concluded in 2003, proved an effective technology forcing policy instrument. For example, at the beginning of the mandate, there were only 2,300 ZEV credit applicable vehicles on the road in California with just six automakers offering seven models (CARB, 2000). By 2003 breakthroughs were made both in terms of battery technology and the development of hybrid vehicles. Eleven different automakers offered over 25 different ZEV and hybrid-electric models, the latter's sales reaching 140,000 for 2003 model year (CARB, 2003). Indeed, some observers argue that the most significant impact of the ZEV mandate was the emergence of hybrids (Bedsworth and Taylor, 2007).

However, California's ZEV mandate has not been without controversy. In particular, a lawsuit led by US auto manufacturers in 2002 argued that the ZEV mandate did not meet legal definitions of feasibility and reasonably cost-effectiveness. Consequently, a temporary injunction halted the mandate through 2004 after which it was restructured. Revisions included greater sophistication to reflect diversified types of vehicles; furthermore, to allow automakers more flexibility in production and sales, the yearly target was replaced by a three-year phase system.

As discussed above, California's ZEV mandate was updated when it was combined with new LEV regulations and GHG reduction rules under California's Advanced Clean Cars program in 2012. In 2016, California a ZEV credit percentage requirement of 4.5% in 2018 and 22% for 2025 (CARB, 2016) with a view to having 5 million ZEVs on California's roads by 2030 (CARB, 2019j). In addition, in 2016, ZEV policy was expanded to the truck fleet through the California Sustainable Freight Action Plan (CALTRANS, 2016).

ZEV Mandate in Quebec and Canada

The Quebec government introduced a ZEV Mandate in 2016, which came into force in 2018 (Government of Quebec, 2018). Car manufacturers are now required to accumulate a minimum number of ZEV credits for sales of ZEVs and low-emissions vehicles (LEVs), in a policy that makes explicit reference to Californian policy (MELCC, 2019). Between 2018 and 2025, the required share of ZEVs is expected to increase from approximately 3% to 20% of total vehicle sales (Whitmore and Pineau, 2018)—just slightly below ZEV requirements in California discussed above. Inspired in part by Quebec measures discussed below, Transport Canada announced in 2017 its intention to adopt a ZEV mandate by the end of 2018 (Transport Canada, 2017). However, this federal measure was still pending in early 2019.

The Political Economy of ZEV Mandates

The political economy of ZEV mandates is similar to that of vehicle emission discussed above. For example, as of 2019, eleven US states have adopted California's ZEV program (CARB, 2019i); these constituted approximately 30% of all new light-duty vehicle sales in the US. However, there are additional advantages for Quebec with its hydroelectric resources to switch towards ZEVs. Oil consumed in Quebec is currently imported mainly from Western Canada (53%) and US (40%) though up until 2015, when the reversal of the "Line 9" pipeline in Ontario and Quebec, the vast majority of oil imported into Quebec came from overseas (Whitmore and Pineau, 2018). The replacement of oil—even from other Canadian provinces—by Quebec hydroelectricity promises to reduce fuel costs for drivers in Quebec, generate additional revenue for the state since the largest producer of hydroelectricity is the state-owned utility Hydro-Quebec (Langue and Hafsi, 2010) and also aligns with nationalist sentiments which, while not as prominent as they were a generation ago, are still politically salient (Castro-Rea and Weller, 2019).

Low-Carbon Fuel Standards in California and Quebec

California's LCFS

The California government began the move toward low-carbon fuels with an executive order issued by Governor Schwarzenegger in 2007 to establish the LCFS (Kahn, 2007; Yeh et al., 2016). It has required vehicle fuel producers and distributors to reduce the carbon intensity of transport fuels by 10% by 2020 and by 20% by 2030 (CARB, 2019g). The standard operates by setting an increasingly stringent annual benchmark for petroleum fuels as expressed in carbon intensity (CI) which is a measure of carbon dioxide produced per megajoule of energy. By promoting diversification of the fuel pool, the standard is a key to reducing petroleum use in 50% by 2030 and broader emission reduction goals as set by AB32 and SB32 (CARB, 2019g). We note that the LCFS has also faced legal challenges, particularly in 2013 and 2014. The California State Supreme Court found that the program was substantively legal, but found procedural errors by CARB during the adoption process. Consequently, the program was revised and reintroduced in 2015.

