STATE ADOPTION OF GREENHOUSE GAS EMISSIONS TARGET AND RENEWABLE PORTFOLIO STANDARDS

by

Liang Li

A Thesis Submitted to the Faculty of the

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS

In Partial Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

In the Graduate College

The University of Arizona

2009

STATEMENT BY AUTHOR

This thesis has been submitted in partial fulfillment of requirements for an advanced degree at the University of Arizona.

Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his or her judgment the proposed use of the material is in the interest of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: Liang Li

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

Dr. George Frisvold
Professor of Agricultural and Resource Economics

8/1/2009
Date

ACKNOWLEDGEMENTS

I would like to first thank my thesis advisor, Professor George Frisvold, for his wise guidance and consistent support during the two year program. I have grown, learnt and been more determined to do researches.

I would also want to give thanks to professors on my committee, Professor Ed de Steiguer and Denis Cory. Professor I have been working with Professor Ed de Steiguer for a year on a similar research that helps me understand U.S. state climate change policies. Professor Cory gives me kind advice and support in class and thesis.

I am grateful for the help I get from the staff and classmates in this department. I really enjoy our program and take pride in graduating and presenting this thesis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

This thesis examines the driving forces behind the adoption of State GHG Emissions Target and Renewable Portfolio Standards. The thesis chooses event history analysis using binary time-series and cross-section data to do empirical analysis for the two policies. Based on the analysis, time trend, neighboring effect, state political system characteristics, relative strengths of interest groups and demographics of a specific state have, maybe not always significant, impact on adoption. At the level of variable groups, time trend, neighboring effect, state political system characteristics contribute significantly to explaining the adoption behavior of the two policies. Relative strengths of interest group variables are significant for State GHG Emission Targets but remain inconclusive for State Renewable Portfolio Standards.

1 Problem Statement and Motivation

1.1About Climate Change and its Impacts

Climate change is any long-term significant change in the "average weather," which may include average temperature, precipitation and wind patterns, that a given region experiences. In the context of environmental policy, "climate change" often refers to global warming, as a sequence of which, the average global air temperature near the Earth's surface increased 0.74 ±0.18°C (1.33 ± 0.32°F) during the hundred years ending in 2005.The Intergovernmental Panel on Climate Change (IPCC) concludes that "most of the observed increase in globally averaged temperatures since the mid-twentieth century is very likely due to the observed increase in anthropogenic (man-made) greenhouse gas concentrations" via the greenhouse effect caused by the greenhouse gases.

The effects of global warming are fundamental both for the environment and human life. Research done by the National Oceanic and Atmospheric Administration (NOAA) suggests that some effects of global warming are already irreversible.[1] IPCC predicts in their recent report that global warming will continue and get wore much faster than was expected. Rising sea levels, glacier retreat, Arctic shrinkage, and altered patterns of agriculture can be already observed. An expansion of tropical diseases, changes in the timing of seasonal patterns in ecosystems are usually termed as secondary effects and they are predicted with a considerable likelihood to happen in the future.

It is worth noticing that many of the effects are non-linear in nature (with possibility for dramatic feedback effects that will contribute directly to future global

---

[1] Please refer to http://www.noaanews.noaa.gov/stories2009/20090126_climate.html for more details.

warming), which means that climate may enter a critical stage where small changes can trigger an abrupt climate change. Examples include partial loss of ice sheets on polar land that would imply a rise of sea level by an observable amount, major changes in coastlines and inundation of low-lying areas.[2] Concerns over the impacts have led to political activism advocating proposals to mitigate or adapt to them. In economics, climate change is often referred to as a global "commons" problem, as every other "commons," it goes through the "tragedy" that individuals are unlikely to take responsibility for global accumulation of atmospheric greenhouse gases (GHGs). This nature leads to the ideal way to address climate change with top-down international treaties, because that is how all the cost can be internalized and no externality exists when making decisions on possible policies in hope to achieve efficiency.

However, in reality, after more than a decade after the signing of Kyoto Protocol, the most encompassing (in terms of the number of countries that get participated in and the targets it tries to meet) international environmental treaty that aims to achieve "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" [3], it is increasingly self-evident that climate policy is a lot messier than what originally has been anticipated. Progress within the Kyoto framework can barely be observed, not only due to large carbon dioxide emitters' disengagement like China and America but also due to the incapacity of many ratifying nations to honor their commitments. This is reflected in numerous failures to reach the pledged targets of emission reductions, exemplified by Canada and Japan, and to implement national or multinational policies, such as the difficulties encountered when establishing the Emissions Trading Scheme

[2] Intergovernmental Panel on Climate Change, Fourth Assessment Report, Working Group II Report "Impacts, Adaptation and Vulnerability."

[3] Kyoto Protocol, Article 2.

in the European Union. Thus policies at sub-global level need be scrutinized under these circumstances as alternatives. This thesis will focus on policies in America.

1.2 Climate Change Policy in America

The United States is the world's largest emitter of greenhouse gases, accounting for almost 25% percent of global emissions. The substantial and permanent reductions in U.S. greenhouse emissions are crucial in dealing with global climate change problems. In the field of environmental law, for most cases, the federal government pretty much takes the lead by establishing baseline environmental quality standards and imposing conditions upon the delegation of permit programs to state governments. However, when we come to climate change policy, it is a totally different story. The federal government has maintained to be disengaged to Kyoto Protocol and a series of legislative proposals that would have built modest targets for the growth of greenhouse gas emissions.

Fortunately, this is not the whole picture of American engagement in climate change policy. There is a conspicuous trend that cannot be ignored. States' efforts in formulating climate change policy have expanded and intensified in the past several years, more specifically, after 2000. Indeed, it makes sense that states address the global problem. Berry Rabe has commented that: "Many states are major sources of greenhouse gas emissions, with considerable potential for reduction. If the fifty states were to secede and become sovereign nations, thirteen would rank among the world's top forty nations in emissions, including Texas in seventh place ahead of the United Kingdom. So if it is globally consequential when other nations establish climate policies, state engagement is more than a matter of environmental trivial pursuit."

The recent trend toward state-driven policy is not unprecedented in American policy construction. In some instances, early state policy initiative has provided setups that were ultimately embraced as national policy by the federal government, which has been evident in a range of social policy domains, including health care and education. (Manna, 2006; Teske, 2004). In other instances, states have taken the lead and largely maintained the policy leadership through multi-state collaboration and federal policymaking, such as occupational licensure and oversight of organ donations[4]. As far as American climate policy is concerned, it is probably going to follow the latter pattern for the following reasons. They can explain the policy diffusion among the states which may be also implicative about the diffusion pattern as well.

First, the absence of federal performance leaves states room for policy adoption. Although Congress continues to evaluate a variety of policy options to deal with climate change, the institutional impediments to any federal action remain significant, suggesting that there will be very limited actions from federal government to deal with climate change for years.

Second, the fact that a growing number of states are beginning to experience significant impacts that are normally thought to be caused by climate change makes the policy adoption necessary. Sea-level rise, for example, is one of the big concerns. Major urban areas built near sea level along the Eastern seaboard including New York City, Boston, Washington D.C., and Miami are expected to be at risk with an expected sea level rise of 18-20 inches above current levels by 2100. It could also lead to widespread wetlands loss threatening important habitat for shorebirds, plants, and nursery areas for fish, and ecosystem services in some states. It is reported that the wetlands and barrier islands that protected South Louisiana have eroded about 30%

[4] World Resource Institute (2007). Climate policy in the state laboratory: How can state influence federal regulation and the implications for climate change policy in the U.S. Washington, DC: World Resource Institute.

since 1900. Also, salt-water intrusion into underground water resources is a headache for states, like California, Massachusetts, North Carolina, South Carolina and Florida, threatening water quality for residential and industrial users[5]. Some of these are having the classic effect "triggering events" that create impetus for a policy response. Indeed, people living in those states, can observe and experience what has changed due to global warming, and are more eager to address the problem themselves.

