Municipal Climate Planning in Regions under Cap-and-Trade

by

Evelyne St-Louis

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Department of Geography
McGill University
Montréal (Québec) Canada

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ABSTRACT

As both state-level cap-and-trade policies and municipal-level CAPs (Climate Action Plans) are increasingly prevalent strategies in climate change governance in the U.S., it is necessary to examine their interactions. Cities in regions under cap-and-trade are limited in their ability to contribute to aggregate emission reductions below the cap level because of the "emissions floor" effect. This study seeks to assess whether these cities modify their CAPs according to this constraint. Using a sample of 20 Californian CAPs, since California is under the Western Climate Initiative cap-and-trade program, and 20 CAPs from states not regulated by cap-and-trade, I quantitatively analyse the emission reduction targets allocated to different sectors; I complement this by a qualitative review of the Californian CAPs. I find no significant difference in how cities under cap-and-trade assign mitigation efforts between capped and non-capped sectors, compared to cities not under cap-and-trade. I discuss the implications of this, and recommendations to facilitate the successful coexistence of cap-and-trade and CAPs.

CHAPTER 1: INTRODUCTION

As climate change is increasingly considered a prominent concern in different spheres of society, people are looking for new ways to deal with this pressing issue. For example, recent trends in environmental governance in the U.S. indicate the changing role of subnational governments in climate change mitigation. There has been a more widespread use of greenhouse gas (GHG) cap-and-trade schemes at the state-level, as well as a tendency for municipalities to draft their own climate change plan and mitigation goals (quantified target emission reduction goals). Although these attempts demonstrate a willingness to engage with the alarming issue of global warming, it is important to examine the weaknesses and limitations of these approaches, because this is the only way to come up with better, more impactful solutions.

The purpose of this article is to contribute to the body of work evaluating the implications and effectiveness of environmental plans and policies. If multi-scaled approaches to dealing with climate change – which imply the involvement of, and action from, several levels of government – are today seen as one of the preferred methods to deal with climate change, then it becomes crucial to assess how plans and policies at different scales will interact, and how this will affect the overall potential for mitigation. There is an important knowledge gap here, which I try to fill in part through this research. Namely, I examine the relationship between cap-and-trade policies, adopted at the state-level in the U.S., and municipal level mitigation planning.

This study focuses on the implications of an inherent feature of cap-and-trade, which limits the ability of cities to further reduce aggregate emissions below the cap. Indeed, once a cap-and-trade system has implemented a cap on emissions from complying sources, this cap becomes a kind of emissions floor. Additional emission reductions achieved by outside sources (not covered by the program) in sectors covered by the cap-and-trade simply 'free up' extra emissions for complying sources. Hence, the sectors in which cities place their mitigation efforts (transportation, energy, waste etc.) have a considerable impact on their ability to contribute to overall (aggregate) emission reductions.

Therefore, the main research question of this study is: do cities in regions regulated by cap-and-trade plan their mitigation efforts differently than cities in regions not regulated by cap-and-trade? The hypothesis I explore is that cities under cap-and-trade allocate *less* of their total mitigation efforts to action in capped sectors – and thus *more* in non-capped sectors – comparatively to cities not under cap-and-trade. This hypothesis assumes that cities regulated by cap-and-trade respond in an economically rational way to the state policy they are under, and adapt their mitigation measures according to the "emissions floor" constraint placed on them. However, if this hypothesis is incorrect, how may we explain the alternative observations? What motivations explain the elaboration of CAPs? What impact does this have for climate change policy-making at various levels of government? What recommendations can we make to improve the coordination of climate change action at the municipal and state levels?

To answer these questions, I analyse municipal climate action plans (CAPs) from across the U.S, comparing CAPs in regions regulated and non-regulated by cap-and-trade. I use a sample of 20 Californian cities as my treatment group (under cap-and-trade), and a sample of 20 cities from various U.S. states as my control group (not under by cap-and-trade). Indeed, California joined the Western Climate Initiative (WCI) in 2007, and entered the first compliance period of this cap-and-trade system in January 2013. I approach the research questions mainly from a quantitative perspective. To quantify and analyse how cities plan their mitigation efforts, I use the emissions reduction targets as outlined in the CAPs. In particular, I look at the proportion of the total emissions reduction target attributed to each economic sector (energy, transport, waste, urban forestry offsets and 'other'). It is key to understand that some of these sectors are covered by the cap-and-trade scheme, such as the energy and transportation sectors in the case of the WCI, but others are not, such as the waste sector. Therefore, the partitioning of the total reduction target between these different sectors has an influence on the overall ability of a city under cap-and-trade to contribute to additional emissions abatement below the level of the cap. I complement the statistical analyses with a qualitative component, in which I informally review the Californian CAPs to see whether cap-and-trade is mentioned, and if so, how it is positioned in relation to the city's efforts.

The results of the quantitative study seem to indicate that cities under cap-and-trade (treatment) do not plan their mitigation reductions between sectors significantly differently than cities not under cap-and-trade (control). In other words, treatment cities attribute approximately as much of their target reductions to capped sectors as control cities. The qualitative review of the CAPs appears to confirm this finding. Hence, my results go against the hypothesis enunciated above. This triggers critical questions concerning cities' reasons for elaborating CAPs, and concerning the importance attributed to them if, in fact, they are limited in their ability to provide additional aggregate reductions below the level of the state cap. In particular, one alternative motivation of CAPs may be to reduce *local* GHG emissions, as opposed to *aggregate* emissions – which would have different implications within the context of cap-and-trade. I also explore other possible motivations for municipal climate planning, viable approaches and goals for CAPs under cap-and-trade, and recommendations to achieve these goals.

This research topic is of particular relevance because cap-and-trade is currently one of the preferred mitigation policy instruments, so there is a need to examine the implications of its implementation. In fact, the province of Quebec agreed to adopt cap-and-trade and joined the WCI in 2008. Quebec also entered the first compliance period in January 2013. In parallel, we are also seeing a multiplication of municipal mitigation efforts throughout the province. Therefore, conclusions drawn from this study may be applied to the Quebec context. More generally, this study will contribute to more informed municipal climate change planning. It is also a step forward in understanding the interactions – at times counter-productive– that can occur between policy instruments at different governmental scales.

With this in mind, the paper is organized in the following way. In Chapter 2, I provide a review of the literature, to present the theoretical background of my research questions, and to demonstrate the knowledge gap I address. This involves questions of political geography, urban planning for climate change, and the interaction between state-level cap-and-trade and CAPs. In Chapter 3, I present the methodology I developed for this research, thus going over the choice of California as the main area of study, the sampling techniques, and the statistical methods. In Chapter 4, I present the main results and their analyses, for both the quantitative and qualitative components of the study. In Chapter 5, I develop an in-depth discussion of these results. I explore the possible scenarios corresponding to the data findings, and their implications in terms of future climate policy making. Finally, I draw the final conclusions in Chapter 6.

CHAPTER 2: LITERATURE REVIEW

In this chapter, I will place my research questions within a broader theoretical context, and highlight the knowledge gap these questions address. First, to introduce the topic of environmental governance from a political geography perspective, I examine the different scales and types of environmental regulation, focusing on the U.S. and California since the 1990s. Namely, with the relative inaction of the federal government on the climate change front, subnational governments have become more involved in mitigation policies, and cap-and-trade is today a common approach adopted at the state level. Second, I shift the attention to the recent impetus for CAPs, and take on more of a planning perspective. Although the popularity of CAPs has been appraised as a positive step forward, researchers have raised doubts about their role within the larger framework of climate change planning. With these perspectives in mind, I discuss in a third section the interactions involved in multi-levelled climate governance: I review the implications of a state-level cap-and-trade policy on municipal mitigation efforts, and how a cap-and-trade system places inherent limits on the capacity of a city to contribute to aggregate emission reductions.

2.1. From a political geography perspective

We can first look at environmental and climate governance using a political geography approach. For the purpose of this research, I use a definition offered by Lemos and Agrawal (2006), which describes environmental governance as "the set of regulatory processes, mechanisms and organizations through which political actors influence environmental actions and outcomes" (p.298). This involves a wide set of actors: national, but also international, subnational and local governments, as well as "non-organizational institutional mechanisms" (p.299), such as market-based approaches. Thus, one of the most challenging issues in environmental governance has been determining the appropriate scale of action (Lemos & Agrawal, 2006; Meadowcroft, 2002). Over time, different scales of government have taken responsibility (or not) for environmental issues; alternative forms of governance, which go beyond conventional state-centered approaches, have also emerged. I will focus more particularly on the way the U.S. has evolved in respect to governance of climate change mitigation.

2.1.1. Absence of action from the federal level

It is fairly recognized that in the U.S., the federal level has not taken any major action to mitigate emissions. The non-ratification of the 1997 Kyoto Protocol by the U.S. is one main illustration of this. It not only contributed to the relative failure of the Protocol, but also impeded multilateral, international climate agreements more generally in subsequent years (Bang, Hovi, & Sprinz, 2012; Lemos & Agrawal, 2006). Although the federal government has put more effort and investment in "research and voluntary programs" (Lutsey, 2008, p.673), responsibility seems to have shifted away from the federal level through decentralization and privatization (Lemos & Agrawal, 2006). Increasingly, people are looking for solutions beyond the federal structure (Byrne, Hughes, Rickerson, & Kurdgelashvili, 2007; Sanwal, 2004).

2.1.2. Rising importance of sub-national environmental governance

Starting around the late 1990s and early 2000s, a new initiative to intervene in climate governance developed at subnational levels. Several authors have described this movement as a major bottom-up initiative (Lutsey & Sperling, 2008; Rice, 2010; Trisolini, 2010; Wheeler, 2008; Wilbanks & Kates, 1999), and Rice (2010) referred to it as a kind of "quiet revolution" in climate governance. Decisions to reduce GHG emissions and implement carbon mitigation plans were voluntarily instigated by both state and city governments. To give a few examples, the U.S. Environmental Protection Agency (EPA) has recorded that currently 32 states in the U.S have adopted climate change plans (U.S. EPA, 2012b). City climate action plans have also been multiplying: as of August 2012, 177 cities had developed complete CAPs, and more than 200 were in the process of drafting one (Boswell and Greve, 2012). A study conducted by Lutsey and Sperling (2008) shows that, between 1990 and 2007, the proportion of emissions 'covered' by a state or city GHG reduction target increased from 5% to 53% of all U.S. GHG emissions.

Why has this shift in scale of climate governance occurred? One common explanation found in the literature is that the "relative inaction at the federal level" (Lutsey & Sperling, 2008, p. 673) triggered this rise in subnational mitigation action. Because the U.S. national government did not take on a role of leadership in climate change, it left "policy room" that local governments took advantage of (Lemos & Agrawal, 2006; Rice, 2010; Schreurs, 2008). However, debates continue around this issue since other researchers, such as Millard-Ball (2012a), argue that some of the plans, particularly municipal ones, do not necessarily have the causal impact we believe them to have, and should not be portrayed as a "Plan B in the face of federal inertia" (p.12).

Indeed, the underlying motivations for implementing CAPs may not be to reduce aggregate emissions, but may in fact lie elsewhere, as we will discuss later in the paper.

2.1.3. Private forms of environmental governance and the case of California

Another major form of environmental governance is market-based mechanisms. This approach relies on economic incentives created by the market to encourage compliance to environmental regulations. Conventionally, this approach is contrasted to the traditional state command-and-control method; however, hybrids between private and public forms of governance are increasingly common (Lemos & Agrawal, 2006). Legal governmental frameworks are often required for a private form of control to be effective, through monitoring and ensuring compliance, as is the case for cap-and-trade or a carbon tax: the market motivates while the state regulates. In the following paragraphs, I review what a cap-and-trade system is, and how it functions in California in the context of the WCI.

One of the main market-based mitigation instruments is cap-and-trade, and it is becoming increasingly popular across the world (Twomey, Betz, & MacGill, 2012). Briefly, cap-and-trade is described as "an environmental policy tool that delivers results with a mandatory cap on emissions while providing emissions sources flexibility in how they comply" to this cap (U.S. EPA, 2009). It is a way to control emissions from a large number of sources, while producing an economically efficient distribution of the costs of abatement. The governmental-regulating agency sets a total maximum amount of emissions for all complying sources, for a given period of time: this is the cap. The stringency of the cap depends on the desired emissions reduction and environmental outcome. Then, emission allowances are allocated to sources under the program. Evidently, the total of all emission allowances allocated cannot exceed the cap. The covered sources can then trade their allowances in order to build a personalized compliance strategy according to their ability to reduce their individual emissions. Thus, overall emission reductions occur as the cap is reached, but the costs are flexibly distributed through the trading process: those who can easily reduce their emissions have the chance to sell their allowances, while those that cannot have the option of buying extra allowances (Millard-Ball, 2009).

In recent years, cap-and-trade programs covering GHG emissions have been used at the state level in the US. States have also formed associations to trade allowances within a larger market. Some notable cases are the Regional Greenhouse Gas Initiative (RGGI) and the WCI.