The LCFS introduced a credit system for compliance to promote flexibility in achieving a carbon intensity benchmark (Yeh et al., 2016). Low-carbon fuel generates a credit, measured in tCO2e, for emissions savings relative to the annual standard based on the fuel's carbon intensity rating. Fuel producers must ensure that their total fuel sales meet the standard by either producing low-carbon fuel or purchasing LCFS credits from other parties sufficient to cover deficits. The program's market mechanism allows the credit price to adjust until the policy reduces high carbon intensity fuel use and encourages low carbon intensity fuel use so that the fuel pool meets the standard. When first recorded in 2013, credits were trading at under $20 per tCO2e, rose to $80 by the end of the year and have reach $200 per tCO2e in 2019 (Duffy, 2019; Yeh et al., 2016: 228). The LCFS has no credit price floor, and has a soft price ceiling set at $200 in 2016 and indexed to inflation thereafter. It is enforced as the price up to which available credits can be sold to cover any outstanding deficits at the end of the compliance period. If insufficient credits are available to cover deficits, deficits can be rolled over with a 5% interest penalty while maintaining compliance. Rulemaking in 2019 includes a proposed hardening of the credit price ceiling via borrowing future residential electricity credits.

Modeling is essential to California's LCFS; it provides information for estimating fuel carbon intensity and exploring the feasibility of fuel mixes to meet compliance. The standards is backed by a complex life-cycle analysis of the carbon intensity of all transport fuels entering California's market, including emissions associated with indirect land-use change (Farrell et al., 2007). Several modeling tools are used in California to assess carbon intensity ratings: a California version of the GREET lifecycle analysis model supplemented by a computable general equilibrium model and land conversion emissions factor model for alternative fuel carbon intensity; and the OPGEE model for petroleum fuel carbon intensity ratings. For California's recent climate target-setting, a Biofuel Supply Module (BFSM) was created by CARB to explore low-carbon fuel supply through 2030 (Duffy, 2019).

The program has proven effective at increasing the flow of low-carbon fuels into California. Over 2011-2017, the contribution of alternative fuels grew from 6.2% of California's transportation fuels to 8.5%, the average carbon intensity of all alternative fuels reported to the program declined 36% and resulted in estimated emissions reductions of 38.3 MtCO2e from baseline levels (Witcover, 2018).

Canada's Clean Fuel Standard

Transport Canada is working with Environment and Climate Change Canada (ECCC) as well as Innovation, Science and Economic Development Canada on the development of a low-carbon fuel standard known as the *Clean Fuel Standard* (ECCC, 2017; 2019a). This aims to reduce fossil fuels use in Canada not just in transportation but also industry, homes and buildings. It is expected to result in annual reductions of 30 MtCO2e by 2030. According to ECCC, the regulatory proposal for the liquid fuel class is expected to be unveiled in early 2020 with implementation scheduled for 2022. Regulations for gaseous and solid fuel streams will be finalized in 2022, to take effect in 2023. In July 2018, ECCC issued a call for tenders for a fuel life cycle analysis model to support the standard (ECCC, 2018). The model is now under development and expected to be launched publicly in 2021.

Political Economy of Low Carbon Fuel Standards

As discussed earlier, California's LCFS is expected to generate significantly greater emission reductions in the transport sector than might be achievable through emissions trading. How is this possible? Political economy factors offer a potential explanation.