Third, many states formed the policy in a way that combines effects of reducing greenhouse gases as well as serving to their economic self-interest. The most popular one is Renewable Portfolio Standard (RPS). To achieve sustainability for electricity industry for a state, an RPS requires that a minimum amount of renewable energy (for example, wind, solar, biomass, and geothermal energy) is included in the portfolio of electric generating resources serving a state. Although RPS is very controversial among scholars because doubts have been raised about its efficiency to achieve the carbon dioxide emission, it still remains welcome among almost all states, due to the fact that it is usually described to deliver multiple benefits, like job-creation, advancing future technologies for long-term economic growth and of course plus climate change.

Fourth, being "first movers" are extremely appealing to some of the states, often taking bold steps with the explicit objective to take national leadership roles on climate policy, like California's greenhouse gas emission reduction regulations for cars and trucks and New York's efforts in the northeast to establish a regional carbon emission trading zone, possibly put themselves in the position to be influential in future federal policy. In this sense, states are similar to corporations; some seek an early and active role, sensing potential strategic advantages over their more reluctant

---

[5] Global Warming: Early Warning Signs. For more details, refer to http://www.climatehotmap.org/

competitors (Hoffman, 2006; Kamieniecki, 2006).

Fifth, taking into consideration together with the fourth reason, the fact that states can utilize alternative approaches to form climate change policy at the federal level, including direct democracy and litigation that confronts federal institutions gives states more incentives to adopt a state level policy. The 2007 U.S. Supreme Court verdict in Massachusetts et al. v. U.S. Environmental Protection Agency indicates that a collective of states can wage and ultimately win an intergovernmental court battle that may serve to force a reluctant federal agency to designate carbon dioxide as an air pollutant. The decision in this case has already triggered additional multi-state efforts to use the federal courts as a venue to challenge other decisions by the private sector or federal agencies.

1.3 Multiple State-level Climate Change Policies

Having identified the reasons for state-level climate change policies, a brief introduction of those policies would be necessary. When analyzing state-level climate policies, one would observe that the time for adoption is pretty concentrated on recent years. The following table from Pew Center will shed some light on the timeline of states' climate change policy formation process.

Table 1 : Greenhouse Gas Policy Innovation

Policy Sector	Primary State	Form	Date of Approval	Other States
Renewable Energy	Taxes	Legislation	2005	32 with RPS
Air Pollution Regulations	Massachusetts	Regulation	2001	New Hampshire
Agriculture	Nebraska	Legislation	2000	Illinois, Oklahoma, North Dakota, Wyoming
Forestry/Natural Resources	Minnesota	Legislation	1991	Montana, Oregon
Waste Management	North Carolina	Legal Settlement	2000	Wisconsin
Transportation	Georgia	Administrative Agreement	1996	California Washington
Energy Development	Oregon	Legislation	1997	Minnesota
Reporting/ Registry	Wisconsin	Regulation Legislation	1993 /2000	California, New Hampshire
Comprehensive	New Jersey	Executive Order	1998	New York, New England States

Source: “Greenhouse and Statehouse-the Evolving State Government Role in Climate Change”, Barry G. Rabe, University of Michigan

State-level policies manifest themselves in a large and diverse range of forms, which include policies designed to reduce greenhouse gases from vehicles and power plants, building codes, state energy conservation incentives, and many other initiatives that may not even have “climate” or “greenhouse” in the policy title. Based on difference in industries that are influenced by those policies, they are generally categorized into four groups[6]: climate action, like Green Gas Emission Targets; energy sector policy, like Renewable Portfolio Standards; transportation sector policy, like vehicle GHG Emission Standards, and building sector policy, like Green Building Standards for State Buildings. For state-level climate policies, California has emerged as a leader in climate change mitigation. In the following part, I will provide four representative policies from each of the group mentioned.

A. State Greenhouse Gas Emission Targets

A greenhouse gas emissions target refers to the emission reduction levels that states set out to achieve by a specified time. These targets typically consist of a state-wide inventory of greenhouse gas emission sources together with a list of potential mitigation actions. Take Arizona for example, on September 8, 2006, Arizona Governor Janet Napolitano issued Executive Order 2006-13, which established a statewide goal to reduce Arizona's GHG emissions to 2000 levels by 2020, and 50 percent below 2000 levels by 2040[7].

In general, the plans are coming out in various titles with different wording, such as the following,: "executive order," for Arizona, California, Virginia and New Mexico; "Law," for Washington and Maine; "House Bill" for Oregon and Connecticut; "Goal" for Utah, Illinois and New York; "Global warming Solution Act" for Hawaii and Massachusetts; "Next Generation Energy Act" for Minnesota; "Climate Change Action Plan" for Vermont, New Hampshire and Rhode Island; "Global Warming Response Act" for New Jersey. This variation may have a slightly different implication in terms of effectiveness. Despite that, other than different target levels, they are virtually the same in terms of aims, constraining power and sometimes even methods used to achieve the targets. Interestingly, it is true for all the climate change

---

6 http://www.pewclimate.org/

7 Please refer to http://www.pewclimate.org/what_s_being_done/in_the_states/emissionstargets_map.cfm for details.

policies that will be discussed later. These targets are usually viewed as definite and comprehensive, thus important state effort to reduce greenhouse gas emissions. As of February 27, 2009, 20 states have adopted State GHG Emission Targets.

B. Renewable Portfolio Standards

Renewable Portfolio Standards is a policy tool widely adopted by state governments to promote renewable electricity generation. An RPS requires a certain percentage of a utility's power plant capacity or generation to come from renewable sources by a given time. Though climate change may not be the prime motivation behind some of the standards, the use of renewable energy is believed to contribute to significant GHG reductions. For instance, Texas is expected to avoid 3.3 million tons of CO_2 emission annually with its RPS, which requires 2,000 megawatts of new renewable generation by 2009. The standards range from modest to ambitious, and definitions of renewable energy as well as types of utilities being constrained vary.

Besides reduction of carbon dioxide emission, benefits could be brought in by increasing a state's use of renewable energy, which include job creation, energy security and technology-driven sustainable economic growth in the long run. Although significant adoption of RPS among states is recent, and the final policy output depends partially on federal policies such as production tax credits, some of the efforts have been quite successful. For example, Connecticut increased its RPS in 2003, extending the standard to all utilities in the state. Iowa met its standard in 1999. As of January 8, 2009, 32 states have adopted RPS, the most popular state-level climate change policy.

C. Vehicle Greenhouse Gas Emission Standards

This process of adoption for this policy echoes the story of California's leadership in some other climate change policies. Some scholars believed that the most significant action to reduce the actual amount of greenhouse gases emitted from anthropogenic sources in the United States is California's regulation of greenhouse gas emissions from passenger cars and light duty trucks.[8]In 2002, California enacted AB 1493 (Pavley Global Warming Bill), a law that requires reductions in greenhouse gas emissions from light-duty vehicles (passenger cars and light duty tucks). The California Air Resources Board (CARB) is responsible for setting the standards, which would apply to new vehicles starting in the 2009 model year, if CARB receives a waiver from the U.S. Environmental Protection Agency (EPA). The standard requires that new vehicles, on average, achieve an emission reduction of 30 percent by 2016 which includes greenhouse gases of carbon dioxide, methane, nitrous oxide, and hydrofluorocarbon emissions. Under the Federal Clean Air Act, California is the only state that has the ability to set standards for motor vehicles, as long as these standards are as stringent as the federal standards and the state receives a waiver from the EPA. As of February 17th, 2009, 18 states have adopted vehicle greenhouse gas emission standards with more than 15 states have adopted or have announced their intention to adopt the California Standards.