The case of California and the WCI is worth describing. The WCI was created in 2007 as a non-profit corporation to harmonize cap-and-trade programs between jurisdictions. The purpose is to encourage collaboration to achieve more cost-effective emission reductions. The WCI is also a source of technical support for the participants. Members of the WCI have changed over time; currently, participants are: California, the province of Quebec, Ontario, British-Colombia, and Manitoba. Previous members, who withdrew between 2010 and 2011, include Arizona, Washington, Oregon, New Mexico, Montana and Utah. In this study, we focus on the case of California, which is interesting because of its history and reputation as a 'green innovator' and an active state in terms of environmental action (Schmidt, 2007; Shobe & Burtraw, 2012).

California currently has a complex set of environmental legislation in place, which I review very briefly. The Global Warming Solutions Act of 2006, also called Assembly Bill 32, effectively set the objective of GHG emissions mitigation into Californian law (California EPA, 2012), and allowed the implementation of a cap-and-trade program by the California Air Resources Board. California thus seems to be on the right track since the first enforceable compliance period of its cap-and-trade program (as part of the WCI) began in January 2013. The state of California is responsible for distributing allowances within its territory, and will be reducing the cap gradually every year. Starting in 2013, the cap applies to large electric power plants and industrial plants emitting 25,000 mtCO2e/year or more. As of 2015, the program will also apply to fuel distributors – thus effectively covering all heating and transportation emissions as well (WCI, 2010). The program also includes an offset system. Offsets are emission reductions occurring outside the capped sectors; thus a capped source can gain 'credit' (net emission reduction) produced by these uncapped sources as a way of complying with the cap (Center for Climate and Energy Solutions, 2012). This concept will be important to understand later on.

Finally, note that the purpose of this paper is not to assess whether cap-and-trade is the most desirable environmental policy. Rather, it is to see how, given a cap-and-trade system, we can better understand and coordinate local action to reduce GHG emissions. I will turn to this question in section 2.3, but first, I will discuss municipal level climate planning in more detail.

2.2. From an urban planning perspective: focus on municipal level climate planning

Climate change has become one of the major challenges of urban planning in the 21st century in terms of both mitigation and adaptation (Bulkeley, Broto, Hodson, & Hodson, 2011;

Wheeler, 2008). According to the U.S. EPA (2012a), mitigation is the act of reducing GHG emissions to diminish, halt, or reverse global warming. Adaptation, on the other hand, is the act of making communities more resilient to the effects of a changing climate. Although both aspects are essential, in this study I focus on mitigation. Indeed, as "*local* institutions engage in the *global* political arena of climate mitigation" (Rice, 2010, p. 931), it is worthwhile to examine what previous literature has concluded about this movement from a planning perspective.

2.2.1 Definition of a Climate Action Plan (CAP)

Most municipal mitigation efforts have taken the shape of Climate Action Plans (CAPs). A CAP always begins with the elaboration of a GHG inventory (Hoornweg, Sugar, & Gómez, 2011). This consists of a detailed summary of all the sources of GHG emissions community-wide – not just City operations – and the associated amount of pollutant emitted (measured in mtCO2e, metric tons of carbon dioxide equivalent). Many challenges arise when drafting such inventories because city boundaries are 'blurry': emissions from outside sources (say an electricity plant outside the city but servicing the city), or from sources not directly under the city's control, such as vehicles on large highways, may or may not be included in the inventory (Hoornweg et al., 2011). CAPs thus measure a city's baseline emissions, and predict its 'business-as-usual' emissions for a given year (what the city would emit if no mitigation measure were undertaken). Most importantly, the CAP sets a target emission reduction for that same given year (Boswell, Greve, & Seale, 2010). The other essential aspect of a CAP is the list of community-wide measures intended to achieve the target set out in the plan, which fall within a wide range of sectors. Typically, policies relate to building efficiency (lighting, heating, water use), renewable energy, public transportation, walkability, bike-friendliness, efficient land-use, waste reduction, recycling, composting, as well as measures to increase urban greenery, encourage local foods and low-emission agriculture, and more generally to educate the public. It is also important to note that city leaders voluntarily elaborate CAPs (Millard-Ball, 2012a): they are not bound by legal obligation nor directly incentivized by market forces.

2.2.2. Examples around the world

The surge of climate change action from local governments has been remarkable since the late 1990s, and has not been limited to North America. One important example is the international association ICLEI – Local Governments for Sustainability, which formed in 1990 at the United Nations. It currently includes a range of cities from over 84 countries (ICLEI, 2012). This large-scale association is valuable in several ways, for example, by providing technical resources and assistance in drafting CAPs. Another example is the *Plan Climat Énergie Territorial* in France (PCET, translated as Territorial Climate Energy Plan), which has made the drafting of PCETs obligatory for a total of 440 French communities by the end of 2012 (PCET, 2012). PCETs are similar to CAPs in both content and purpose, since they are based on quantitative emission inventories and mitigation measures, though contrarily to North America, these plans are mandatory.

2.2.3. Preliminary Analysis of CAPs

As several years have passed since the initial rise of CAPs, many authors have sought to examine these plans in more detail. They have evaluated the quality of the plans (from an planning perspective), the ambitiousness of the reduction targets, the type of policies chosen, and the process and actors implicated in the plan's elaboration. Others have also looked at the motivations underlying the adoption of CAPs (Bassett & Shandas, 2010; Wheeler, 2008) and their actual causal impact (Millard-Ball, 2012a). More generally, researchers have sought to determine whether CAPs "really work", which remains a controversial topic.

On the one hand, the innovation of CAPs and the central role of cities can play in climate change has been acknowledged. For example, Kennedy, Demoullin, and Mohareb (2012) find that all the cities chosen in their sample had effectively reduced their *per capita* GHG emissions by approximately 0.27 mtCO2e/year on average. Moreover, Kousky and Schneider (2003) recognize cities' initiative as "not insubstantial" (p.369) and successful as a preliminary mitigation approach.

Authors have also puzzled at the involvement of cities in climate planning despite the issue of free riding, and have investigated motivations for implementing CAPs, that seem contrary to the economic theory of climate change as a global commons problem (Raihani & Aitken, 2011). The theory of the free rider problem can be used in this case because climate change is considered a global public good, and is thus non-excludable (Kousky, 2003), meaning that there is no way to retain, or capture, the benefits of this public good for those who helped provide it. Consequently, if one does nothing to contribute to the maintenance of the public good, one can still 'free-ride' on the contribution of others. Applied to the urban scale, we might expect that a city would tend to free ride on the mitigation efforts undertaken by neighbouring municipalities. As cities realize other cities are free riding on their personal efforts, we would also expect that the collective desire to participate in municipal mitigation efforts would diminish or eventually die down (Engel & Orbach, 2008). Various authors have studied this apparent contradiction. Notable examples are Kousky and Schneider (2003), Bassett and Shandas (2010), and Wheeler (2008), whose studies consist of interviews with city officials involved in drafting CAPs. Rice (2010) argues that through the territorialisation of carbon – the "active creation and quantification of bounded and ordered spaces of carbon-producing activities" (p.930) – city governments effectively localize climate change to their territory and perhaps overcome the local costs/global benefits disconnect. We will examine this claim later in the paper.

Finally, Dodman (2009) and Lefèvre (2012) review the main reasons why the urban scale can sometimes be ideal to tackle climate change mitigation. Firstly, cities have responsibility over land use planning, local public transportation, industrial regulations, and more generally over energy consumption in both transportation and buildings (old and new constructions) – which are all major sources of GHG emissions. Secondly, cities represent a dense organization of people, buildings, and industries. This density allows mitigation measures to be more effective than they would in non-dense areas (mass transit for example), and encourages innovation – both technological and behavioural – to emerge and spread quickly.

On the other hand, authors have criticized the planning quality of CAPs and bring up important caveats. For example, Tang, Brody, Quinn, Chang, and Wei (2010) evaluate CAPs from 40 cities and find that the plans do well in terms of awareness and knowledge of climate change, moderately well in analyzing the impacts of climate change, but do poorly in terms of action implementation. On their part, Stone, Vargo, and Habeeb (2012) argue that the targets set out by cities will be insufficient to effectively deal with climate change and more particularly, with rising temperatures, and that adaption should be more prominent in cities' strategies. To demonstrate this, they use temperature trends from 1961 to 2010 to estimate the impact of local-scale climate chance mechanisms, and they compare this to the emission target reductions and heat management strategies planned by cities and states.

The most common critique made of CAPs, however, is that city action and its success are conditional on action from other levels of government. For example, Wiener (2006) warns us against solely relying on cities, because they are unlikely to produce large aggregate effects, and may simply shift emissions to other regions or localities. Moreover, Schreurs (2008) questions cities' efforts to play a real "agenda-setting role" (p.344) because they do not have control over large-scale, far-reaching policies. In the next section, we turn to the question of multi-levelled environmental governance, and in particular, we discuss the relation between state and local action that needs to be better understood and coordinated.

2.3. Bringing the two perspectives together

2.3.1. The need for multi-levelled climate governance

As states and cities take on larger roles in mitigation efforts, we must ask: what form of governance has shown to be most effective in actually reducing absolute emissions? In fact, researchers are increasingly acknowledging that a hybrid system of governance may be the most appropriate approach. Authors such as Kousky and Schneider (2003); Lefèvre (2012), Dodman (2009), Kennedy et al. (2012), Haas (2004), Schreurs (2008), Underdal (2010) and Rice (2010) advocate for a multi-levelled form of environmental governance. For example, Dodman (2009) argues that the international level should bring support and guidance, the national level should provide an adequate legislative structure, and the municipality level should show policy commitment by implementing suggested measures. Krebs (2011) and Underdal (2010) make a similar point: though a centralized component is essential to encourage collective action and the transmission of best practices, the local level is valued for its flexibility and its capacity for direct implementation of policies. Finally, Lefèvre (2012) argues that cities must be considered in post-2012 climate change agreements since they can be effective intermediaries between national/international institutions, and enterprises and individuals.

However, to arrive at such a successful hybrid system, we must examine how different scales of policy interact to work together, or inadvertently against each other. There is a lack of knowledge in this area of study: Shobe and Burtraw (2012) point out that most climate change policy analysis has looked at national and international agreements, implying that policies at the subnational level would naturally harmonize. This assumption may be preventing us from uncovering inefficiencies within climate change policy. As highlighted by Passey, Bailey, Twomey and MacGill (2012), "understanding the extent that instruments can undermine each other may direct policy makers to shape the design process" (p. 559) of these instruments. This research paper hopes to be one step in this direction by looking at the unexplored interaction between state cap-and-trade programs and local-level CAPs.

2.3.2. Interactions between CAPs and state level cap-and-trade

One of the main implications of cap-and-trade on local climate planning efforts is the risk of preventing any additional GHG emissions reductions below the cap. This inherent feature of cap-and-trade schemes underpins the conflict of having uncoordinated state and local mitigation efforts, and is key to this study. The cap is what leads to emission reductions at the state-level and its stringency is increased over the years. However, this cap also limits any *additional* mitigation efforts in covered sectors, achieved by outside sources not covered by the program. Indeed, the state-regulated *cap* also becomes an emissions *floor* because total emissions from covered sectors will always amount to the cap level set out (Passey et al. 2012; Shobe & Burtraw, 2012; Twomey et al., 2012). For example, say that a given emitter – outside of the cap-and-trade program – reduces its emissions by *x* mtCO2e. This now represents an extra *x* mtCO2e available for emission by sources covered by the cap, which they otherwise would have traded or have had to reduce. Alternatively, the *x* amount freed up causes the price of carbon to fall for the traders. Thus, there is a "lack of additionality" of abatement activities in sectors not covered by the program or by emitters outside the program (Twomey et al., 2012, p.425).

Thus, cap-and-trade undermines the potential for outside actors to reduce aggregate emissions. According to Twomey et al. (2012), these outside actors are mainly local municipalities and "ethically motivated individuals or organizations " (p.425), which act on a voluntary basis. In this study, we focus on cities and the measures outlined in their CAPs. On the one hand, CAP measures that risk being ineffective in terms of state-level aggregate impacts are those in sectors covered by the cap-and-trade, including the energy sector, such as renewable energy projects, and the transportation sector, for example through improvements to the transit system. This isn't to say that such measures have a null effect, but they provide an economic benefit by reducing the cost of compliance, instead of the environmental benefit of reducing aggregate emissions. For a more in-depth economic analysis of the implications of cap-and-trade, refer to Bird, Holt, and Levenstein Carroll (2008) for a discussion of the U.S. renewable energy market, and Millard-Ball (2009) for the transportation sector. These two sectors are key to municipal leaders because they contribute to such a large portion of a community's emissions.

On the other hand, reductions in sectors not covered by cap-and-trade can have a direct impact on aggregate emissions, such as abatements in the waste sector, or offsets from urban forestry and green spaces. Since the cap-and-trade program does not account for these sectors in its calculations of the cap, they cannot be 'cancelled out' by increases elsewhere.

So, how do cities react to this limitation? Because municipal mitigation action is voluntary, it remains unclear what cities' response will be, if any, to the implications of cap-and-trade. We begin to explore this in the next section.

2.3.3. Cities' reaction to limitations imposed by cap-and-trade

Twomey et al. (2012) suggest that cap-and-trade can be problematic within a multi-levelled environmental governance because it impedes voluntary action at other governmental levels. However, we must address certain questions before arriving at such a conclusion. First, are city officials and CAPs planners *aware* of this inherent limit placed on them by cap-and-trade, and do they adapt their behaviour accordingly? What motivations underlie these decisions? This research paper seeks to provide some preliminary answers to these questions; in particular regarding how cities under cap-and-trade divide their mitigation efforts between different sectors.