First, relative to carbon pricing, California's LCFS introduces a higher, more focused, carbon price because it is applied only towards emissions relative to carbon intensity standard. In contrast, carbon pricing puts a price on all GHG emissions associated with a fuel, except biogenic carbon, which is often exempted. This leads to a second major difference: carbon intensity standards penalize the production of high-carbon intensity fuels while subsidizing low-carbon intensity fuels. This carries some attractive features politically as the LCFS incentivizes the production of low-carbon fuels without prompting as many fundamental changes in human behaviour as a similarly denominated carbon market price would. In essence, the LCFS does not require as much behavioural change to reduce emission because of its lower impact at the pump; it still incentivizes producers to bring more low-carbon fuel to market. Cap-and-trade raises the price of carbon within all fuels, which encourages individuals to drive less, and favors fuels lower in carbon, but is obviously more politically salient.

We present a numerical example in Table 3 below that demonstrates how a carbon intensity standard contrasts to carbon pricing using two fuels, one with characteristics similar to diesel and the other similar to renewable diesel, and with carbon intensity ratings set *for both policies* at levels similar to those seen in the LCFS. Absent any policy, these two fuels cost a hypothetical $3 and $4 per gallon to supply, respectively. In the example, the carbon intensity standard of is set at 90 gCO2e/MJ, which is an approximately 10% reduction relative to diesel. We walk through two carbon price scenarios: a first is set at $20 per tCO2e, which reflects current cap-and-trade allowance market price, and the second $200 per tCO2e—which is nearly three times carbon market price ceilings but in line with current LCFS credit prices.

Results point to politically salient outcomes. First, regardless of the price put on carbon, the cost of bringing diesel to market is higher under cap-and-trade than under the LCFS whereas the cost of supplying renewable diesel is lower—the LCFS actually subsidizes the production of low-carbon fuel. Second, the increased cost of diesel under the LCFS at a cap-and-trade price of $200 per tCO2e is $0.27/gallon, similar to the additional cost of diesel at a carbon market of $20 per tCO2e. Third, given our initial production costs, the impact of both policies is to shift the relative cost of supply fuels in favour of low-carbon ones. But the price change felt at the pump is muted for diesel under the LCFS relative to cap-and-trade. Both the LCFS and cap-and-trade at $200 per tCO2e bring the cost of renewable diesel below diesel, but the LCFS does so at a lower fuel cost.

One final consideration is worth noting: the LCFS evaluates the carbon intensity of fuels over their full life cycle regardless of where such emissions occur. Most carbon pricing policies assess emissions which occur within a jurisdiction's boundaries. Since most of the emissions from biofuel production occur in agricultural systems, which are typically excluded from cap-and-trade programs, and can occur outside jurisdictional boundaries, cap-and-trade systems often lack the ability to assess the full fuel life cycle impacts. This means most carbon pricing systems treat biofuels as having a carbon intensity of zero, which can give them a policy advantage far in excess of their actual emissions-reducing effect.

TABLE 3: COMPARISON OF CHANGES TO THE COST OF SUPPLY TRANSPORT FUELS BETWEEN CAP-AND-TRADE AND LCFS

Fuel Type	Carbon Price	Carbon Intensity	Energy Density	Production Costs	Changes to Cost of Producing Fuels		Total Supply Costs after Policy	
					Cap-and-Trade	LCFS	Cap-and-Trade	LCFS
	$/tCO2e	gCO2e/MJ	MJ/gallon	$/gallon	$/gallon	$/gallon	$/gallon	$/gallon
Carbon Price of $20 per tCO2e								
Diesel	$20	100	135	$3.00	+$0.27	+$0.027	$3.27	$3.03
Renewable Diesel	$20	40	125	$4.00	+$0.10	-$0.125	$4.10	$3.87
Carbon Price of $200 per tCO2e								
Diesel	$200	100	135	$3.00	+$2.70	+$0.27	$5.70	$3.27
Renewable Diesel	$200	40	125	$4.00	+1.00	-$1.25	$5.00	$2.75