D. Building Standards for State Buildings

Building Standards for State Buildings is a voluntary standard that was created by the U.S. Green Building Council to provide a complete framework for assessing building performance and meeting sustainability goals, which involves energy consumption that relates to carbon dioxide reduction. Although it is a new policy instrument - with the first adoption in Arizona in 2005 -, it has been diffused among states relatively quickly. As of October 2008, 19 states have adopted the policy.

8 Kirsten H. Engel, 2006 "State and Local Climate Change Initiative: What is Motivating State and Local Governments to Address a Global Problem and What Does this Say about Federalism and Environmental Law?", Arizona Legal Studies Discussion Paper No. 06-36.

1.4 Aims and Scope of the Thesis

The questions that initiate my research and to which my thesis tries to answer are: Why do states behave so differently in adopting climate change policies? What are the factors that influence states' policymaking behavior? How are states affected by those factors?

I seek to answer the questions by focusing on two state level climate change policies outlined in the previous section: State Greenhouse Gas Emission Targets and RPS. The thesis will consider state climate change initiatives beginning from 2001, basically a common starting point for the two policies, attempting to trace out the major patterns of policy diffusion. The thesis will provide analysis to guide future climate policy development by first outlining a systematic theory for policymaking process in regard of climate change policies, which will lead to a consideration of influencing forces that have driven the formation of the policies and second, testing the relevant importance of the driven forces based on the theory analysis. Although socioeconomic variables which represent the driven forces have been analyzed intensively by previous scholars, more detailed modeling process will reveal new potentially interesting variables. With empirical testing, we will get to know not only intuitively what the contributing factors are but also how influential they are in the scenarios for State GHG Emission Targets and RPS.

The analysis is of importance in that: states, viewed as "laboratories of democracy," provide an ideal venue to examine the rise of climate change policies as a new policy instrument to adapt to climate change as well as address sub-national issues. They also offer their valuable experience to distill lessons for policy makers at multi-government levels. Moreover, researchers might be interested in empirical tests of a range of theories of policymaking that account for differences across units of analysis, because that may not be easily examined at the national level.

1.5 Thesis Organization

In Chapter 2, I first review literature on policymaking, especially for environmental policies, through which a systematic policymaking process could be modeled. I then propose hypotheses regarding the driving forces from the theory model. After that, I discuss the variables that could represent the driving forces in the empirical model. For clarity and future reference, I also summarize the information analyzed earlier in a summary table which contains significant variables from previous research work that support variables chosen in my empirical model. Then, I review the literature for RPS, summarizing it in a table as well

Chapter 3 provides a theoretical analysis regarding data treatment and model specification. To do the empirical tests while trying to best suit the property of the available empirical information, event history analysis with clog-log model specification using binary time-series and cross-section data will be chosen to be the econometric methodology of the empirical tests.

Chapter 4 models the adoption of State GHG Emission Targets. I first give general description of policies, in which basic components of the policy and policy diffusion pattern will be discussed. After that, I document the data that will be used to represent the variables in the model proposed in Chapter 2. I present descriptive statistics of the data and group the variables by types of hypotheses. Then I discuss the regression results and answers to my research questions and comment on implications of major findings.

Chapter 5 models the adoption of RPS with exact same organization as Chapter 3.

Chapter 6 summarizes the findings and outlines the conclusions. As the closing chapter, I compare and contrast my results from Chapter 3 and 4. I then explore the implications of my work for the understanding of the adoption of climate change policies. I conclude with a discussion of areas for future research.

2 Literature Review on State-level Adoption of Environmental Policies

2.1 Literature Review for Theories on Policy Making

William Gormley (1986) has characterized regulatory situations making policy decisions involving complex but not particularly salient issues (climate change is a typical one) as consisting of "board room" politics. Under these circumstances policy action occurs among bureaucrats, professionals, and business groups. How this plays out depends on the alignments within the business community and degree of consensus that emerges about the policy in question and often hammered out behind closed doors. Politicians are then involved for the final policy output.

Adoption of a policy is the final product of this policymaking process. To explain adoption of policy, modeling of policymaking is necessary and I find it helpful to think through this process systematically because explanatory variables will emerge at different stages of the process accordingly and interesting hypotheses can be proposed along the way.

The process is over-simply stated here in that it seems different contributing variables get in at different stages as if they only exist in that stage, but the real process is more complicated and all the variables involved may influence one another consistently in the whole process. However, with the stage-wise modeling, the proposed variables and hypotheses are organized in a more logical way. Based on the literature, I tend to think the policymaking as a four stage process:

A. Originating

At the beginning, there is a demand for a policy that originates internally or externally. The internal reasons for environmental policies like state GHG target and RPS usually originate from public opinion on climate change problem. Erikson, Wright, and McIver (1989) point out that public opinion influences public policy directly and indirectly through a combination of factors. Internal influences aside for now because they will be embodied in the policymaking process discussed later. External stimulus could be from neighboring states. Lowry (1992) argues that “state leadership in national policies is affected by the horizontal dimension of interstate competition and the vertical dimension of federal involvement.” In other words, the behavior of states is determined by the interaction of these two dimensions of federalism. Then in the context of federal absence in climate change policy, state policy is influenced by the horizontal dimension of interstate competition only.

Generations of state politics scholars have believed that a U.S. state is more likely to adopt a law if its neighboring states have already done so, that is, there is a positive regional effect on policy diffusion (Stream 1999; Mooney and Lee 1995; Berry and Berry 1990; Lutz 1986; Light 1978; Sutherland 1950; McVoy 1940; Davis 1930). Walker (1969) found that over time, a number of states have earned a reputation for their role in developing innovative policies. Also, State legislatures might give in to public pressure to adopt policies known to exist in other states.

Another explanation to this external influence on states is from social learning theory (Rogers, 1995). The roots of this diffusion-as-social learning paradigm are in the literature on rural sociology, education, and communications that explores the geographical diffusion of a variety of innovations among people and organizations, in which diffusion is equal to communication and innovation spreads through a word-of-mouth process, from neighbor to neighbor. This explanation for diffusion was widely accepted by state politics scholars for two reasons.

First, state policymakers and citizens share the human cognitive bias of accepting the familiar and being reassured by those things closest to them (Freeman 1985; Tversky and Kahneman 1973; Lutz 1986). State policymakers and citizens look to other states in a search for solutions, and the states to which they look first are their neighbors, due to familiarity, ease of communication, cross-mixing of media and population, and common values (Walker 1969; Cyert and March 1963; Hagerstrand 1965; Katz, Levin, and Hamilton 1963; Mintrom and Vergari 1998). Policy information gleaned from the experiences of familiar neighboring states reduces both the policy and political risks inherent in policymaking (Bennett 1989; Boemke 1999).

Second, states are sometimes in competition with their neighbors to attract good things and repel bad things (Dye 1990; Tiebout 1956). A state may adopt a lottery to avoid having its citizens cross the border to buy tickets in a neighboring state's lottery (Berry and Berry 1990; Pierce and Miller 1999), or it may set its public assistance at the same level as its neighbors to avoid attracting poor immigrants from them (Peterson and Rom 1989).