One option is that planners and officials are not aware of the limitation. This can be problematic if they are giving misleading justifications for policies (Twomey et al., 2012). For example, the switch to green electricity may reduce a neighbourhood's emissions, but may not make a difference in state-level emissions. Similarly, "carbon neutrality" may be correct in relative terms (at the city level), but not in absolute terms at the state-level.

The other option is that planners are aware of the limitation placed on them by cap-and-trade. In this case there are several possibilities to disentangle. One hypothesis is that the city's objective is to effectively contribute to aggregate GHG emission reductions, in which case we can foresee two scenarios. First, cities are economically rational and have therefore explicitly planned to invest more of their mitigation efforts in sectors not covered by the cap-and-trade policy, for example by reducing waste or increasing urban forestry. Second, cities understand that reductions they accomplish in covered sectors make no aggregate difference, but they anticipate that their efforts may eventually lead the state to impose more stringent caps. In both cases however, there is a risk of a decrease in political support for mitigation projects (Millard-Ball, 2009). This is significant for CAPs because they are voluntary: if citizens and politicians know that the mitigation policies they are funding are in fact providing the advantage of lower compliance costs for other emitters, then political support for such projects may decrease. The idea of mitigation measures actually contributing to reducing emissions may also be maintained as a "convenient fiction" to preserve political support (Millard-Ball, 2009, p. 23).

Alternatively, the objective of a CAP may not actually be to reduce aggregate emissions. Although this may sound incoherent considering a CAP is based on quantification of GHG reductions, it is worth thinking through two possible scenarios. First, a city may deeply care about reducing emissions at the *local* level, whether or not this contributes to overall reductions. This can provide other environmental benefits such as improved air quality, or social benefits such as more liveable spaces or traffic congestion relief (Millard-Ball, 2009). We may even think that a city wants to reduce its dependency on increasingly costly oil. A second scenario is that the main motivation for drafting a CAP lies elsewhere than in actually reducing emissions. For example, the elaboration of a CAP may stem from citizens' or leaders' ethical motivations. In his study, Millard-Ball (2012a) questions the causal impact of CAPs, using a sample of Californian cities, and argues that "cities are using climate plans to codify policies that were likely to happen anyway" (p.1). For example, plans were sometimes elaborated to recognize the efforts the city was already making and satisfy citizens' environmentalist demands, more than to actually spur climate change action.

In conclusion, it is clear that there is a knowledge gap to be explored. By quantitatively analyzing the reduction targets set out by sector in CAPs from regions both regulated and non-regulated by cap-and-trade, I wish to answer the research questions raised earlier: are cities under cap-and-trade planning their mitigation efforts accordingly to the inherent limitation imposed on them by this policy? Are they apportioning a smaller share of their mitigation reductions to capped sectors in order to contribute effectively to aggregate emissions reductions? The following chapter presents the methodology I used to answer these questions.

CHAPTER 3: METHODOLOGY

In this chapter, I explain the methodological steps I undertook for this research. I begin by explaining the overall experimental design. I then justify the choice of area of study, the sampling techniques used, and how I collected the data. I end by explaining the type of analysis I applied, and the relevance of these choices given the research questions set out.

3.1. Overall experimental design

This study is designed around the comparison of a treatment group of cities (in a region covered by cap-and-trade) to a control group of cities (in regions not covered by cap-and-trade). This design allows a quantitative comparison of reduction targets across *regions* (control vs. treatment) and across *sectors*. In this study, I used five main sectors: energy, transport, waste, forestry and a residual 'other' category. The energy and transport sectors are capped (or covered) sectors, while the waste, forestry and 'other' sectors are uncapped (uncovered) sectors.

By analysing the reduction targets extracted from a sample of CAPs, and comparing them across sectors and regions, we can determine whether there is a significant difference between treatment and control CAPs, and verify the stated hypothesis. Figure 3.1 shows the possible scenarios of how treatment cities deal with the limitation placed on them by cap-and-trade, and how these scenarios translate into data results. The hypothesis I am testing is shown in the blue box – that cities under cap-and-trade are aware of the limitation placed on them by this policy, and respond in an economically rational way by allocating less of their total mitigation efforts to capped sectors. Note that several of the alternative explanations, shown in orange, correspond to the same data results ("What I expect from the data"): this is because the quantitative research design adopted does not allow us to distinguish between them. However, I will discuss the meaning and likelihood of these scenarios in qualitative terms in Chapter 5. These results will also lead to a broader discussion of the impacts these scenarios can, or do already have on multi-scaled climate change policy.

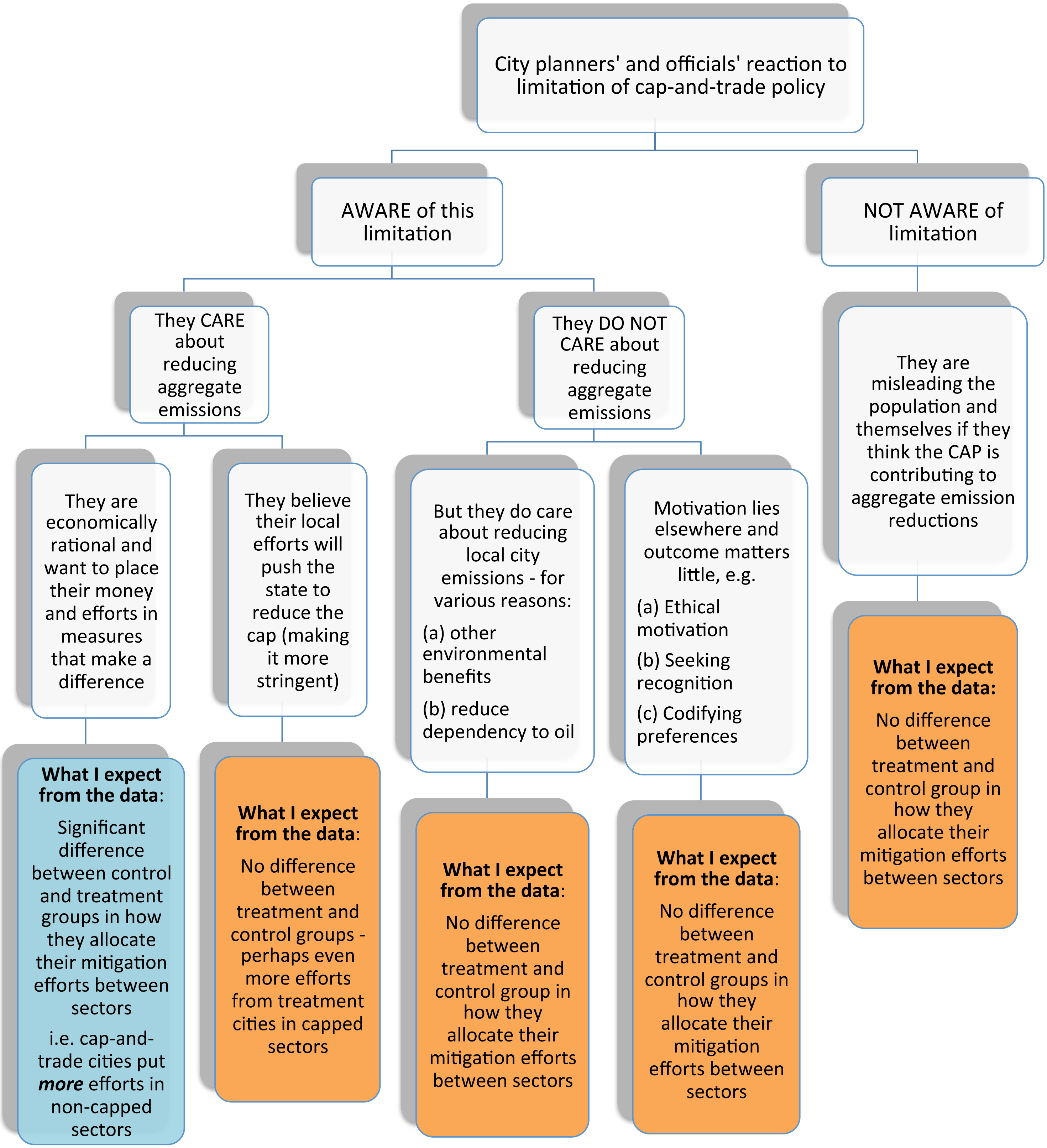


Figure 3.1. Flow chart of the possible scenarios of how cities plan their mitigation efforts, and the translation of these scenarios into expected data results.

3.2. Area of study

I use California as the region regulated by a cap-and-trade program, and 12 different states as the regions not regulated by cap-and-trade. Despite the wide range of GHG trading systems that exist around the world (RGGI in the northeast US, the European Union Emissions Trading System, NSW Greenhouse Gas Reduction Scheme in Australia…), I opted for the WCI, and California more particularly, because this region corresponded most closely to the criteria I set out for my data. For practical purposes, California was suitable because of the abundance of adequate CAPs published, easily accessible, and drafted in a relatively standardized format. Using California was also appealing because of its reputation as an innovative and environmentally friendly state. Finally, the WCI was interesting to use because it covers both the energy and the transportation economic sectors – not just emissions from electricity, as is the case with the RGGI. My analysis therefore incorporates more than one covered sector, which is meant to provide a richer and more complex set of results.

3. 3. Sampling technique

My sample consists of a total of 40 municipal climate plans: 20 plans from Californian cities (treatment group), and 20 plans from various cities across the U.S. not under cap-and-trade (control group). A list of the cities from which these plans were taken from is included in Appendix A, and the location of these cities is shown in Maps 3.1 and 3.2. The sampling technique used was purposive because of the specific criteria the plans had to meet. I based myself on a datasheet provided by Boswell and Greve (2012) compiling all the known published CAPs in the U.S., as well as one compiled by Millard-Ball (2012b) that focuses on Californian cities. I also conducted extensive research on municipalities' websites. The final sample size is relatively small due mainly to limitations in the adequacy and availability of data (many plans did not fulfill the standards needed for the quantitative analysis this study conducts). The first set of criteria both treatment and control groups had to fulfill is as follows:

Criteria 1: the plan is a CAP. According to Boswell and Greve (2012), four features characterize a CAP: it is based on GHG emissions inventory; it addresses community-wide emissions, not just municipal operations emissions; it addresses climate change as the main topic (though it may address sustainability and the environment, but as secondary topics); finally, it is structured as a full plan with an introduction, background, and policy-section – instead of a few ideas on a website. Note that CAPs may go under different names, such as Climate Protection Plan, Local Action Plan, Energy Action Plan etc.

Criteria 2: the CAP includes a detailed quantitative breakdown, by policy or by sector, of the emissions reduction target. In other words, it has a thorough analysis of the policies to be implemented, and the associated amount of mtCO2e each action is expected to reduce.

Criteria 3: the CAP is published by a city or by a civil township. I excluded CAPs published by counties as they can overlap with cities' CAPs.

Map 3.1. Location of the 20 control group cities, not under cap-and-trade

Map 3.2: Location of the 20 Californian treatment group cities, under cap-and-trade

3.3.1. Sampling for the Control Group

In addition to these criteria, sampling for the control group also took into account the plans' date of publication due to states' previous or current involvement in cap-and-trade programs. I did not use plans that were written when a state *intended* to participate in cap-and-trade. This would produce an inadequate comparison to Californian cities because the assumption is that the plans from the control group were elaborated by planners who were aware that cap-and-trade would not imminently be implemented in their state. Plans from Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island and Vermont were rejected because these states are members of the RGGI. For states that used to be part of a cap-and-trade program, only plans published prior to the beginning of the agreement, or after the official withdrawal from the program were eligible. This applied to New Jersey, which withdrew from the RGGI in 2011, and to Arizona, Montana, New Mexico, Oregon, Utah and Washington, which withdrew from the

WCI in 2011. Understandably, this narrowed the pool of plans from which I could sample the control cities. Finally, for states having never participated in cap-and-trade programs, the plan publication date had to be 2005 and later, so as to match approximately the date of publication of the plans used in the treatment group.

After reviewing approximately 70 plans across the U.S., only 20 CAPs fit these criteria. Although it would have been interesting to have a control sample from a single state chosen for its geographic, political, and/or socio-economic similarities with California (such as Washington or Oregon), this proved impossible due to the small sample size this would have yielded. Instead, the plans come from a variety of states, which produces a more diverse control group, and may actually provide a more solid comparison to a state as unique as California.

3.3.2. Sampling for the Treatment Group

For the treatment group, the publication date was also an important factor. Because the WCI agreement was signed in February 2007, plans published before January 2008 are considered 'pre-WCI' while those published as of January 2008 are considered 'post-WCI' plans. Timing of planning and implementation is blurry, but I assume that all authors of post-WCI plans were at least aware that cap-and-trade was in place (given it takes a few months for the news of the agreement to spread), so that they would have realistically had the option to incorporate this knowledge into their plan.

Secondly, I used a matched sampling technique to ensure comparability of the control and treatment groups based on population size in 2010. To do this, I organized the control cities into six categories of different population sizes. Then, from the pool of eligible Californian cities (knowing their respective population sizes), I sampled a total of 20 treatment cities so as to have the same number of treatment cities and control cities in each population category. Sampling was done randomly within each population category. However, a few adjustments were made for matching for large cities: Seattle, Denver and Chicago (control group) all have populations larger than 500,000 people, while in the treatment group, only San Jose fit in this category (cities with populations exceeding 500,000 people, such as Los Angeles, San Diego, San Francisco, Riverside or Long Beach were either pre-WCI plans, or did not fit other criteria). Therefore, I had to add two cities to the next largest population category.