CLIMATE POLICY AND REGIONAL PLANNING IN CALIFORNIA

History of Regional Transport Planning in the US

In this final significant low-carbon transport policy, we shift from jurisdiction-wide policies to regional/municipal policies. The expansion of California environmental legislation has had significant impacts on regional transportation planning, which really began in the US in 1962 with the passage of the Federal Aid Highway Act. The act mandated that any metropolitan area with a population of greater than 50,000 create a metropolitan planning organization (MPO) that would facilitate a "continuing, comprehensive, and cooperative" transportation planning process in order to obtain federal transportation funds (Sciara, 2017). MPOs fulfill this mandate by creating regional transportation plans (RTPs), which are produced every five years and define the MPO's vision for transportation investments over the next twenty years (Sciara and Handy, 2017). The bulk of day-to-day operation of MPOs involves assessing the impact of planned investments using transportation forecasting models necessary for the RTP (Bollens, 1997; Sciara and Handy, 2017).

The passage of Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991 greatly changed the role of MPOs. For the first time, transportation planning was linked with air quality planning. Metropolitan areas were categorized into attainment areas defined by the severity of air pollution (Sciara, 2017). Any metro area that was out of attainment (e.g. at least one criteria pollutant above the federal standard) had to develop a transportation plan that would support attainment (CARB, 2017d). Another important addition introduced by ISTEA was a budget constraint: all investments must have an identified revenue source (CARB, 2017d). These changes have meant that, even without legislative or budget authority, MPOs now have substantive influence on the content of the RTP (Sciara, 2017).

Climate Policy Extends to Regional Planning in California

As part of the efforts to reach California's 2020 emission reduction targets, *The Sustainable Communities and Climate Protection Act* of 2008, (State Bill 375, "SB375") was passed in a manner that builds on the federal regional transport planning process above. First, SB375 required that MPOs adopt "Regional Plan Climate Targets" which are expressed as a percent change in per capita passenger vehicle GHG emissions relative to 2005 (CARB, 2018d). These regional targets are thus different from absolute caps of California's cap-and-trade program and focus on per capita GHG emissions reductions resulting reductions in vehicle miles traveled (VMT). Each of California's 18 MPOs has a specific regional climate plan target determined by CARB. Across California, relative to 2005 levels, current MPOs plan for a 9.6% reduction in per capita passenger vehicle GHG emissions by 2020 and an 18% reduction by 2035 (CARB, 2018a: 22-23).

Second, SB375 also required that a Sustainable Communities Strategy (SCS) be incorporated as an element into the RTP. The SCS requires: (i) a land use element that accommodates all forecast population growth and (ii) a transportation network to meet all regional needs (ILG, 2015). In effect, the SCS "identifies strategies to reduce greenhouse gas emissions from driving, which can also foster healthier and more equitable and sustainable communities" (CARB, 2019d). Some flexibility is offered in that, if the region is unable to meet its original SCS reduction targets, it has the option of preparing an Alternative Planning Strategy (APS) which is free from some of the budgetary and political constraints applicable to the SCS (CARB, 2019d).

SB375 has also resulted in significant changes in the RTP process. It requires each RTP be consistent with the SCS, and both must be consistent with the regional housing plan. For the first time, land use and transportation planning are directly linked in formal law. Under SB375, CARB determines SCS compliance, giving the state agency a new direct role in the RTP process. Finally, SB375 has led to transport systems models playing a larger role in the policy process. Transportation forecasting models have become critical to the demonstration of RTP compliance with federal and state air pollution and GHG reduction requirements.

However, the effectiveness of SB375 in achieving regional pollutant emissions reduction and GHG reduction is questionable. All of California MPOs areas are under nonattainment for at least one criteria pollutant (CARB, 2017d) while GHG emission reduction and VMT targets for 2020 are not expected to be met any Californian MPO (CARB, 2018a: Appendix A, A2-A4). Furthermore, CARB and MPOs also struggle with regional data on VMT and GHG emissions necessary for evaluating SB375 (CARB, 2018a: 23-24). Finally, although CARB has not yet imposed penalties for non-compliance, the lack of progress in VMT reduction may generate additional regulatory efforts (CARB, 2019d).