Based on that social learning framework, state policy scholars have emphasized a positive regional effect almost exclusively-if a state adopts a policy, its neighbors are more likely to adopt it (Stream 1999; Mooney and Lee 1995; Berry and Berry 1999; Walker 1969; Sutherland 1950; McVoy 1940; Davis 1930). However, it is important to realize that two other complicating learning possibilities exist. First, the information available on some polices may be nationalized, making learning from neighbors no more common than learning from states elsewhere in the country (Gray 1994; Lutz 1986), which might make the neighboring effect insignificant at all. Second, neighboring effect would change over the course of a policy's diffusion if the policy's evaluation or the amount or type of information available changed (Rose 1993). For example, learning may be driven by optimistic policy information early in the diffusion process, but negative political information may dominate later in the process. It means neighboring effect can be both negative and positive, as opposed to the always positive neighboring effect stated by early scholars. Thus I find it is interesting to test whether the following is true or not:

Hypothesis 1: States with high percentage of adopting states as neighbors are more likely to adopt State GHG Emissions Targets/RPS.

Social learning theory provides the theoretical basis for the literature on policy diffusion (Glick and Hays 1991; Weimer 1993; Schneider and Ingram 1988; Rose 1993). However, most state policy diffusion[9] studies fail to explore fully the potential variation in this process and the resulting regional effects (Lamothe 1998). More explanatory variables need to be brought in.

B. Towards Equilibrium among Interests

After a demand has been formed, advantaged and disadvantaged interests within the society that relates to the policy find a way to articulate their need, through some industry organizations or interest groups (Salisbury 1968) and then an equilibrium is formed among interests. Salisbury further commented that the needs for organized interests relates to the nature of policymaking process-without being forcefully articulated, policy potentials remain just potential, not policy output. Research on interest groups also suggests that they will be important in determining innovation adoption and regulation (Bernstein 1955; Mills 1956; Stigler 1971; Peltzman 1974; Moe 1989: Lowry 1992; Ringquist 1993; Cigler and Loomis 1995; Ingram, Colnic, and Mann 1995; Gray and Lowery 1996). Thus policymaking process enters “towards equilibrium” stage. I will analyze the roles played by various interest groups in

[9] “Regional effect” and “diffusion” sometimes are treated as they are the same in the state politics literature. However the distinction is important since “diffusion” can happen through a “non-regional” way, which could be found in Gray’s (1973) national interaction model or through the efforts of a national interest group (Haider-Markel 2001). “Regional effect” will be mainly concerned in this analysis.

climate change policy scenario.

In regard of environmental policy, environmental groups have a consistent history of actively lobbying state and federal government institutions to increase public participation and overall decision-making transparency to make a pro-environmental policy environment. Conversely, impediments to pro-environmental legislation and policy generally come from industries with intensive carbon emissions. They would probably prefer that the number of participants involved in the decision-making of environmental issues be relatively small, in hope of a policy environment more favorable to them.

However, reality might be more complicated than the simple outline. Depending on the nature of the policy, compliance incentives may be given to interest groups that have traditionally opposed to the policy. And both negatively and positively related interest groups seem to share a common interest in persuading state environmental officials to adopt the policy. Vogel (1995) concluded that environmentalists and producers sometimes form coalitions, which he describes as “Baptist-boot-legger” alliances, which are viewed to significantly affect the 1977 Clean Air Act Amendments and, more recently, world trade issues. While in other scenarios, industries seem to be able to gain the benefits of regulation for themselves and a regulatory agency seems to be more responsive to regulated entities than to overall public good (Rosenbaum, 1995). The phenomenon is typically termed as “agency capture,” which is also documented in Bernstein (1955), Anthony Downs (1967) and Banks and Weingast (1992). Thus Influences from environmental groups should be positive while the influences from carbon industries could both be positive and negative. Based on above observation, I hypothesize:

Hypothesis 2a: States with strong environmental groups are more likely to adopt State GHG Emissions targets /RPS.

Hypothesis 2b: States with strong carbon industries are less likely to adopt State GHG Emissions targets /RPS.

Other than these two interest groups, citizen participation, viewed as interests expressed by the public, has become an increasingly important component of public policy making in the United States. This is particularly true in the realm of environmental policy. Since the late 1960s, most federal environmental legislation has provided formal mechanisms that concerned citizens and organizations can utilize to become involved in environmental decision making. Congressional motivation for these provisions stems, in part, from a desire to avoid “bureaucratic capture”. Public participation in environmental decision making can range from attending public hearings, responding to public notices, serving on citizen advisory boards or stakeholder groups, and participation in collaborative decision-making bodies. Public enthusiasm in participating usually relates to the level of environmental public support among citizens within a state. Thus it is important to take public support into consideration. To do so, I hypothesize:

Hypothesis 2c: States with more environmental public support are more likely to adopt State GHG Emissions Targets/RPS.

Later their interaction and competition shape an equilibrium determined by their comparative strength.

C. Into the State Political System

The equilibrium pattern will be pressed upon a set of governmental intermediaries within the policymaking system of the government (1987; Evans et al. 1985; Herring 1967; Schattschneider 1960). The government intermediaries that consist of political parties, governmental institutions, and the attitudes of the elite members of those will eventually act to form the policy, given “boundaries of possible action” (Eulau and Prewitt 1973).

The ideology of the political intermediaries bears significant empirical importance in determining legislative and regulatory outcomes (Kalt and Zupan, 1984; Levitt 1996). Previous research has found liberalism to be positively related to pro-environmental regulation at the state level (Hedge and Scicchitano 1995). Also, environmental concerns have often been viewed as an expression of a liberal penchant for regulation private industry (Ringquist 1993). In other words, if the political intermediaries, naming the political parties, political institutions and governor within states, have more liberalism in political ideology, then adoption of environmental policy is likely to be the policy output in the end. Accordingly, my hypotheses are:

Hypothesis 3a: States with more liberalism in political parties are more likely to adopt State Emissions Targets/RPS.

Hypothesis 3b: States with more liberalism in political institutions are more likely to adopt State Emissions Targets/RPS.

Hypothesis 3c: States with more liberal governors are more likely to adopt State Emissions Targets/RPS.

D. Policy Output

Like being mentioned before, the political system finally has to form a policy within “boundaries of possible actions,” which are sometimes referred to as “socioeconomic” conditions within states. Erikson, Wright, and McIver (1983) made the persuasive argument that the socioeconomic measures are so prominent in some models that tries to explain state-level adoption of policy are actually surrogates for public demands or opinion, which is consistently with the first empirical efforts to model the state policy output are made by Dawson and Robinson (1963)[10]. They argued that inter-party competition had little effect on welfare programs across states, and that the observed variation in policy could be explained by levels of economic development alone. Their findings were against conventional wisdom that public polices from governments are responsive to the need of the citizenry through political parties. Even if a generalization of Dawson and Robinson’s conclusion to a broad range of state policies is questionable, their findings that socioeconomic variables are significant predictors of adoption of a state policy became very influential thereafter.

The conventional hypothesis with respect to wealth is that the greater the amount of resources available to a state, the more likely it is the state can afford to undertake more stringent regulations or to adopt policy innovations (Williams and Matheny 1984; Lowry 1992; Ringquist 1993). Requiring state agencies to address to environmental problem will require additional economic resources. Simply put, wealthier states may be more likely to adopt an environmental policy.

However, even if state resources are needed for the adoption, some innovation policy them-selves may aid in the creation of wealth for states through job creation, fees imposed, and other means. For instance, the need for waste tire processors and

[10] Dawson, Richard E., and James Robinson. 1963. “Inter-party Competition, Economic Variables, and Welfare Policies in the American States.” Journal of Politics 25: 2, pp. 265-89.

waste tire transporters created by Minnesota’s Waste Tire program provided the state with $10 million in jobs (Brown and Olson 1992, 22). Thus, the influence from wealth situation for a certain state could be both negative and positive for the adoption of climate change policy. I choose to hypothesize:

Hypothesis 4a: Wealthier states are more likely to adopt State GHG Emissions Targets/RPS.