3.4. Data collection

In this section, I will describe what data I collected from the sample CAPs and the methods used to do so. The data collected falls in the following three categories:

(1) I extracted data concerning the general emissions inventory and target reductions: total emissions for the baseline year (in mtCO2e), business-as-usual emissions for the target year (in mtCo2e), percent target reduction for the target year (%), and the equivalent targeted amount (in mtCO2e).

(2) I extracted specific quantitative information about the amount of mtCO2e expected to be reduced in the five sectors mentioned earlier. The first two sectors, energy and transport, are covered by the WCI cap-and-trade program: the energy sector – including measures concerning building efficiency, renewable energy and water conservation, and the transportation sector – including measures directly concerned with transportation (biking, public transport, car-sharing…) as well as land-use (transit-oriented development…). The three other sectors are not covered by cap-and-trade: the waste sector –measures that increase recycling, composting, and that reduce waste; the urban forestry/greenery sector, or the creation of carbon offsets by increasing urban greenery; finally, measures that do not fit in any of these categories, such as education measures, community involvement and buying local foods.

(3) I also compiled the *actual* amount of emissions (in mtCO2e) the city expects to reduce as a result of the policies listed in each of these five sectors. A distinction must be made between the target set out by the city in the beginning of the plan (for example, *x* amount of mtCO2e corresponding to a 20% reduction in emissions below the 2005 level by 2020), and the *actual* amount of mtCO2e the city has planned to mitigate, equal to the sum of the amounts associated to each proposed policy. In many cases, the *actual* amount was lower than the amount set out at the beginning of the plan. We call the difference between these two measures a "challenge gap". Thus, I also recorded whether the plan has a challenge gap, and whether this gap is explicitly justified in the plan.

In addition, I translated the amounts of mtCO2e per sector into percentages of emission reduction per sector by calculating the ratio of the amount attributed to one sector to the total *actual* total amount of mtCO2e the city expects to reduce. Note that I use the actual amount, not the theoretical amount given at the beginning of the plan. It is essential to translate these numbers to percentages because there can be important absolute differences across cities, but small relative differences due to variations in population size, economic growth, or industrial activity. Using percentages instead of absolute values standardizes the measures and makes them comparable. What matters here is: in which sectors do cities think it is worth investing their mitigation efforts? What proportion of the total reduction does each sector (capped vs. non-capped) receive?

Finally, I gathered additional data on the cities' populations to use as control variables. From the U.S. 2010 Census and American Community Survey, I collected: population size in 2010, median household income, and education level (expressed as the percentage of 25+ year-olds with a Bachelor's degree or higher). These variables are important to include as potential confounding variables, since they may be influencing the allocation of a city's emission reduction target into sectors. For example, a city with a higher proportion of university graduates may be more aware of cap-and-trade policies and its implications, thus shifting mitigation efforts towards particular sectors. Alternatively, a city with a higher proportion of lower income residents may not prioritize the development of a CAP over other social policy issues, thus resulting in a less thorough or researched CAP. Moreover, the use of a control group eliminates the need to include many more control variables, since this research design controls for what is similar between the control and cap-and-trade cities, and between the control and cap-and-trade sectors.

I will end by clarifying certain methodological issues. First, when a given policy is associated to a range of mtCO2 to be reduced, I use the more conservative lower bound estimate for my computations. Second, some plans separate their policies between measures affecting City operations and community-wide measures. Such a division allows the City to show-off what it is personally accomplishing, and thus set the "good example" for citizens and other actors. In such cases, the policies were re-organized by sector, regardless of whether they were City operations or community measures. Third, if a plan sets out two target reductions for two target years, then I used the shorter-term target. Although it is plausible that the long-run target is a more adequate reflection of the city's long-term vision, the short-term target's consequences will be most felt during the implementation of cap-and-trade. Moreover, exact estimates on the amount of emissions a policy will reduce are difficult to make, especially as the time span increases, so short-term predictions may be more accurate. Finally, cities usually re-adjust these plans every 5 to 15 years, so the numbers projected for the longer-range target may change anyways.

3.5. Analysis performed

In this study, I approach my research questions mainly from a quantitative perspective. There has been little quantitative analysis or empirical work done around this topic, so it is insightful to look concretely at how cities are actually planning out their mitigation efforts. In this section, I will explain what specific comparisons I looked at, and the statistical methods used to perform these comparisons. Finally, I complement my quantitative methods with a more informal qualitative review of the CAPs.

3.5.1. Statistical comparisons performed

To answer my research questions, I use two main approaches, which differ in their computational aspect, but can be used to argue the same point. The purpose of using two different measures is to have one main analysis, and one validity test. In both cases, I compare Californian plans under the cap-and-trade state program (treatment group), to plans not under a cap-and-trade program (control group) by looking at the quantitative breakdown of their emission reduction targets by sector.

The first analysis consists of looking at target reductions allocated to a given sector, calculated as a percent of total targeted reductions. By definition, these target reductions add up to 100%. The point is to understand what influences the way a city partitions its effort between capped and non-capped sectors, and if being under cap-and-trade changes the 'weight of mitigation' a city attributes to capped sectors. I conduct a broad analysis comparing capped to non-capped sectors (Regression 1.a.), and a more narrow analysis (Regressions 1.b.), in which I break down the total target reduction into the five separate sectors mentioned previously (energy, transport, waste, forestry and 'other').

The second analysis (Regression 2), used to validate the first approach, consists of looking at target reductions allocated to a given sector, calculated as a percent of total current emissions (i.e. the baseline year emissions). This approach takes into consideration the overall level of mitigation effort implemented by a city. With this, I wish to understand what influences the variation in a city's level of effort in each sector.

3.5.2. Statistical design

For these analyses, I performed linear multiple regressions using SPSS software. I used a heteroskedastic-consistent method (Huber–White standard errors), based on a technique developed by Hayes & Cai (2007). I opted for this method because the assumption of homogeneity of variance, necessary to perform multiple linear regressions, seems to be violated in the data. Indeed, the scatter plots showing the standardized residuals against the independent variable values do not all present a random pattern, indicating the assumption may be violated (see Appendix B for test results). Moreover, to satisfy the normality assumption, I used the log transformations of the numerical factors in each regression.

Regression 1.a.

I performed a first regression in which the dependent variable is the percent reduction allocated to capped sectors, *as a percent of total targeted reductions*. Because the sum of 'percent reduction allocated to capped sectors' and 'percent reduction allocated to non-capped sectors' is equal to 100%, I only need to run one regression, and I only include one main independent variable: 'Region' (categorical factor with two levels, 0= region not covered by cap-and-trade, 1=region covered by cap-and-trade). I also include three control variables: City Population in 2010, City median household income (2006-2010), and City education level (2006-2010), expressed as percentage of 25+ year-olds with a Bachelor's degree or higher.

In terms of interpreting results, if the 'Region' variable displays a significant p-value, we can assume that there is a significant difference in how control and treatment cities allocate their mitigation efforts between capped and non-capped sectors. In fact, if the regression coefficient is significant and *negative*, we can conclude that treatment cities place less relative effort in capped sectors, and more relative effort in non-capped sectors. This would support the hypothesis that cities respond in an economically rational way to cap-and-trade, and plan their mitigation efforts accordingly (hypothesis shown in blue, Figure 3.1). A significant and *positive* coefficient would be contrary to all the hypotheses presented in Figure 3.1. However, if the regression coefficient is not significant, we can conclude that control and treatment cities plan their mitigation efforts between sectors in similar ways. This corresponds to the scenarios shown in orange in Figure 3.1.

Set of Five Regressions 1.b.

I then performed a set of five similar regressions. They are of the same format as the one described above, except that the dependent variable is the percent reduction allocated to a *specific* *sector* as a percent of total targeted reduction (respectively: energy, transport, waste, forestry and other).

In terms of interpretations, a significant and *negative* regression coefficient for the energy and transportation sectors, as well as a significant and *positive* regression coefficient for the waste, forestry and 'other' sectors, would support the hypothesis in blue of Figure 3.1. Finding a non-significant regression coefficient would mean, in each case, that there is no significant difference in the mitigation effort allocated to that given sector.

<u>Regression 2</u>

For the validity test, I performed a regression in which the dependent variable is the percent target reductions, *calculated as a percent of total current emissions*. For this regression, the factors are slightly different. The main independent variables are: 'Region' (categorical factor with two levels, 0= region not covered by cap-and-trade, 1=region covered by cap-and-trade), 'Sector' (categorical factor with two levels, 0= non-capped sectors, 1=capped sectors), and an interaction effect (Region*Sector). Moreover, by using percentages of current emissions, I control for the relative differences in amounts of CO_2 emitted by cities i.e. how polluting a city is right now. I also need to control for how much a city is willing to reduce: for this, I include the same set of three control variables (say, for example, if the city has a high proportion of high income, university-degree inhabitants who push the government for having more stringent reductions). In a future study, the use of fixed effects could be also interesting here.

For this regression, the interpretation of the regression coefficients is different. The interaction effect, Region*Sector, is most relevant to answering the research question: a significant coefficient would mean that the effect of region (being under cap-and-trade or not) on the percent of target reduction does change depending on the sector in question. This would correspond to the hypothesis shown in blue in Figure 3.1. Alternatively, a non-significant regression coefficient would mean that the effect of the region variable on the percent of target reduction is identical for both capped and non-capped sectors.

3.5.3. Qualitative analysis of CAPs

Using quantitative, statistical methods is useful because it gives a concrete idea of what cities are actually doing, and it provides generalizable results. However, one disadvantage is that it does not offer a sure indication of people's awareness and motivations. Thus, a secondary aspect of the methodology involved some qualitative review of the plans' content: I was interested in seeing whether the Californian plans mentioned cap-and-trade, and if so, in what terms and in how much detail. I also looked at how the city's efforts were placed more generally within the framework of the state's policies and legislations. I did this only for the Californian subsample of plan.

In addition, in the case of CAPs that included a challenge gap, I took a closer look at whether this challenge gap was acknowledged, and whether it was addressed by referring to state mitigation efforts (in other words, if the CAP recognized that state reductions would 'fill in' the challenge gap). Because this aspect of the research is only complementary to the quantitative analysis, I did not conduct a formal content analysis but rather an informal review of the CAPs by surveying the entire plan looking for key terms, as well as a more thorough analysis of the chapter of the CAP dealing with the state-level policies.

CHAPTER 4: RESULTS AND ANALYSIS

In this chapter, I summarize the main findings of my study. First, I show the results using the target percent reductions for a given sector *calculated as a percentage of total targeted reductions*. I do so by looking at the breakdown of the total target reduction of a CAP between capped and non-capped sectors, as well as the breakdown between the five sectors (energy, transport, waste, forestry and other). In both cases, I find that being in a cap-and-trade region does not have a statistically significant effect on what share of the total target reduction is assigned to a given sector. This contradicts the initial hypothesis suggesting that cap-and-trade cities are indeed adapting their CAPs according to the "emissions floor" limitation of this policy. Second, as a validity test to the first measures, I show the results using the target percent reductions for a given sector *calculated as a percentage of total current emissions*. Here, I also find that there is no statistical difference in how much a city decides to reduce in capped sectors, between control and treatment cities. This validity measure is important because it looks not just at the partitioning of a total target into the five sectors, but it takes into account the magnitude of efforts a city is putting in a sector. Finally, after synthesizing the results of the qualitative review of the sample of Californian CAPs, I found that there was no substantial recognition of cap-and-trade policy in most plans. Thus, the results seem to point to the same conclusion: cities under cap-and-trade are not doing anything noticeably different in their CAPs and mitigation planning than cities not under cap-and-trade.

4.1. Regressions using target reductions as a percent of total targeted reductions

4.1.1 Capped vs. non-capped sectors

The results of the first regression (Regression 1.a.) involve the comparison of capped (energy and transport reductions) to non-capped sectors (waste, forestry and 'other' reductions). To begin with, the descriptive statistics are telling: the mean percent reduction planned for capped sectors, as a portion of total targeted reductions, is 84.9% in the case of treatment cities, and 85.9% for control cities, which are very similar values. These results are confirmed by the regression (Table 4.1.) The regression yielded a low R-square value ($R^2 = 0.0462$), indicating that only 4.6% of the variation in the dependent variable is explained by the four predictors included in the regression. Overall, the model was not significant ($p=0.757 > \alpha = 0.05$). None of the control variables (Population in 2010, Education level, and Median household income) were found to be significant ($\alpha = 0.05$). The independent variable of interest (Region) did not have a significant effect on the target percent reduction allocated to capped sectors, when controlling for all other variables ($p=0.7763 > \alpha = 0.05$). The low 'Region' regression coefficient (b= -0.0125) means that a switch from a region not under cap-and-trade to a region covered by cap-and-trade, after controlling for the other variables, is likely to *decrease* the target percent reduction allocated to covered sectors only by 1.25%. In other words, cities under cap-and-trade are putting less relative effort into capped sectors, *as in fact the theory would imply*. However, this difference is not only very small in terms of effect size, but it is also not statistically significant.