Regional Climate and Transport Policy in Quebec

Regional plan climate targets to reduce per capita vehicle GHG emissions backed by complex transport modeling processes and tied to federal and state funding, as observed in California above, do not appear to have a counterpart in Quebec nor Canada. While efforts to reduce municipal and related transport emissions do exist, they appear largely voluntary and not tied to funding or compliance purposes. We focus our discussion below on Montreal, the largest metropolitan area in Quebec and demonstrates many of issues at play in other Quebec regions.

We first begin with municipal efforts. The City of Montreal has adopted *Montreal's 2013-2020 Citywide GHG Emissions Reduction Plan*, which sets a 30% GHG reduction target for the city relative to 1990 levels (Ville de Montréal, 2018). The plan includes 12 actions including a transition in modes of transport and the development of public transit. While the city's efforts have so far led to a reduction of emissions to 28% below 1990 levels, most of the emission reductions were from fixed sources while transport emissions slightly increased (Ville de Montréal, 2019: 6-7). This is attributed to the growth of vehicle use, the increasing number of SUVs and light-trucks and a decrease in the modal share of public transit despite significant investments (Ville de Montréal, 2018). More recently, the City of Montreal's *2016-2020 Transportation Electrification Strategy* proposed the purchase of nearly 1,000 electric or hybrid buses by 2025 and the exclusive acquisition of eclectic buses thereafter. Montreal is also aiming to install 1000 electric charging stations by 2020 in the collaboration with the provincial government (Ville de Montréal, 2016).

Looking to the wider Montreal region, all municipalities are represented under the authority of the *Communauté métropolitaine de Montréal (CMM).* It has authority in the planning, coordination and funding of land use, public transit, economic development, social housing and environment (CMM, 2019). In 2012, the CMM published its *Metropolitan Land Use and Development Plan* (PMAD). The plan aims in particular to increase the modal share of public transport at rush hour from 25% to 30% by 2021 and to 35% by 2031. However, to the best of our knowledge, transport system modeling is not required to demonstrate conformity with the PMAD.

A new body for to administer and coordinate public transport was introduced in the Montréal region in 2017, known as the *Metropolitan Transportation Regional Authority* (ARTM). For example, the City of Montreal has its own public transportation service, the *Service de Transport de Montréal (STM)*, but its coordination with other transport services in the larger metropolitan area is governed by the ARTM. However, to the best of our knowledge, the ARTM's decision-making is not based on transport system modeling to demonstrate conformity with the GHG emission reduction commitments of either the City of Montreal nor Quebec provincial government.

The situation contrasts to a certain degree with new infrastructure programs of the Canadian federal government, which require an evaluation of GHG emissions but uses relatively simple evaluation tools associated with carbon offsets. In 2016, Infrastructure Canada's *Investing in Canada Plan* committed $29

CDN billion (~$22 USD billion) and $27 CDN billion (~$20 USD billion) were allocated, respectively, to public transit and green infrastructure across the country over a 12-year period (Infrastucture Canada, 2018; 2019b). In the area of green infrastructure, the allocation of funds to provinces and municipalities is undertaken by Infrastructure Canada through their *Climate Lens* programme, intended to support the *Pan-Canadian Framework* (Infrastucture Canada, 2019a). It requires that emission reductions from new federally-funded infrastructure projects should be calculated using rules similar to carbon offset protocols. While perhaps of similar objectives to transport modeling requirements in California, such carbon offset protocols are much less sophisticated than the modeling efforts underway in California (Wara, 2008).

Political Economy of Regional Plan Climate Targets

In comparison to other complementary climate policies in the transport sector the political economy of reducing regional per capita vehicle GHG emissions would appear to be more challenging because it requires changing peoples driving behaviour and reducing VMT—goals similar to carbon pricing. Ostensibly, a significant portion of regional climate targets might be realized by switching to low-emission fuels and vehicles, but it is unclear to what degree.