Hall and Kerr (1991) suggest that some states have conditions that better suit them to adopt environmental policies, often viewed as another element that determines the “boundaries of possible actions”. Thus the special conditions that make states better suited to adopt State GHG Emission Targets and RPS need to be taken into consideration.

The energy sector alone produces 40% of U.S. carbon dioxide emissions, which makes it one of the most important sectors for any climate change policy. Energy consumption tends to be inelastic in U.S. and so is energy production. Thus reducing carbon dioxide emissions solely by decreasing energy production is not likely to be sufficient. Thus reducing emissions while energy production is maintained seems to be the solution. Since energy sector relies heavily on the local natural resource endowments, it follows that if a state has tremendous natural endowment in “green” resources, the state will have more potential to reduce carbon dioxide emission, thus likely to adopt State GHG Emission Targets and RPS.

In the context of RPS, natural endowment resource is even more important as it affects how much electricity generators can produce and thus decides how heavily the economic share, in terms of State GDP, the renewable energy producers weight, which in turn determines the strength that will act upon state political system to express the group interest from renewable developers. As Rabe (2006) points out: “One increasingly sees formal representation in the state legislative process from renewable energy developers who have established a foothold in the state and are eager to expand their role through RPS expansion. In numerous states, such organizations are far more visible and influential in RPS deliberations than conventional environmental advocacy groups”. Then it follows that natural resource endowment needs to be taken into consideration while modeling policymaking process. Based on the analysis, I hypothesize:

Hypothesis 4b: States with more natural resource endowment are more likely to adopt State GHG Emissions Target/ RPS.

To sum up, policymaking goes through of a series of stages to reach adoption. There are nine thesis hypotheses emerging from my theoretical modeling of adoption of climate change policy consecutively. At the “originating” stage: a. States with high percentage of adopting states as neighbors are more likely to adopt State GHG Emissions Targets/RPS. For the stage of “towards equilibrium among interests”: b. For States with strong environmental groups are more likely to adopt State GHG Emissions targets /RPS. c. States with strong carbon industries are less likely to adopt State GHG Emissions targets /RPS. d. States with more environmental public support are more likely to adopt State GHG Emissions Targets/RPS. For the stage of “into the state political system”: e. States with more liberalism in political parties are more likely to adopt State Emissions Targets/RPS. f. States with more liberalism in political institutions are more likely to adopt State Emissions Targets/RPS. g. States with more liberal governors are more likely to adopt State Emissions Targets/RPS. For the stage of “policy output”: h. Wealthier states are more likely to adopt State GHG Emissions Targets/RPS. i. States with more natural resource endowment are more likely to adopt State GHG Emissions Target/ RPS. Those hypotheses will be tested using the variables discussed in the following section.

2.2 Empirical Literature Review and Discussion of Variables Chosen

The following variables are proposed to be included in the empirical model to explain the adoption of state climate change policy, especially for State GHG Emission Targets/RPS:

A. Variables Related to Hypotheses

a. Weighted Neighboring Index (neigh_pop_1) [Variable Name (Label)]

Weighted neighboring index is the proportion of bordering states with GHG emission target weighted by population of neighboring states accordingly. A brief formula is given by: $neigh\_pop\_1 = \frac{pop(neighboring\_states\_adopted)}{pop(all\_neighboring\_states)}$. I choose it to be the measure of horizontal pressure, or the influence of other state decision makers. Neighboring index enters the literature of research on diffusion of state environmental policy in various forms.

Berry and Berry (1990, 1992) find in the context of state lottery adoptions that the number of previously adopting neighboring states are found to influence the probability of adoption.[11] This two early and influential EHA state policy diffusion studies were biased due to a peculiarity regional effect variable-the number of neighboring states having previously adopted the policy. This biasness also applies to

[11] Berry, Frances Stokes, and William D. Berry. 1990 “State Lottery Adoptions as Policy Innovations: An Event History Analysis”, American Political Science Review 84:395-415.

using the proportion of neighbors and the number or proportion of co-regional states. Berry and Berry (1999) suggest using distance or length of border to weight the "neighborness" of a state (Lutz 1986). Similar to their suggestion, I will be using the proportion of bordering states with GHG emissions target weighted by population as my first variable.

b. Sierra Club (Sierra)

Sierra club is proportion of sierra members divided by state population. By division, I obtain a per capita measure of environmental interest group strength. Because of it numerous action campaigns and political activities, including actions focused on climate change, the Sierra Club is an appropriate group to use in operating environmental interest groups strength. This measure is supported in literature as well.

Maxwell, Lyon and Hacket (2000) try to explain the changes in the rate of toxic emissions over time. They find the only one variable that is significant from their socioeconomic variables is environmental group membership which is significant under .005 percent level with a negative sign. Innes and Sam (2006) study the determinants and effects of firms' participation in the 33/50 program, a voluntary pollution reduction program initiated by government regulators. They also find that 33/50 participation was more likely for firms operating in states with larger environmental groups, suggesting a positive impact for environmental program from environmental groups. Mazur and Welch (2000) also include the environmental membership levels as variables to model adoption of climate change program and find it significant. Daley and Garand (2005) model the horizontal diffusion, vertical diffusion and internal pressure in state environmental policymaking and find the variable that carries information about current members of and donors to Sierra Club significant.

c. Carbon Industry (Carbon_2)

Carbon industry is defined as GDP share of carbon industry between 1999 and 2006 for each state. Carbon industry consists of agricultural, oil & gas extraction, utility and coal production industry. The energy-related emissions account for over 80% of U.S. greenhouse gas emissions and have grown by 19.4% since 1990.[12] By fuel type, energy-related carbon dioxide emissions are from natural gas and oil, coal production and electricity generation.[13]Other than energy-related carbon emissions, agricultural activity is also a significant contributor to U.S. carbon dioxide emissions, responsible for 8% of the GHG emissions, mostly in the form of methane due to livestock cultivation and nitrous oxide due to fertilizer use. Thus the relative economic importance of those industries is a decent measure of the relative strength of carbon industry interest within a state. Although literature remains inclusive about the theoretical relationship of regulated industry and policy adoption, similar measures could be found in previous researches to test the relationship.

Potoski (2001) and Sapat (2004) find the impact of industrial lobbying groups such as the coal industry in highly productive states is non-significant. However, Ringquist (1994) find the strong presence of the mining industry in a state negatively related to a state’s water quality regulation strength and presence of agricultural industry is negatively affected by the regulation, suggesting a negative correlation between the two.

d. Public Support (Edu, Per_in)

My proposed measure of public support is education level and income level, captured by percent of population with a bachelor's degree or higher among people 25 years or older and per capita income in one thousand accordingly.

---

[12] http://engineers.ihs.com/news/2008/eia-energy-related-carbon-dioxide.htm, the report is released in May, 2008 as a news service by HIS.

[13] Carbon dioxide emission history data from 1949, available at http://www.eia.doe.gov/environment.html.

Empirical evidence suggests that individual support for environmental spending is positively linked to the level of education and the level of income (Elliott et al., 1997). A population's understanding of the benefits from environment-friendly policies is positively linked with the level of education for a number of reasons including a more accurate assessment of the costs and benefits of different policy measures and greater awareness of issues like climate change.