These results are important, because they indicate that there is no significant difference in the way that cities under cap-and-trade allocate their reductions between capped and non-capped sectors, in comparison to cities not under cap-and-trade.

Variables	Regression Coefficient	Standard Error	p-value
Constant	1.4150	1.4861	0.3476
Log Population 2010	-0.0003	0.0301	0.9919
Log Education	-0.0579	0.1229	0.6408
Log Median Household Income	-0.1190	0.3021	0.6931
Region	-0.0125	0.0435	0.7763

Significance at $\alpha = 0.05$
$R^2 = 0.0462$
N= 40

Table 4.1. Results of the regression looking at the target percent reduction allocated to capped sectors, as a percent of total target reduction

4.1.2. Breakdown into five sectors

The descriptive statistics for the five regressions each examining one particular sector (Regressions 1.b.) are summarized in Table 4.2 and Figure 4.1. We find that none of the five regressions yielded an overall significance, and in each case, the 'Region' variable was not significant ($\alpha = 0.05$), as shown in Table 4.3. These results support those found previously, that is, there is no significant difference between treatment and control cities in how they allocate their mitigation efforts between sectors.

The partitioning of the total target reduction into five sectors supports our initial findings in another way, by looking at the smaller differences observed in the data (though they are not statistically significant). Namely, the coefficients for the 'Region' variable for the energy and transport sectors are relatively high compared to the 'Region' coefficient obtained in the case of capped sectors (Section 4.1.1). Switching from a control city to a treatment city is likely to cause a *decrease* in 8.9% of the target percent reduction allocated to the energy sector. Conversely, this same switch is likely to cause an *increase* in 7.7% of the target percent reduction allocated to the transport sector. Finally, the 'Region' coefficients for the waste, forestry and 'other' are very low.

If we were expecting treatment cities to plan their mitigation efforts significantly differently than control cities, we would expect treatment cities to allocate less efforts to capped sectors, and more efforts to non-capped sectors – this being the 'economically rational' reaction to the limitations of cap-and-trade. However, the regression results show that though treatment cities do allocate slightly less to the energy sector compared to control cities, they also allocate *more* efforts to the transport sector – which is contradictory. Had the results truly fit the given hypothesis, we would have observed a similar pattern in both the energy and transport sectors. For this reason, we can assume that the small differences observed (although not statistically significant) are not related to the fact that treatment cities are indeed allocating less to the energy sector because of cap-and-trade. Of course, one could counter this by saying that the WCI only covers transport emissions as of 2015, so Californian cities have not accounted for this yet. However, this seems unlikely because CAPs are meant to span over several years, and should in theory take into account policy changes to be implemented in 2015.

Moreover, we notice that in both treatment and control cities, the energy sector receives a majority of the total reduction target (more than 50%), and the transport sector receives a considerable share of it as well – while the waste, forestry and 'other' sectors combined count for less than 20% of total reductions. We may explain this large difference by the fact that the energy and transport sectors constitute large portions of cities' total emission inventories, while the waste sector usually only represents a smaller portion (Dodman, 2009). This was readily observable when reviewing the GHG emission inventories from the sample CAPs.

Finally, we notice that in all the regressions reviewed above (sections 4.1.1 and 4.1.2), the three control variables were not statistically significant, meaning they do not help explain the variation in the allocation of the total target reduction between sectors. Recall that we do not have to control for how polluting a city is at a given time because the dependent variable used in these regressions is the distribution of the total target into its different sector types: the dependent variable is thus indifferent to how much the city is emitting, and to how ambitious the total reduction target itself is. Finally, the use of a treatment-control research design is surely controlling for other confounding predictors.

	Capped sectors	Energy sector	Transport sector	Waste sector	Forestry sector	'Other' sector
Mean target percent reduction - treatment cities	84.9%	52.8%	32.1%	13.5%	0.2%	1.4%
Mean target percent reduction - control cities	85.9%	62.6%	23.3%	11.1%	0.4%	2.6%

Table 4.2. Descriptive statistics: mean target percent reduction allocated to each sector, as a percent of total targeted reduction.

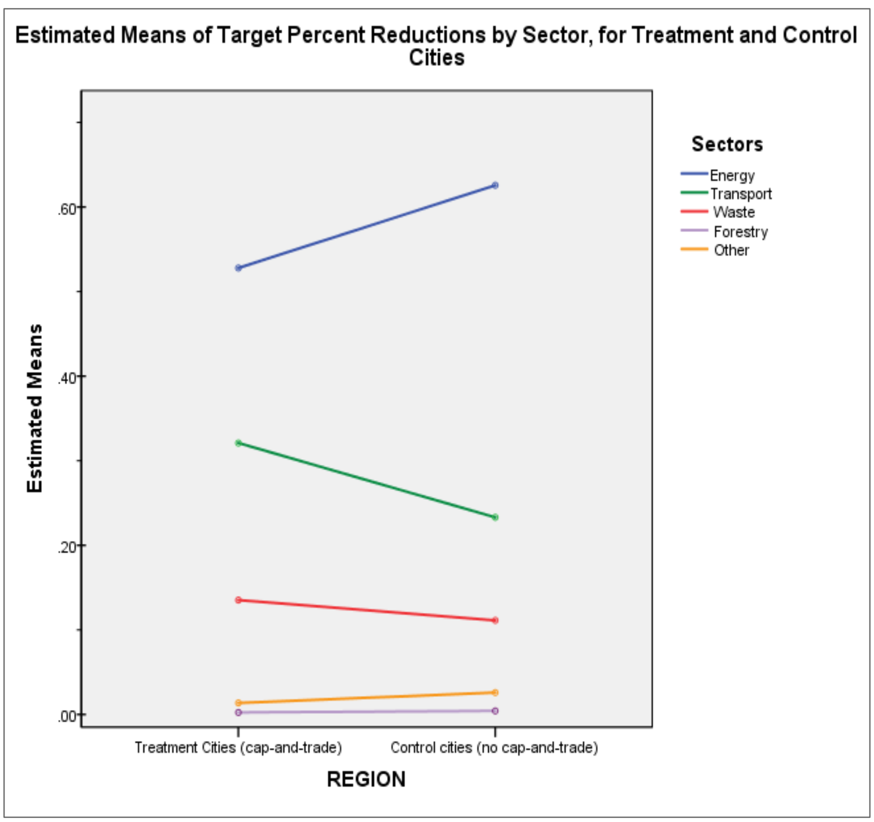


Figure 4.1. Diagram of the estimated means of target percent reductions by sector and by region

	Energy			Transport			Waste			Forestry			Other		
	N=40 **R^2 = 0.1781**			N=40 **R^2 = 0.1456**			N=40 **R^2 = 0.0428**			N=40 **R^2 = 0.0755**			N=40 **R^2 = 0.0333**		
	Coeff	**Std Error**	**p-value**	**Coeff**	**Std Error**	**p-value**	**Coeff**	**Std Error**	**p-value**	**Coeff**	**Std Error**	**p-value**	**Coeff**	**Std Error**	**p-value**
Constant	3.0559	1.8878	0.1145	-1.6402	2.1977	0.4605	-0.5315	1.5103	0.7270	0.0712	0.0527	0.1859	0.0438	0.3567	0.9031
Log Population 2010	-0.0924	0.0674	0.1791	0.0921	0.0739	0.2209	-0.0063	0.0295	0.8314	-0.0002	0.0020	0.9110	0.0069	0.0110	0.5330
Log Education	0.1062	0.2836	0.7104	-0.1642	0.2918	0.5772	0.0081	0.1220	0.9476	0.0113	0.0078	0.1549	0.0386	0.0609	0.5303
Log Median Household Income	-0.4001	0.3598	0.2736	0.2810	0.4408	0.5279	0.1402	0.3076	0.6514	-0.0128	0.0091	0.1673	-0.0081	0.0771	0.9173
Region	-0.0893	0.0817	0.2818	0.0768	0.0858	0.3769	0.0193	0.0431	0.6569	-0.0002	0.0023	0.9168	-0.0066	0.0236	0.7811

Significance is at $\alpha = 0.05$
"Coeff" refers to the Regression Coefficient, and "Std Error" refers to the Standard Error

Table 4.3. Results of the five regressions, using target reductions by sector as a percent of total targeted reductions

4.2. Using target reductions as a percent of total current emissions

The results of the regression using target reductions for capped and non-capped sectors calculated as a percent of total current emissions (Regression 2) are in line with the previous results, and help strengthen the conclusions already drawn.

As shown in Table 4.4, the mean target reductions between control and treatment cities for a given sector are similar. The regression confirms these results (Table 4.5). First, we find that the 'Sector' variable is significant (p value = $0.0001 < \alpha = 0.05$; coefficient = 0.1835). This means that the sector (capped or non-capped) has a significant effect on the target percent reduction, ignoring the effect of other variables: indeed, capped sectors receive a larger percent of current emissions than do non-capped sectors. We observed this in Section 4.1, and explained that this is probably due to the fact that the energy and transport sectors represent a large portion of a city's total emissions.

Second, we find that the 'Region' variable is not significant (p value = $0.9852 > \alpha = 0.05$; coefficient = -0.001). This means that when ignoring the effect of Sector, (i.e. across capped or non-capped sectors), control and treatment cities do not allocate a significantly different target percent reduction; put differently, their total mitigation ambition is not significantly different.

Third, and most interesting, we find that the interaction effect (Region*Sector) is not significant (p-value =$0.7662 > \alpha = 0.05$; coefficient = 0.0195). This is a relevant because it indicates that the effect of 'Sector' is the same across both control and treatment cities. This confirms our hypothesis that cities covered by cap-and-trade do not plan their mitigation efforts between sectors differently than cities not covered by cap-and-trade.

	Capped sectors	Non-capped sectors
Mean target percent reduction - treatment cities	23.4%	3.1%
Mean target percent reduction - control cities	21.0%	2.7%

Table 4.4. Descriptive statistics: mean target percent reductions by region and by sector, calculated using target reductions as a percent of total current emissions

Variables	Regression Coefficient	Standard Error	p-value
Constant	0.0400	0.9794	0.9675
Log Population 2010	0.0126	0.0405	0.7565
Log Education	-0.0666	0.1182	0.5748
Log Median Household Income	-0.0206	0.1675	0.9025
Region	-0.0004	0.0210	0.9852
Sector	0.1835	0.0449	0.0001
Region*Sector	0.0195	0.0654	0.7662

Significance at $\alpha = 0.05$
$R^2 = 0.3625$
N=40

Table 4.5. Results of the regression looking at the target reductions between covered and non-covered sectors, as a percent of total current emissions

Finally, we also found that none of the control variables were significant. Thus, when ignoring the effects of the other variables, population size in 2010 did not have a significant influence on the dependent variable (target reductions calculated as a percentage of current carbon emissions). The same can be said about median household income and education levels. This is interesting, given the variety of cities found in the sample, and seems to confirm that cities across the U.S. have similar mitigation plans despite political, demographic, socio-econ and geographic differences. Note, however, that the design of the dependent variable controls for how polluting a city currently is, since it is calculated as a percentage of current emissions, and not in absolute values. This is key to evaluate the validity of these research findings.

4.3. Qualitative review of CAPs

4.3.1. References to cap-and-trade in Californian CAPs

Based on an informal qualitative review of the 20 Californian CAPs, I found that 11 do not explicitly mention cap-and-trade (Albany, Burlingame, Citrus Heights, Emeryville, Hillsborough, Palmdale, Piedmont, Sacramento, San Carlos, Tulare, and West Hollywood). Note that these plans are not particularly older in terms of publication date than the CAPs that do mention cap-and-trade (refer to Appendix A for the plan publication dates).

In the best of cases, the plans that do not refer to cap-and-trade include a general reference to AB32 and to market mechanisms. For example, the following phrasing came up in the CAPs of Hillsborough, Burlingame, and Palmdale: "the California Air Resources Board was tasked as the lead agency to develop regulatory and market mechanisms to reduce emissions. The reduction measures in the Scoping Plan will be further developed over the next several years" (Town of Hillsborough, 2010, p. 4).

Other CAPs (Sacramento, Albany, Piedmont or Emeryville) remain more vague, for example saying that AB32 institutes a "mandatory limit on greenhouse gases emissions, reducing emissions in California to 1990 levels by the year 2020" (City of Emeryville, 2008, p. 14), or "AB32 requires ARB to adopt a quantified cap on GHG emissions [...] and institute a schedule to meet the emissions cap" (City of Piedmont, 2010, p. 14) – but without giving any indication of the ways the state is planning on achieving this target, and without mentioning market-based tools or cap-and-trade.

Among the CAPs that do mention cap-and-trade, some simply state the fact that an emissions trading scheme will be introduced in California, for example "the [Scoping Plan] establishes many measures, including developing a California cap-and-trade program [...]" (City of Dublin, 2010, p. 47). Other plans are more comprehensive in their discussion of the new policy. Hayward's and Fullerton's CAPs give details about how the cap-and-trade policy will work, namely explaining that non-covered entities can voluntarily join the program through holding allowances (City of Fullerton, 2012). However, the limitation of cap-and-trade on the city's ability to reduce aggregate emissions is not addressed. Finally, Corona's CAP also discusses issues around cap-and-trade in a paragraph for "actions beyond 2020", when the plan-makers consider that the effects of cap-and-trade will be in full force (City of Corona, 2012). The focus is mainly on the impact the policy will have on energy and fuel prices, but the plan also recognizes that the city will have to adjust its actions to the new realities of this policy.