However, relative to carbon pricing, regional plan climate targets have certain advantages. The most important is that strategies for reducing VMT, such as redesigning land-use plans to reduce commute times and promoting public transportation, can be developed by the same regional governments that negotiated the targets with CARB. Regional governments have at their disposal relatively sophisticated transport system models which allow regional governments to gauge what set of strategies are most promising. Ideally, using these tools, regional governments might negotiate regional per capita vehicle GHG emissions strategies that are feasible.

But regional government bodies face two additional challenges: managing regional transport systems that are complex while the SB375 lacks of significant flexibility mechanisms to facilitate compliance. For example, while a statewide market for regional per capita vehicle GHG emission might be envisioned, this would run against the regional focus of *The Sustainable Communities and Climate Protection Act*. This lack of flexibility helps also explain why CARB has been reluctant to impose severe penalties for poor performance to date.

Discussion and Conclusion

Our review of emissions trading and complementary policies in the transportation sector in California and Quebec points to the possibility of replicating California's suite of climate policies in a sequential manner that generates political benefits in terms of reduced and distributed costs while alleviating concerns about free-ridership in jurisdictions linked by emissions trading. In addition to joining California in establishing North America's largest emission trading system, Quebec has adopted many innovative transport policies from California. These include the recent adoption of a ZEV mandate and also, previously, California's vehicle emission standards—though Quebec has deferred to the Canadian federal government for these matters when federal efforts were judged sufficiently stringent. The Canadian federal government has taken leadership on the development of a policy instrument akin to California's LCFS. Overall, climate and transport policies similar to those in California have been introduced in Quebec in a consistent manner since at least 2006.

Overall, such results may indicate a tendency on the part of jurisdictions to follow the blueprint laid out by California's climate policies—including the technical underpinning—rather than begin with a clean slate. In this regard, the existence of such a blueprint may actually lessen the technical strain on later policy adopters, since the technical requirements for following a blueprint are more apparent *a priori* than for developing one. One important gap, however, is replication of California's policy to reduce regional transport emissions through a regional planning process backed by transportation modeling requirements. Though California's efforts here have not yielded significant results, regional climate targets are an innovative effort to address transport related emissions by targeting land-use and regional planning. While more attention needs to be given to developing the technical capacities of Quebec and the Canadian federal government for such a complex suite of policy instruments, partnership with California offers important opportunities for policy learning.

Institutional capacity, defined here as a jurisdictional government's "ability to overcome opposition from vested interests in policy formulation" (Meckling and Nahm, 2018: 743), is also an area where important insights might be gained from the California experience. California's Air Resources Board is a state agency that designs policy in response to policy goals set by the California state legislature (Collantes and Sperling, 2008; Meckling and Nahm, 2018). Until quite recently, the Quebec government had been moving in a similar direction, establishing in 2017 *Transition énergétique Québec* (TEQ)—a state agency with a mandate to support Quebec's transition towards an efficient and low-carbon energy economy under the 2030 *Energy Policy* (MERN, 2017). However, in summer 2019 a recently elected Quebec government sought to reassert control over the climate file, including the abolition of TEQ and reorganization of the Green Fund (Barbeau and Bovet, 2019). Some observes have raised concerns about the potential for increased political interference in the policy process.

The sequence by which so-called complementary policies have been introduced in Quebec is also more complex than reported in other studies. Prior to embarking on emissions trading, Quebec already sought to adopt California's vehicle emissions standards when it was perceived that the Canadian federal government was not moving fast enough. Even after linkage, the province would introduce a ZEV mandate while deferring to a new Canadian federal government for stronger Obama-era vehicle emission standards. While the Canadian federal government has since 2016 made carbon pricing a keystone of its national climate policy, it has recently pivoted to California's even more stringent vehicle standards, pursued an equivalent to California's LCFS while also announcing a limit on carbon pricing at $50 CDN (approximately $38 USD). Both at the Quebec and Canadian federal government levels, low-carbon transport policies have preceded and succeeded efforts to put an economy-wide price on GHG emissions.