For income level, as income rise, sensitivity to the perceived costs of an environmental regulation decreases, resulting in increasing support for environmental regulations. A higher level of income also implies that a state has greater fiscal resources to implement and support environmental policies (Lester and Lombard, 1990). In other words, income level could also be viewed as a measure for economic situation for a certain state to provide information on how wealthy the state is. Thus per capita income is included for two reasons: both a proxy for public support and economic situation of a state, which is requested by hypothesis brought up in the policy output stage to test whether wealthier states are more likely to adopt State GHG Emissions Targets/RPS or not.

e. Liberalism of A State's Governing Party

(1) Party Ideology (PED)

In the United States, liberalism is most often used in the sense of social liberalism, which supports some regulation of business and other economic interventionism which are believed to be in the public interest. When trying to measure liberalism, a large number of scholars make use of differences in ideology between the two major parties in the United States, assuming that Democrats are liberal and Republicans are conservative (Hedge and Scicchitano 1994). Indeed, this assumption is supported by studies on "Ideological Realignment in the U.S. Electorate" by Alan Abramowitz and

Kyle L. Saunders in 1998. They show there is a high correlation between the level of liberalism and party identification. Survey data indicate that among people who are liberal, 85% are democrats and among people who are democrats, 80% are liberal or moderate.[14] And the assumption of being Democrat as an indicator of being liberal is more likely to be the case when people observe a trend that increased ideological polarization of the Democratic and Republican Parties during the recent three decades.[15]

Then I include party ideology as a measure for liberalism of the state governing party in my model. PED is a dichotomous variable defined in the following manner: PED is given the value of 1 if Democratic Party wins the presidential election and 0 otherwise. Similar measure has been adopted previously in research about environmental concern by Dietz, Stern and Guagnano (1998).

(2) Inter-party competition (PENM_tv_d)

A second variable that proposed to capture the influence on a state governing party and to serve to provide more detailed information on characteristics of liberalism in the party in power is the degree of inter-party competition in that state. More competitive political parties vie for public support by promising attractive polices to prospective voters (Key, 1949). Consistent with this theory, states with a higher degree of inter-party competition will enact more comprehensive public programs, perhaps including environmental regulations. Politicians will favor a certain policy if it is supported by a majority of voters (Kirchgassner and Schneider, 2003). The most observable inter-party competition within a state happens during presidential election every four years. Thus PENM_tv_d, defined as presidential election net margin won by Democratic Party's proportion of total vote, is included

[14] 1978 American National Election Study and 1992-94 American National Election Study Panel Survey

[15] Alan Abramowitz and Kyle L. Saunders 1998 "Ideological Realignment in the U.S. Electorate", The Journal of Politics, Vol 60, No. 3: 634-652.

here to measure relative liberalism within a state's political system.

f. Liberalism of A State's Political Institution (Ctrl_2)

Based on the assumption that Democrats are liberal and Republicans are conservative (Hedge and Scicchitano, 1994), a measure of partisan control of state political institutions is proposed to capture the liberalism of a state's political institution. The simplest indicator focuses on the party in control of a single institution, however majority control of an institution does not confer absolute power over decision-making (Smith 1997). Thus more detailed observation about state legislature is required.

Some argue that greater the control of government institutions by a liberal party, the more likely a state is to adopt an environmental policy, which is premised on the belief that liberal parties are more likely to adopt spending programs. Kiewiet and McCubbins (1985) found that party control affects congressional appropriations, with Democrats-when they control Congress-granting more generous appropriations than Republicans, suggesting the same fact at state level as a state legislature generally takes on the same duties for a state as Congress does at the Federal level.

While the another view, developed and tested by Hansen (1983), indicates states in which the governorship and both legislative bodies are control by the same party (called unified governments) are more likely to adopt a state program than states in which control of governmental institutions is split between the two parties (called divided governments), regardless of which political party has unified control.

Taking into consideration the fact that governor has special duties as chief executive outside his/her role in state policymaking process which in turn affects policymaking process, I find it is better to measure the effect separately, which will be discussed later. Thus for now I focus capturing information on ideology-institutional control of state legislature.

Combined those arguments on empirically tested relationship between state legislature and the adoption of state policy, it follows that to which extent a state legislature is controlled by Democratic Party is an important factor determining the policy output. Thus I propose to include a variable called Ctrl_2, which is a dichotomous variable that is given the value of 1 when democrats control two state political institutions, House of Representatives and the Senate, and 0 otherwise. Similar measures could be found in previous literature to support my choice.

Berry and Berry (1992) do research on factors that explain tax innovation in states, they include weighted information on houses of the state legislature and governor in their empirical model, however it turns out the factor is not significant in explaining state tax innovation behavior. Brown (1995) studies the impact of party control on state welfare policy and include an index consisting of three dichotomous indicators being whether the governor is a Democrat, whether the state House of Representatives is controlled by the Democratic Party (1 if Democrats hold a majority of seats, 0 otherwise), and a similar measure of Democratic control in the state Senate. This variable is significant in explaining variation of state welfare policy.

g. Governor (GPA)

The last variable that attempts to capture the liberalism within a state is governor political affiliation. Kalt & Zupan (1984) point out that members of political system may pursue their policy goals by channeling and altering the pattern of interests entering the political system, by discounting group pressures and following their own ideological dispositions; similarly Hird (1991) argues that individuals within the political system may simply follow professional criteria when making policy decisions. Thus as the most important elite individual of state political system, governor political affiliation needs to be considered as a separate factor when modeling adoption of state environmental policy, which is widely adopted in literature to measure the liberalism of a state political system.

Berry, Ringquist, Fording, Hanson (1998) research on measures of the ideology of a state's citizens and political leaders. They include governor political affiliation as a factor measuring state government ideology and show a high level of reliability of this measure. Erikson, Wright and McIver (1989) model the state policymaking process and they use local party ideological identifications to measure party elite liberalism and find it significant both in models for Democratic Party identification and legislative liberalism.

h. Natural Resource Endowment (Renewable)

The last variable that corresponds to the modeling of policymaking process is a variable captures the characteristics of a state's natural resource endowment. As mentioned before, a state will make a decision about a certain policy within "boundaries of possible actions". In the context of climate change, a lot of policies that address the carbon dioxide emission need to deal with energy sector, which is the single largest sector in US and accounts for over 80% of the emission[16]. Given inelasticity of energy demand thus resulting stable energy supply and no significant difference among technology available for states to develop energy from various sources, it follows that the natural endowment of a state resources that relates to energy is an important factor in the model. (e.g., forests in Maine, hydroelectric resources in Pacific Northwest)

I propose to use "renewable," the existing capacity of a state renewable energy generation, more specifically defined as proportion of electricity generated from

[16] http://engineers.ihs.com/news/2008/eia-energy-related-carbon-dioxide.htm, the report is released in May, 2008 as a news service by HIS.

hydro, nuclear, geothermal and biomass (the four major sources), to capture the state nature energy source endowment.

Another reason to include the variable especially for RPS is that a state with rich renewable energy resources can be expected to attract corporation interested in developing such a potential as economies of scales can be achieved. Then renewable electricity generators will have an interest in securing and increasing their market share through an RPS, which could be viewed as another source of group interest for RPS on top of carbon industry, environmental group and public participation for State GHG Emission Target. The role of natural resources in climate policymaking has been identified from previous empirical work.

Fisher (2006) does study on how natural resources interests have been translated into political outcomes in the form of American climate change policy and argues that natural resources are important in understanding climate policy by using renewable data in the analysis. Literature regarding the relationship between climate change policy and natural resource endowment is rare. However, outside environmental policy, a number of scholars have studied the role in natural resources have played in decision making in the United States (Heinz et al. 1993; Nash, 1968; Sherrill 1983; Vietor 1980) and showed the significance of natural resources.

B. Control Variables (stdp, density)

I have also included two variables to serve as controls for variance among the states that are not directly related to my modeling of state climate policy. I focus on the demographic characteristics as the climate policy aims to address a problem originally caused by human-beings. The first control variable is stdp, capturing the changing nature of the population within a state, defined as proportion of population change in terms of a state’s population. The second is density, capturing the “volume” nature of the population for a certain state, defined as population per square mile land.