In summary, based on the sample of CAPs studied, it seems that a large portion of Californian plans do not address the issue of cap-and-trade, and even the plans that do refer to it do not necessarily engage with the policy implications in depth.

4.3.2. Challenge gaps

In terms of the presence of challenge gaps (present if the actual total targeted reduction is smaller than the target reduction set out in the beginning of the plan), we found that six CAPs presented a challenge gap in the treatment group, and 10 CAPs presented one in the control group. This is relevant to assess the quality of municipal climate planning: if a plan's actions do not achieve the target set out at the beginning of the plan, the overall quality of the plan may be compromised. Also, in the treatment cities, all of the plans that had a challenge gap recognized the fact that they had one; in the control cities, 7 out of the 10 CAPs acknowledged the fact that their plan contained a challenge gap.

Moreover, it is interesting to look at the presence of challenge gaps in the case of the Californian plans in order to see how they address they gap, and to understand what role these cities attribute to state emission reductions. Indeed, in the treatment group, 5 out of 6 justified this gap by saying that state and federal strategies would help fill it – for example, Hillsborough's CAP states that "new state and federal initiatives and programs that focus on transportation and energy generation can assist Hillsborough in meeting the AB 32 reduction target" (Town of Hillsborough, 2010, p. 15)

CHAPTER 5: DISCUSSION

In this section, I go over the meaning of the main statistical finding of this study: that cities under cap-and-trade allocate approximately as much of their target reductions to capped sectors as do control cities. Then, based on both the quantitative and qualitative results, I draw out the larger considerations concerning the interaction between city and state climate planning, the motivations for municipal climate action, and what this implies in terms of possible future planning action to take against climate change.

5.1. Discussion of the statistical results

The results obtained from the different sets of regressions show there is no statistical difference between control and treatment cities' allocation of mitigation efforts between capped and non-capped sectors. In other words, treatment cities attribute approximately as much of their target reductions to capped sectors as control cities.

One possible explanation for this is related to cities' emissions inventories. Generally, the energy and transport sectors count for a large majority of a city's total emissions, and the waste sector only for a small portion. In addition, 'forestry' measures refer to carbon *offsetting* measures (consisting of carbon sequestration, instead of actual emission reductions), and actions categorized in the 'other' sector are often non-concrete, such as emissions reductions from education programs and community involvement. Thus, even if Californian cities *wanted* to place more mitigation effort in non-covered sectors, they may be restricted in their options. If most cities are faced with the reality that the majority of their emissions are coming from buildings, transportation, and industries, then it may be unrealistic or unfair to expect them to significantly change the reductions they allocate to these sectors simply because they are under cap-and-trade.

Another alternative is that most cities (34 out of 40 in my sample) base their CAPs on recommendations, tools and models given by ICLEI (Local Governments for Sustainability), which may create repetitiveness or 'automatism' in the way ICLEI members plan their mitigation efforts. This may explain the similarity observed between treatment and control climate planning.

However, the most probable explanation is that cities regulated by cap-and-trade are not bearing in mind, in the elaboration of their CAPs, the limitation placed on them by a cap-and-trade policy. They are not placing a significantly larger portion of efforts to non-capped sectors in order to circumvent the "floor effect" of cap-and-trade. This is observable in quantitative, statistical terms, and is further confirmed by qualitative observations. After reviewing the CAPs from Californian cities, it seems unlikely that the plan-makers are taking into consideration the implications of cap-and-trade, since so few of the plans actually mention cap-and-trade.

We can thus reject the hypothesis shown in blue in Figure 3.1, which states that cities under cap-and-trade are aware of the limitation imposed on them by this policy, and that they respond in an economically rational way by allocating more of their total reductions to covered sectors in comparison to cities not under cap-and-trade.

Consequently, I will now look more generally at how municipal climate plans relate to state climate and environmental planning, since it appears CAPs are not taking cap-and-trade into account. Indeed, un-explored interactions between different scales of climate planning underpin the knowledge gap this study seeks to address.

5.2 Interaction between state and municipal climate planning in regions under cap-and-trade

Based on the quantitative and qualitative analyses of the Californian CAPs, there seems to be an unclear relationship between city and state mitigation measures – particularly in regions under cap-and-trade. Indeed, all the CAPs include a section dedicated to explaining the various legislations adopted by the Californian state. Nevertheless, a considerable number of these CAPs do not refer to cap-and-trade (or to an equivalent expression), and in general, give little importance to this policy – although its implementation will be quite impactful. Even amongst the eleven plans that do explicitly refer to cap-and-trade, only a few go into detail about how it functions and its potential effects. Finally, none of the plans refer to the ability of cap-and-trade to nullify aggregate emission reductions accomplished in capped sectors by outside sources.

To make things more ambiguous, certain Californian CAPs rely on state regulation to achieve the total municipal reduction target they set out for themselves, or to close their challenge gap. In a sense, this is an interesting strategy, because it means the planners are aware that they are working within, and interdependent to, a larger geographical and political framework. However, it is contradictory that these plans take into consideration reductions induced by state measures at the city level, yet fail to consider the impacts of cap-and-trade on city actions. This may be because the effects of cap-and-trade were not felt at the time of the plan elaboration; nevertheless, a CAP is meant to plan for environmental actions for a span of several years.

For example, the cities of San Carlos and West Hollywood recognize that they cannot achieve any ambitious mitigation goal without the contribution of statewide strategies. Thus, they add estimates of statewide reductions to the city's total emission reduction target (59.7% of total planned reductions is attributed to statewide reductions in San Carlos and 65.4% in West Hollywood). However, San Carlos hardly refers to cap-and-trade, and West Hollywood says it cannot estimate the effects of AB 32, but that "as the regulatory framework surrounding AB 32 grows, it may be possible to evaluate a wider range of statewide reductions" (West Hollywood, 3-47, 2011). The cities of Hillsborough and Burlingame also include statewide strategies in their overall mitigation efforts. The Hillsborough CAP explains that state and federal actions in energy and transportation sectors will help Hillsborough reach its target and close the challenge gap. Similarly, Burlingame's CAP recognizes that there are outside factors "beyond Burlingame's control in meeting the emission reduction target. Burlingame has limited ability to control decisions that impact a significant portion of its emissions, most notable those in the transportation sector" (City of Burlingame, 2009, p. 28).

In contrast, certain cities such as Citrus Heights assert they will *not* depend on statewide measures to achieve their own local objectives, suggesting that it is their duty to share the burden of mitigation efforts. There is a clear desire to develop independent means of reducing the city's personal emissions:

> While statewide reductions alone are nearly sufficient to achieve the City’s target, their effects are not certain, and implementing them is an action beyond the City’s control. The City accepts that it has a fair share responsibility to implement GHG reduction measures addressing communitywide emissions within its control. (Citrus Heights, 2011, p. 8)

Therefore, there is little consistency in how a city's actions articulate themselves with the state's actions, or how the state's actions are seen to impact the city's emissions. This brings us back to the issue raised in Chapter 2 concerning the need to understand the interactions occurring in multi-scaled approaches to climate change. If several levels of government are involved, such as the local and state levels, then they must take each other into account.

It is plausible that, in the case of cap-and-trade regions, planners at the city level are not truly aware of the constraint placed on them as emitters not covered by the cap. This would be problematic not only because it would be 'misinformed' planning, but also because it would be misleading for citizens, granted they believe the city's efforts are contributing to aggregate emissions reductions. There is the risk that a decrease in political support for these CAPs would occur with the realization that these efforts are supporting positive economic benefits instead of actual environmental outcomes (Millard-Ball, 2009). This is meaningful in the case of CAPs because they are elaborated on a voluntary basis. For this reason, Millard-Ball (2009) also speculates that the idea of emission reductions may be maintained as a convenient fiction.

However, we can also argue that the disconnect between cap-and-trade and local climate planning is problematic in so far as citizens, politicians and/or scientists expect, or count on, CAPs to effectively participate in the reduction of aggregate emissions. Indeed, if the assumption is that CAPs do reduce overall emissions – even in regions under cap-and-trade – and that they will help solve climate change, then there is a problem. As shown in the literature review, this is generally the case. But is this really the motivation for municipal climate plans? We need to look at alternative or underlying motivations for the elaboration of CAPs to prepare CAPs. For this, we refer back to Figure 3.1. The hypotheses shown in orange correspond to the statistical results obtained in our study, and we will examine these successively to see which may be representative of what is going on in regions such as California.

5.3. Alternative motivations for municipal climate planning

In this section, I review and critically assess the different scenarios shown in Figure 3.1 and what repercussions they would have on climate planning more generally. Considering CAPs are implemented voluntarily, these motivations are essential to explore.

5.3.1 Increase the stringency of the state's cap

A first hypothesis to explore is that plan-makers are seeking to reduce aggregate GHG emissions, and are conscious of the limitation of cap-and-trade, thus implying that the city is aware that its local mitigation measures will make it easier and cheaper for covered sources and emitters to meet the cap (Passey et al., 2012, Burtraw and Shobe, 2009). Thus, the goal of the CAP may be to gradually reduce the overall cap. For instance, if the price of carbon falls because of the voluntary action from cities in the energy or transport sectors, then the state may implement an increase in the stringency of the cap – perhaps more than if voluntary action had not reduced the cost of compliance for emitters. This is a plausible motivation because in the long run it is beneficial overall for the state.

5.3.2. Reduce local emissions to achieve various local benefits

A second hypothesis may assume, on the contrary, that the main motivation of a CAP is not to reduce aggregate GHG emissions. This is an interesting and likely possibility, and is echoed by various authors such as Millard-Ball (2012a), and Engel & Orbach (2008) who explore the "benefits flowing from decisions to act locally on climate change, which are not dependent on effective reductions in global concentrations of greenhouse gases" (Engel and Orbach, 2008, p.121). There has been a tendency to emphasize the benefits of mitigation at the macro level, whereas it may be useful to use a microanalysis of these local initiatives (Engel & Orbach, 2008).

The motivation of CAPs may be to reduce *local* emissions, in contrast to aggregate emissions (for example, Sacramento achieves a reduction of total city GHG emissions, whether or not this translates into a reduction at the state level, since it is possible that this local reduction would be taken up by another emitter). Thus, the drawbacks of cap-and-trade are not as relevant because the outcome sought out by the CAP is not compromised by cap-and-trade. Reducing local emissions may be a strong motivation to make CAPs, as it can have several tangible benefits on the community: it can lead to environmental benefits, such as increased air quality; social benefits such as increased active transportation and reduced traffic congestion; and economic benefits such as reduced dependency to oil. Generally, lower local emissions would lead to a more sustainable lifestyle in the long run, and a city "ready for the carbon-constrained age" (Burtraw and Shobe, 2009, p.12). Incidentally, this also puts into perspective the assumption that cities have overcome the local costs/global benefits dilemma, since municipal governments are in fact incurring considerable benefits by reducing local emissions.

This hypothesis is supported by looking at what CAPs actually announce as the goals of the plan. For example, the Citrus Heights CAP states that, other than reducing GHG emissions, the plan will also lead to five community benefits: improved air quality, increased energy independence, creation of healthier neighborhoods (public spaces, mixed land-uses, connectedness to the transit system), creation of local jobs due to new technologies or retrofits, and finally, money savings through using less water and less energy (Citrus Heights, 2011, pp. ES-4). In addition, this hypothesis is also supported considering "local climate change initiatives frequently define goals for emissions reductions, but fail to specify the expected impact of the plan on concentrations of global greenhouse gases" (Engel & Orbach, 2008, p. 130)

5.3.3. Political, ethical, symbolical motivations

A third hypothesis is that the environmental outcome of municipal climate planning matters little, and that the actual motivation for CAPs lies elsewhere. I base this idea on a paper by Engel and Orbach (2008) that examines the "demand" from citizens, and voluntary "supply" from politicians, for local climate planning. On the demand size, CAPs may act as symbolic statements in solidarity against climate change. Because CAPs are often written broadly in terms of scope, timing and aggressiveness (and because the plan is voluntary), the plans may be simply representational of a desire to be doing something against climate change. Engel and Orbach (2008) also explain that people may support CAPs because it gives them a "warm glow" (p.130), or a feeling of doing something useful. Thus, local officials respond to these public citizen pressures (Kousky and Schneider, 2003).

On the supply side of the provision of CAPs, one motivation may be "political entrepreneurship" (Engel & Orbach, 2008, p. 134), since the endorsement of green actions is popular in politicians' agendas, and may be a way to gain attention or recognition. Furthermore, there is the possibility of economic gains through the creation of new businesses, job opportunities, or through offset purchases for example. Finally, we can refer back to Millard-Ball (2012a) who argues that CAPs simply codify environmental preferences and actions that would have occurred anyways. CAPs may have become "more of a marketing device than a template for action, helping a city to gain a (probably deserved) 'green' reputation for action that predated or occurred independently of climate planning" (Millard-Ball, 2012a, p.12).

Having examined these possibilities, we should bear in mind that all cities may not be in the same situation, and are surely motivated to develop CAPs for multiple and different reasons. Nevertheless, given these possibilities, how should we assess the potential of municipal climate planning as a viable strategy against climate change? This is what I examine in the next section.