The fact that California, Quebec and Canadian federal governments continue to pursue additional low-carbon transport policies even after introducing carbon pricing suggests that jurisdictions serious about climate change find carbon pricing to have political limits that prevent it from rising high enough and rapidly enough to drive significant emission reductions in the transport sector. As we have seen in our discussion of the political economy implications of various low-carbon transport policies adopted by the Quebec and Canadian federal governments, such policies convey considerable political benefits by reducing and distributing costs and linking low-carbon transport policy with other issues, notably air quality, traffic congestion and sustainable communities. Many low-carbon transport policies have evolved from early efforts to tackle air quality and fuel economy, which has arguably generated a self-reinforcing political effect.

Arguably, despite low carbon market prices, emissions trading helps in this sequencing process by generating revenues for redistribution. In California, a portion of auction proceedings is allocated to the Greenhouse Gas Reduction Fund (GGGF), which has received about $8.5 billion dollars to date (CARB, 2019b). The top three programs funded through the carbon auction revenues have been High Speed Rail ($2.5 billion), Low Carbon Transportation ($2.2 billion), and Affordable Housing and Sustainable Communities program ($1.9 billion) (CARB, 2019c). In Quebec, more than 80% of the Green Fund budget has been allocated to the Ministry of Transport (MTQ), the Ministry of the Environment and the Fight Against Climate Change (MELCC) as well as, until recently, TEQ (CGFV, 2018a). While there have been concerns about how effective such carbon revenue has been deployed towards the achievement of emission reduction goals, their distributive effects appears important for the complex sequence of climate and transport policies found in California and Quebec.

These findings also allow us to revisit the debate about emissions trading and complementary policies. If complementary policies force emission reductions that are relatively more costly than other opportunities in that jurisdiction, then they contribute to low carbon market prices there. This complicates the economic rationale for emissions linking, since carbon market prices observed in California, for example, do not actually represent the cost of the full suite of policy measures the state is using to reduce emissions.

Nonetheless, we can consider two scenarios in light of the above dynamics depicting relations between California and a jurisdiction like Quebec where the costs of abatement are higher. If a jurisdiction linked with California's carbon market has no complementary policies, then the purchase of low cost emission allowances from California would be a great bargain—meaning that the linked jurisdiction is acquiring emission reductions at a price below their actual costs to California. However, if the jurisdiction has complementary policies similar to California's, then the exchange of emission allowances between them is more equitable as each jurisdiction is absorbing higher costs to reduce emissions on its territory through complementary policies. Our review of the evolution of low-carbon transport policies in the case of California and Quebec suggests that the situation is, albeit imperfectly, more akin to the second scenario.

From a political perspective, California's willingness to link with jurisdictions like Quebec may be seen as a strategy to induce greater emission reduction efforts where it is currently more expensive to reduce emissions. In its current state, California's cap-and-trade system may be better regarded as an instrument for incentivizing and sharing the burden of reducing emission collectively. But for such a combination of explicit and implicit carbon prices to be politically acceptable from California's perspective, partner jurisdictions need to adopt similarly stringent complementary policies that can drive emission reductions until carbon market prices themselves have the political support needed to be ramped up. Put differently, linkage may actual be an incentive to such jurisdictions to ramp up their complementary policies, with the knowledge that low-cost abatement opportunities exist through the carbon market should such policies deliver fewer reductions than anticipated.

This conclusion is complicated by the fact that oversupply and resource shuffling might also be expected to continue to depress prices on the California-Quebec carbon market. Adopting rules to further tighten up oversupply and resource shuffling would improve conditions for linking emissions trading as market prices would more clearly reflect abatement costs. Further research endeavoring to distinguish the effects of oversupply, resource shuffling and complementary policies would be worthwhile, especially if extended to jurisdictions like Quebec linked with California on emissions trading.

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