Previous literature that researches on the relationship between population change still remains inclusive about the relationship. However, it seems there is a consensus among economists, that high population growth has negative impact for environment in general.[17]Thus it is interesting to include population characteristics in the model as well.

For the convenience of future discussion, I summarize the main literature that support of my choice of explanatory variables discussed above in the following table:

[17] Carole L. Jolly 1994 "Four Theories of Population Change and the Environment" Population and Environment" Vol 16: 1, pp.61-90.

Table 2 : Summary of Literature

Authors/Publication	Policy/Years	Statistical Method	Measure of interest
Frances Stokes Berry, William D. Berry/ American Political Science Review	State lottery adoptions/ 1964-1986	Probit Maximum Likelihood	Number of previous adopting states
John W. Maxwell, Thomas P. Lyon, Steven C. Hackett/ The Journal of Law and Economics	Self-regulation environmental policy/ 1988-1992	Ordinary Least Squares (Not specified)	Environmental Group Membership
Robert Innes, Abdoul Sam	33/50 program/2006	Probit Maximum likelihood	Sierra Club state membership (from 1989-1995, measured per capita)
Allan Mazur, Eric Welch and Stuart Bretschneider/Journal of Policy Analysis and Management	Adoption and Contribution of Climate Challenge Program/ 1995-1997	Logit and Tobit	Environmental membership levels
Dorothy M. Daley, James C. Garand/American Politics Research	State hazardous waste programs/ 1989-1998	Generalized Estimation Equation Regression	Current and recent members of and donors to Sierra Club

To be continued

Authors/Publication	Policy/Years	Statistical Method	Measure of interest
Matthew Potoski/ Public Administration Review	State clean air programs/weathe r or not exceed federal standards as in 1999	OLS, Logit and Ordered Logit	Value added by manufacturing by those industries most responsible for air pollution as a percentage of state's gross product
Evan J. Ringquist/Policy Studies Journal	State water pollution control and hazardous waste management programs/1988 for state water pollution control programs; 1987 for hazardous waste management programs	OLS under path analysis	Value of mining output as a percentage of gross state product (GSP)
Euel Elliott, Barry J. Seldon and James L. Regens/Journal of Environmental Management	Public attitudes toward environmental spending/ 1974-1991	Probit	Midpoint of categorical data of income intervals and deflate them by consumer price index
James P. Lester, Emmett N. Lombard/Natural Resources Journal	the factors that determined how committed to environmental protection for the states/ 1970-1990	Intention to use Probit or Logit under path analysis	personal income suggested

To be continued

Authors/Publication	Policy/Years	Statistical Method	Measure of interest
Thomas Dietz, Paul C. Stern and Gergory A. Guagnano/Environment and Behavior	Social structural and social psychological bases of environmental concern/1993	"error in variable" regression method	Categorical self-reported ideology on a dimension from extremely liberal to extremely conservative
Frances Stokes Berry, William D. Berry/American Journal of Political Science	State tax innovation/1916-1937 (individual income tax); 1919-1929 (gasoline tax); 1919-1939, 1960-1971 (any tax)	Probit Maximum Likelihood	Weighted information on houses of the state legislature and governor (0-1:conservative-liberal) [weight for governor=0.5; weight for state legislature=0.5]
Robert D. Brown/ American Political Science Review	Impact of party control on state welfare policy/1976-1985	cross-sectionally heteroscedastic and time-wise autoregressive model	Democratic Party Control Index consisting of three dichotomous indicators: whether the governor is a Democrat, whether the state House of Representatives is controlled by the Democratic Party (1 if Democrats hold a majority of seats, 0 otherwise), and a similar measure of Democratic control in the state Senate

To be continued

Authors/Publication	Policy/Years	Statistical Method	Measure of interest
William D. Berry, Evan J. Ringquist, Richard C. Fording, Russel L. Hanson/ American Journal of Political Science	Measuring ideology of a state's citizens and political leaders/1960-1993	None	Governor Political Affiliation
Robert S. Erikson, Gerald C. Wright, Jr, John P. McIver/ American Political Science Review	Model of State Policy Process/1970s	OLS under path analysis	Local party chairmen's conservatism-liberalism using ascertained ideological identifications of county party chairs in 1979-1980
Dana R. Fisher/ Sociological Forum	Climate Change Policy/2000	None	Renewable energy share of total production and consumption

3 Methodology of the Thesis

3.1 Event History Analysis

Since policy diffusion being introduced to the field by Berry and Berry in 1990 in "Parametric Models, Duration Dependence, and Time-Varying Data Revisited"[18], the standard approach to model and test policy diffusion has been event history analysis (EHA).

Event history analysis, which is also known as survival analysis, transition analysis or duration analysis, refers to a set of procedures for time series analysis. Event history analysis is defined in terms of three attributes: (1) data units (for example, individuals or organizations) move along a finite series of states; (2) at any time or point, changes may occur, not just at certain time points; and (3) factors influencing events are of two types, time-constant and time-dependent.[19] A complete basic setup of event history analysis will be provided in the Appendix.

Discrete event history analysis is the analytic tool of choice for many scholars interested in policy diffusion across states. In policy diffusion analysis, data are collected on all the states that are in the risk set. A state is said to fall into the risk set if that state has a non-zero probability of adopting the policy for a series of discrete periods. When a state adopts the policy, it is deleted from the risk set. This is the standard way to collect data if one is to research on policy diffusion and the data is usually called grouped duration data. There are several reasons why grouped duration data is chosen over cross-sectional data and panel data. First, cross-sectional data is descriptive of a steady state or a snap-shot of a dynamic process. If one is to model fluctuations or changes, the cross-sectional data is not so informative because the data

---

18 Berry, Frances Stokes, and William D. Berry. 1990 "State Lottery Adoptions as Policy Innovations: An Event History Analysis", American Political Science Review 84:395-415.
19 Coleman, James 1981 P1 "Longitudinal data analysis". NY: Basic Books.

depend upon the specific conditions prevailing at the time of survey, while panel and event history data are more capable of describing the dynamics of a certain process. Second, compared to panel or time-series data, event history data are often better suited to the need of analysis for studying the timing of change. For each unit of analysis, event history data provide information about the exact duration until a state transition as well as the occurrence and sequence of events. The aim of the thesis is to model adoption, which is the change in state's policy. Given the fact that once adoption happened and it is not reversible, there is no need to record any subsequent information for that state. Thus grouped duration data is chosen to be the way to organize data in this thesis.

3.2 Theoretical Model Setup

Generally, there are three categories of models that are at hand to deal with event history data: nonparametric, semi-parametric and parametric models. The major difference between the three is their way to treat the hazard function. For nonparametric models, they make no assumptions about the shape of hazard function, which is estimated purely based on empirical data. They have comparatively limited use in comparing a fair number of groups, other than that it is seldom used in empirical work in event history analysis for now. Parametric models, on the contrary, need researchers to specify in advance the shape of hazard function. If it is specified wrongly, estimates can be seriously biased. However, for most of the cases, it is hard to make the correct assumption of the hazard function ahead of researches. Semi-parametric models give researchers more flexibility when making assumptions about the shape of the hazard function. No assumption about the relationship between hazard shape and time is made but assumption about how explanatory variables will affect the hazard function is made. Specifically, covariates are assumed to raise or lower the hazard function in a multiplicative fashion. The dependent variable is the hazard for the event. Assume all groups of observations have the same shape hazard function, but that function is moved up or down in parallel with the others according to the influence of covariates in the model. Because it allows for estimation of the parameters of interest in the presence of an unknown time varying baseline hazard, semi-parametric models are heavily used in empirical work and chosen in this thesis.