5.4 Recommendations and future steps for local climate planning in cap-and-trade regions

The purpose of this paper is not to put down what cities are accomplishing on the climate change front, but rather understand where they are coming from, and what different directions they should go in so as to fulfill the goals they set out for themselves. I see two potential approaches to take with regards to the assessment of municipal climate planning, and each of these comes with a different set of recommendations.

5.4.1. Cities can contribute to aggregate GHG emission reductions

One direction for municipal climate planning is to work towards contributing to the reduction of overall GHG emissions. In this case, there are several obstacles to address, some of which were raised earlier, including the issue of free riding, and the problem of the limited geographic scale and political power of cities to implement policies that can successfully address climate change. Our focus, however, is on cities in cap-and-trade regions, and how they can deal with the "emissions floor" constraint placed on them by cap-and-trade. Thus, I concentrate on how action can be coordinated between the state and local level in order to allow, and even encourage, cities to contribute to overall GHG emission abatement.

A first important comment to make is that, because of the importance of the portion of emissions from the energy and transport sectors in cities' total emissions, and because the WCI covers both of these sectors, it may not be realistic to expect cities to concentrate much more of their reductions efforts in the three non-covered sectors used in this study. Indeed, the waste sector represents only a small percent of total emissions; the 'other' category refers in most cases to long-term social actions such as increased citizen education; finally, 'forestry' corresponds to the use of offsets, which is in fact one of the ways through which cities can effectively contribute to additional reductions (Twomey et al., 2012, Millard-Ball, 2009). One consideration though, is that the use of offsets is more or less useful depending on what proportion of total emissions are covered by the cap-and-trade scheme (Twomey et al., 2012). For example, the WCI is meant to cover up to 85% of Californian total GHG emissions (C2ES, 2012), which leaves limited opportunity for an important use of offsets.

Alternatively, one way forward may be to encourage local mitigation reductions in order to achieve a gradual reduction of the state cap (Twomey et al., 2012). CAPs would thus contribute to an economic benefit (reducing the cost of compliance for emitters), which would itself lead to an environmental benefit (increasing the cap stringency).

However, by studying policy instruments at the state and local scales, it seems that both should be taking each other into consideration: the state cap-and-trade policy should also find ways to factor in local governments – not just the other way around. Thus, I examine ways in which policy-makers can accommodate cap-and-trade to make it compatible with voluntary reductions at the local level. This would be an interesting outcome, because local climate planning does present several unique advantages. For example, it allows decentralized and flexible action, which is more adapted to local conditions. It is also the level of government closest to the scale of implementation (Underdal, 2010).

The mechanism recommended by Twomey et al. (2012) is a "set-aside reserve method for retiring carbon permits" (p.433). This would imply an automatic retirement of permits from the cap-and-trade scheme, equivalent to verified abatement of emissions from additional action by outside sources. Thus, there would be a reserve of set-asides from the program's pool of allowances, and regulators would remove allowances the same year as the additional abatement is undertaken. Covered emitters can thus clearly see how many allowances are set-aside from year to year. In fact, the WCI has set up an 'Optional Voluntary Renewable Energy Set-aside Allocation'. This resembles the solution suggested by Twomey et al. (2012), but it only includes voluntary abatement through renewable energy activities (WCI, 2010), which is a good first step forward, even though actions from other sectors cannot yet be accounted for.

Millard-Ball (2009) also raises the possibility for additional abatement around the use of safety valves, a feature included in certain cap-and-trade schemes. However, the WCI does not have such a mechanism, so I will not develop further on this alternative here.

The potential downside of adjusting the cap-and-trade design with such features is additional costs of administration, as well as the added uncertainties that policy-makers cannot fully predict. However, the solutions still remain plausible to implement within a traditional cap-and-trade program (Twomey et al., 2012).

5.4.2 Cities cannot contribute to aggregate GHG emissions reductions

An alternative direction for municipal climate planning in cap-and-trade regions is to consider it as *not* contributing to reduction of aggregate emissions. This is a tenable position, because as shown earlier, other environmental, social and economic benefits can ensue from the measures undertaken, as well as a generally more sustainable and less energy-dependent lifestyle. But if this is the approach adopted towards municipal climate planning, we must reassess how much credit we are giving these CAPs in the face of the problems of climate change. There may be a need to review our assumptions about the impact of the recent surge in local climate planning. As Engel and Orbach (2008) express, there is a risk of developing a "placebo effect [through which] the pervasiveness of local initiatives may create the impression that something effective is being done" (p.136). In this case, we are faced with an even more pressing need to ensure that state policies (cap-and-trade or others) are useful, and that federal or international strategies be developed and implemented effectively.

5.4.3 Quality of municipal climate plans

I end with a research finding concerning the general quality of CAPs in the U.S. Although this is tangential to my research questions, it is important to discuss in terms of recommendations for the future elaboration of CAPs. I base myself on reviews of numerous CAPs from across the U.S, including plans rejected for this study – though I do not claim to have performed a thorough enough analysis to make generalizable comments about all local climate planning.

First, several plans do not include explicit implementation strategies: they do not explain how they plan on achieving the ambitious targets they set out, or they do not include quantifications of the reductions they expect each action to contribute. In fact, Boswell (2010) found that one third of the 30 U.S. CAPs he analysed did not quantify emissions reductions from proposed mitigation strategies. This is problematic because "for the plan to be effective, adopted mitigation actions must cumulatively reach the GHG emissions reduction target identified […] To assess whether or not mitigations will be adequate to reach the target, they must be quantified." (Boswell, 2010, p.455)

Second, even the more adequate plans were not necessarily complete, since several of the plans used in my sample presented challenge gaps. As discussed earlier, some of the CAPs recognize this gap and suggest ways of overcoming it. However, other plans do not even acknowledge this breach in their quantifications – which is problematic if cities claim to be serious about reaching their abatement goals.

5.5 Research Limitations

Different limitations to the study must be recognized in the discussion of results. First, the sample size used was relatively small, which means the validity of the study could be increased with a larger sample. However, this is a limitation partly caused by the lack of CAPs that fit the criteria enunciated – namely, the lack of CAPs that had sufficient quantitative breakdown of strategies into actual amounts of mtCO2e.

A second limitation of this study is that it is impossible to know what the decisions makers at the municipal level really know and believe. Quantitative methods are useful to analyse concrete and 'objective' planning choices (target reductions, in this case), and they represent a straightforward way to measure differences in planning between cap-and-trade and non cap-and-trade areas. Downfalls, however, include not having a precise idea of what planners and elected officials know and take into account. Thus, conclusions and explanations are sometimes more speculative. I also made assumptions about the relation between the publication year of a plan and the planner's knowledge of cap-and-trade – though in theory, there is no way of verifying whether the planner really knew about the policy or not.

Third, it would have been interesting to conduct an analysis of Californian CAPs before and after the implementation of the WCI. This would have involved the comparison of target reductions with and without cap-and-trade across the same state, instead of across the U.S. This was initially going to be another validity test for the quantitative aspect of the research. However, I found an insufficient number of pre-WCI plans that had the appropriate format and quantitative details about reductions by sector.

5.6. Future research

Consequently, future studies could go down different possible avenues. A similar study could be conducted with a bigger sample size, which will be more feasible if the popularity of municipal climate planning continues to increase. Such a study could focus on a different region of the US (such as the region covered by the RGGI) or a different part of the world. It would also be interesting to conduct a parallel qualitative study, by conducting interviews with plan-makers for example. One focus of the interviews would be to ask about the involvement of California in cap-and-trade and the perceived impacts on the municipality –this would be especially interesting as the WCI program really starts off in 2013.

Further research could also be conducted on more technical and policy-making aspects of this research, like how to design a cap-and-trade scheme in order to allow for additional reductions from voluntary sources. For example, there is a need to understand how to measure these additional reductions, and how to incorporate them into the program (Passey et al., 2012).

CONCLUSION

To recapitulate, this study has found that cities in regions regulated by cap-and-trade do not seem to allocate their mitigation efforts between covered and non-covered sectors in a significantly different way than cities that are not under a cap-and-trade program. This is based on a quantitative analysis of the target reductions for a sample of CAPs from California, which adopted the WCI cap-and-trade program in 2007, and from various other U.S. states that are not covered by a cap-and-trade scheme. The statistical results were supported by a qualitative review of the Californian CAPs, which showed that in general, the CAPs assigned little consideration to cap-and-trade.

This is a key finding because cap-and-trade programs have the potential effect of preventing additional emission reduction below the level of the cap in sectors covered by the program. In other words, my findings demonstrate that mitigation action undertaken by Californian CAPs may not be contributing to any aggregate GHG emission reduction. This is important because in our current neoliberal economy, cap-and-trade is becoming increasingly popular, and several regions around the world are adopting it. At the same time, more and more cities are developing their own CAPs and mitigation targets. Therefore, it is crucial to understand the repercussions of cap-and-trade on municipal action, as well as to explore ways of circumventing these limitations. The conclusions drawn from the Californian case study are hopefully generalizable to other cap-and-trade regions, such as the province of Quebec.

For this reason, working to develop "robust policies", in the sense used by Twomey et al. (2012) seems like an appropriate recommendation. The argument for robust climate policy is that mitigation policy based on a single instrument may be too fragile. Indeed, robustness is a "measure of how well a climate policy continues to be effective, efficient and equitable under unexpected changes in parameters" (Twomey et al., 2012, p.431). In the same way that having only one policy to mitigate climate change may be inadequate, having an instrument that prevents voluntary action at the municipal or individual level may also be unwise or insufficient.

Therefore, in the case of cap-and-trade, this translates into designing the scheme so that it does not *discourage* action at other levels, but rather facilitates additional emissions reductions from other sources, such as cities. For example, this could mean the inclusion of a set-aside reserve system, meaning the retirement of permits equivalent to the annual additional abatement measures from voluntary sources. Another interesting modification would be for the state government to use part of the revenue generated by cap-and-trade (through auction of the carbon permits for example) to fund the implementation of CAPs, and provide appropriate information and resources. It is be important to develop effective ways to include such mechanisms, because this provides an incentive for local governments to keep participating in climate change action. However, the cap-and-trade regulators must find a way to do so without imposing excessive additional administrative costs (Twomey et al., 2012).

Another argument in favor of the development of a robust cap-and-trade design is that local climate planning is often criticized for being too dependent on other levels of government in order to be successful in reducing overall GHG emissions. Thus, robust policies would allow for voluntary decentralized actions from cities to be better integrated to the mix of larger-scale market based instruments. This is in line with the broader argument that a multi-scaled approach to climate change will be effective, granted that the interactions amongst the different scales are taken into account.

We must keep in mind that there is a host of other plausible reasons for which CAPs are elaborated other than reducing aggregate emissions. Cities may be seeking to reduce local emissions, regardless of whether this affects overall emissions, because this produces environmental, social and economic benefits. Elected officials may also be responding to citizens' symbolic or ethical motivations to be 'doing something' against climate change. Finally, CAPs may be simply codifying pre-existing decisions and preferences, as a tangible proof that the local government is undertaking mitigation actions. Although these different motivations are not necessarily mutually exclusive, I believe it would be interesting and useful for the goal of local climate planning to be, even in cap-and-trade regions, to reduce aggregate emissions. Indeed, local climate planning presents several advantages that planning at other levels does not necessarily have, and the recent impetus for the elaboration of CAPs presents great potential for climate governance.

To conclude, this study represents one step forward in understanding the multiple interactions of climate policy strategies at different political levels. It also demonstrates the need to remain critical in our assessment of these strategies and of their real impacts.

REFERENCE LIST

Bang, G., Hovi, J., & Sprinz, D. F. (2012). US presidents and the failure to ratify multilateral environmental agreements. *Climate Policy, 12*(6), 755-763. doi: 10.1080/14693062.2012.699788

Bassett, E., & Shandas, V. (2010). Innovation and Climate Action Planning. *Journal of the American Planning Association, 76*(4), 435-450.

Bird, L. A., Holt, E., & Levenstein Carroll, G. (2008). Implications of carbon cap-and-trade for US voluntary renewable energy markets. *Energy Policy, 36*(6), 2063-2073.

Boswell, M. R., & Greve, A. I. (2012). *Climate Action Plan Database*.

Boswell, M. R., Greve, A. I., & Seale, T. L. (2010). An assessment of the link between greenhouse gas emissions inventories and climate action plans. *Journal of the American Planning Association, 76*(4), 451-462.

Bulkeley, H., Broto, V. C., Hodson, M., & Hodson, M. (2011). *Cities and low carbon transitions* (Vol. 35): Taylor & Francis.

Burtraw, D., & Shobe, B. (2009). State and Local Climate Policy under a National Emissions Floor. *Climate Change Policy: Insights from the US and Europe, Paris*, 23-24.

Byrne, J., Hughes, K., Rickerson, W., & Kurdgelashvili, L. (2007). American policy conflict in the greenhouse: Divergent trends in federal, regional, state, and local green energy and climate change policy. *Energy Policy, 35*(9), 4555-4573. doi: 10.1016/j.enpol.2007.02.028

California EPA. (2012). Assembly Bill 32: Global Warming Solutions Act. Retrieved November 30, 2012, from http://www.arb.ca.gov/cc/ab32/ab32.htm

Center for Climate and Energy Solutions (C2ES). (2012). California Cap-and-Trade Project Summary. Arlington, VA.

Citrus Heights. (2011). *Citrus Heights Greenhouse Gas Reduction Plan*.

City of Burlingame. (2009). *Climate Action Plan*.

City of Corona. (2012). *Climate Action Plan: Environmental Impact Report*.

City of Dublin. (2010). *Climate Action Plan*.

City of Emeryville. (2008). *City of Emeryville Climate Action Plan*.

City of Fullerton. (2012). *The Fullerton Plan: Climate Action Plan*.

City of Piedmont. (2010). *Climate Action Plan*.

Dodman, D. (2009). Blaming cities for climate change? An analysis of urban greenhouse gas emissions inventories. *Environment and Urbanization, 21*(1), 185-201.

Engel, K. H., & Orbach, B. Y. (2008). Micro-motives and state and local climate change initiatives. *Harv. L. & Pol'y Rev., 2*, 119.

Haas, P. M. (2004). Addressing the global governance deficit. *Global environmental politics, 4*(4), 1-15.

Hayes, A. F., & Cai, L. (2007). Using heteroscedasticity-consistent standard error estimators in OLS regression: An introduction and software implementation. *Behavior Research Methods, 39*, 709-722.

Hoornweg, D., Sugar, L., & Gómez, C. L. T. (2011). Cities and greenhouse gas emissions: moving forward. *Environment and Urbanization, 23*(1), 207-227.

ICLEI. (2012). ICLEI Member List. Retrieved November 30, 2012, from http://www.iclei.org/index.php?id=global-members

Kennedy, C., Demoullin, S., & Mohareb, E. (2012). Cities reducing their greenhouse gas emissions. *Energy Policy, 49*(0), 774-777. doi: 10.1016/j.enpol.2012.07.030

Kousky, C., & Schneider, S. H. (2003). Global climate policy: will cities lead the way? *Climate Policy, 3*(4), 359-372.

Krebs, M. (2011). Lessons of climate change, stories of solutions. California: Government leadership. *Bulletin of the Atomic Scientists, 67*(1), 60-63. doi: 10.1177/0096340210393926

Lefèvre, B. (2012). Incorporating cities into the post-2012 climate change agreements. *Environment and Urbanization, 24*(2), 575-595. doi: 10.1177/0956247812456359

Lemos, M. C., & Agrawal, A. (2006) Environmental governance. *Vol. 31* (pp. 297-325).

Lutsey, N., & Sperling, D. (2008). America's bottom-up climate change mitigation policy. *Energy Policy, 36*(2), 673-685. doi: 10.1016/j.enpol.2007.10.018

Meadowcroft, J. (2002). Politics and scale: Some implications for environmental governance. *Landscape and Urban Planning, 61*(2-4), 169-179. doi: 10.1016/s0169-2046(02)00111-1

Millard-Ball, A. (2009). Cap-and-Trade: Five Implications for Transportation Planners. *Transportation Research Record: Journal of the Transportation Research Board, 2119*(-1), 20-26.

Millard-Ball, A. (2012a). The Limits to Planning: Causal Impacts of City Climate Action Plans. *Journal of Planning Education and Research*.

Millard-Ball, A. (2012b). *CCP Members California*.

Passey, R., Bailey, I., Twomey, P., & MacGill, I. (2012). The inevitability of 'flotilla policies' as complements or alternatives to flagship emissions trading schemes. *Energy Policy, 48*(0), 551-561. doi: http://dx.doi.org/10.1016/j.enpol.2012.05.059

PCET. (2012). Centre de Resources pour les Plans Climat-Énergie Territoriaux. Retrieved November 30, 2012, from http://www.pcet-ademe.fr/

Raihani, N., & Aitken, D. (2011). Uncertainty, rationality and cooperation in the context of climate change. *Climatic Change, 108*(1), 47-55.

Rice, J. L. (2010). Climate, carbon, and territory: Greenhouse gas mitigation in Seattle, Washington. *Annals of the Association of American Geographers, 100*(4), 929-937. doi: 10.1080/00045608.2010.502434

Sanwal, M. (2004). Trends in Global Environmental Governance: The emergence of a mutual supportiveness approach to achieve sustainable development. *Global environmental politics, 4*(4), 16-22.

Schmidt, C. W. (2007). Environment: California out in front. *Environmental Health Perspectives, 115*(3), A144-A147.

Schreurs, M. A. (2008). From the Bottom Up Local and Subnational Climate Change Politics. *The Journal of Environment & Development, 17*(4), 343-355.

Shobe, W., & Burtraw, D. (2012). Rethinking environmental federalism in a warming world. *Resources for the Future Discussion Paper*(12-04).

Stone, B., Vargo, J., & Habeeb, D. (2012). Managing climate change in cities: Will climate action plans work? *Landscape and Urban Planning*.

Tang, Z., Brody, S. D., Quinn, C., Chang, L., & Wei, T. (2010). Moving from agenda to action: Evaluating local climate change action plans. *Journal of Environmental Planning and Management, 53*(1), 41-62.

Town of Hillsborough. (2010). *Climate Action Plan*. Hillsborough, CA. .

Trisolini, K. (2010). All Hands on Deck: Local Governments and the Potential for Bidirectional Climate Change Regulation. *Stanford Law Review, 62*, 669.

Twomey, P., Betz, R., & MacGill, I. (2012). Achieving additional emission reductions under a cap-and-trade scheme. *Climate Policy, 12*(4), 424-439. doi: 10.1080/14693062.2011.649591

U.S. EPA. (2009). *Cap-and-trade: Essentials*. Retrieved from http://www.epa.gov/captrade/documents/ctessentials.pdf.

U.S. EPA. (2012a). Smart Growth and Climate Change. Retrieved November 30, 2012, from http://www.epa.gov/smartgrowth/climatechange.htm

U.S. EPA. (2012b). State and Local Climate and Energy Program. Retrieved December 1, 2012, from http://epa.gov/statelocalclimate/state/state-examples/action-plans.html

Underdal, A. (2010). Complexity and challenges of long-term environmental governance. *Global Environmental Change, 20*(3), 386-393. doi: 10.1016/j.gloenvcha.2010.02.005

WCI. (2010). *Design for the WCI Regional Program*. Retrieved from http://www.westernclimateinitiative.org/component/remository/general/program-design/Design-Summary/.

Wheeler, S. M. (2008). State and municipal climate change plans: The first generation. *Journal of the American Planning Association, 74*(4), 481-496.

Wiener, J. B. (2006). Think globally, act globally: The limits of local climate policies. *U. Pa. L. Rev., 155*, 1961.

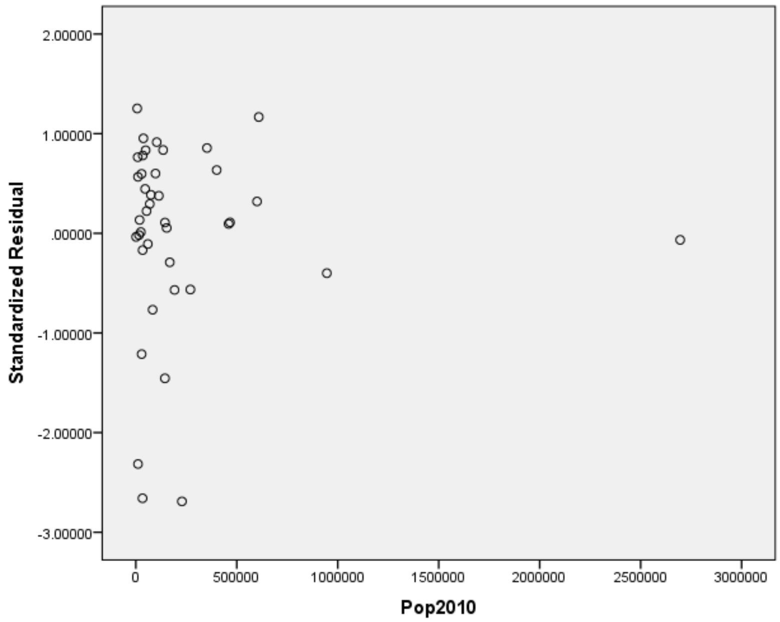
Wilbanks, T. J., & Kates, R. W. (1999). Global change in local places: how scale matters. *Climatic Change, 43*(3), 601-628.

APPENDIX A: List of the 40 municipalities used in the treatment and control samples

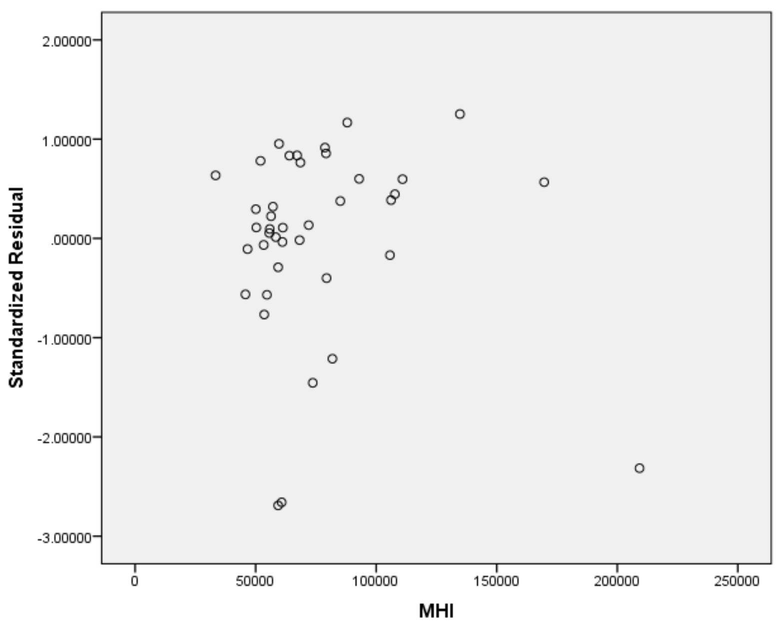
Treatment group sample: Californian cities regulated by cap-and-trade		**Control group sample**: Cities in states not regulated by cap-and-trade	
Jurisdiction	**CAP Publication date**	**Jurisdiction**	**CAP Publication date**
Albany, CA	April 2010	Anacortes, WA	November 2006
Apple Valley Town, CA	July 2010	Ann Arbor, MI	July 2012
Burlingame, CA	June 2009	Aspen, CO	May 2007
Citrus Heights, CA	August 2011	Boulder, CO	2006
Corona, CA	February 2012	Bozeman, MT	March 2011
Dublin, CA	October 2010	Chicago, IL	2008
Emeryville, CA	November 2008	Cincinnati, OH	June 2008
Fullerton, CA	February 2012	Denver, CO	October 2007
Glendale, CA	March 2012	Durham, NC	September 2007
Hayward, CA	June 2009	Evanston, IL	November 2008
Hillsborough, CA	February 2010	Fort Collins, CO	December 2008
Murrieta, CA	July 2011	Haverford Town, PA	April 2009
Palmdale, CA	August 2011	Kansas City, MO	July 2008
Piedmont, CA	March 2010	Key West, FL	October 2009
San Carlos, CA	October 2009	Lake Oswego, OR	February 2012
San José, CA	November 2011	Miami, FL	June 2008
Santa Rosa, CA	January 2012	Mission, KS	June 2009
Sacramento, CA	January 2012	Mount Lebanon, PA	June 2010
Tulare, CA	April 2011	Seattle, WA	May 2011
West Hollywood, CA	April 2011	Ypsilanti, MI	May 2012

APPENDIX B: Heteroscedasticity Test Results (standardized residuals against the independent variable values)

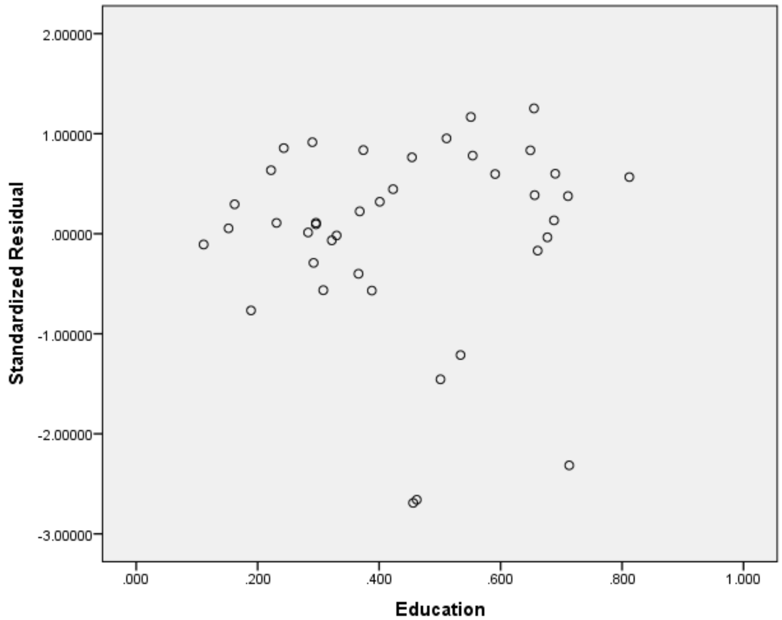
City Population in 2010



City Median Household Income



City Education Levels



Region (0 = region not under cap-and-trade, 1= region under cap-and-trade)