The object of the thesis is to model the adoption event using several explanatory variables. There are two effects when considering the effects of explanatory variables on probability of adoption: one is to change the hazard directly at a certain point in time, the other is to change the time-dependence indirectly in time, which is a structural change. The data we have here is for comparatively a short time (8 years), so it is reasonable to assume we only have direct effect and marginal effect of explanatory variables are time-invariant, meaning the derivatives of log hazard with respect to explanatory variables are constant for intervals and durations. Cox (1975) proportional hazards model will be suitable for this setup. In this model the instantaneous hazard rate is,

$$\lambda(t \mid x_{i,t}) = \lambda_0(t) e^{x_{i,t}\beta},$$

Where $x_{i,t}$ is the vector of independent variables at time t. Thus the hazard rate depends both on the independent variables via $e^{x_{i,t}\beta}$ and how long the unit has been at risk via $\lambda_0(t)$ which is the baseline hazard. Now recall that our data are grouped duration data which are not available within-interval, which means only characteristics associated with conditional survivor probabilities on the observation time points are identified from the data and the within-interval behavior of the hazard is not testable using grouped data. Thus the proportional hazard model will be used in a discrete way.

3.3 Binary Logit Model and Proportional Hazard Model

Before we proceed further with proportional hazard, evidence provided below show that with proper handling, discrete proportional hazard is the same as binary logit, which is accessible in any standard statistical software, flexible in functional form specification and friendly in data arrangement.

Suppose that a duration of interest t in the jth interval. So that it satisfies

$$t_{j-1} \le t < t_j$$

We define the time-varying function as

$$Z_j(t) = X\beta + h_j(t)$$

Corresponding hazard specification is the following form

$$\lambda_j(t, X, \beta) = h_j'(t)\left\{\frac{f_j(Z_j(t))}{1 - F_j(Z_j(t))}\right\},$$

where j is the jth interval ; f and F are density and cumulative distribution functions accordingly and with some restrictions on h. 20 The conditional interval survivor function in jth interval is given by

$$\alpha_j(t, X, \beta) = 1 - F(Z_j(t))$$

and the survivor function over all intervals is

$$S_T(t, X, \beta) = \alpha_j(t, X, \beta)\prod\nolimits_{k-1}^{j-1}\alpha_k(t_k, X, \beta).$$

We note that the unconditional probability of an event in jth discrete interval is

[20] h should satisfy some conditions for the requirement of hazard specifications and corner conditions imposed by conditional survival functions. H function should first be continuous and differentiable on $\left[t_{j-1}, t_j\right)$. Then for all j, satisfy $\lim_{s \to t_{j-1}} h_j(s) = -\infty$ and $h_j'(s) \ge 0$ where $s \in \left[t_{j-1}, t_j\right)$.

simply

$$\Pr ob(t_{j-1} \leq T < t_j \left| X, \beta) = S(t_{j-1}, X, \beta) - S(t_j, X, \beta) = F(Z_j(t_j)) \prod_{k=1}^{j-1} \{1 - F(Z_k(t_k))\} \right.$$

which is identical to the likelihood associated with a serious of binary outcomes with same corresponding specifications thus we will be using binary logit in the data analysis.

3.4 The choice of functional form

First, consider the functional forms for dichotomous dependent variables that most political scientists are familiar with: the probit and logit functions. If $P_{i,t}$ is the probability that state i adopts a given policy at time t, then the probit function is

$$p_{i,t} = \phi(x'_{i,t}\beta)^{21},$$

the logit function is

$$\log(\frac{p_{i,t}}{1-p_{i,t}}) = x'_{i,t}\beta .$$

Another competitive alternative is the complementary log-log (usually denoted as cloglog) function:

$$p_{i,t} = 1 - \exp[-\exp(x'_{i,t}\beta)] .$$

Most of the time, these functions are used interchangeably in the analysis of dichotomous random variables. However, a simple graph showing the three functions with respect to different Xb values reveals that they are not that similar.

[21] Where ϕ is the cumulative distribution function of the standard normal.

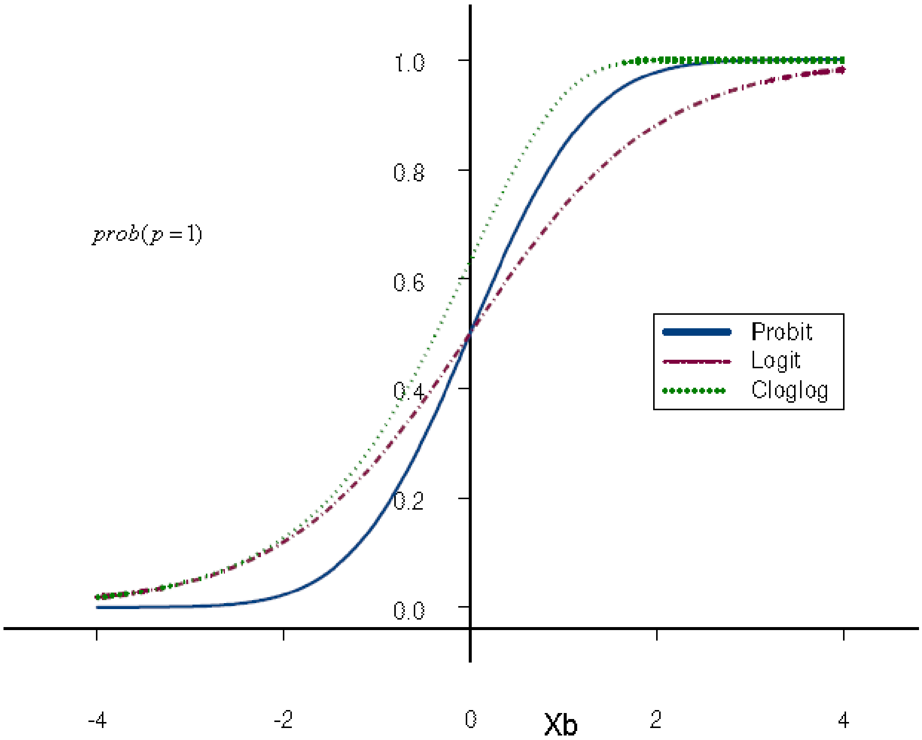

Figure 1: Logit, probit and cloglog functions compared.

In many cases when the predicted probabilities do not take extreme values, this is not important. However this difference can become a problem in analyses with a large number of observations or where many of the predicted probabilities are close to 0 or 1, and if the unobserved continuous linear index has very large or small values[22]. For state policy diffusion analysis, the dependent variables in the dataset are often being a few 1s and hundreds of 0s. For GHG emission target we concern here specifically, 332 of dependent variables are zero and 20 of them are one. Thus policy adoption in this data setting is a rare event, making the choice of functional form potentially consequential. [i] As Figure 1 illustrates, the logit function has fatter tails than the probit, approaching 0 and 1 more slowly. Cloglog function is asymmetrical; it has a flat tail as it approaches 0, but it approaches 1 more quickly, the most rapid one among the three. This suggests that the cloglog function may be more theoretically appropriate for rare event discrete Event history analysis. Another justification for

[22] Aldrich, J. and F. Nelson. 1984 Linear Probability, Logit and Probit Models. Beverly Hills CA: Sage

using the cloglog function is that it is mathematically the discrete-time analog of the continuous-time Cox proportional hazards model, which is showed in Appendix.

3.5 Analysis of Time-Dependence

Theoretically, logit and complementary log-log method assume the observations are independent from each other. If violation exists against the assumption, which means time-dependence is present in the data generating process, then the use of a model such as logit or complementary log-log with only a linear $x\beta$ specification is inappropriate since if time-dependence is not estimated then it follows that omitted variable bias is present. The cost at a minimum would be inefficiency and incorrect standard errors, and may, in complicated cases, even lead to inconsistent parameter estimates[23]. Also, wrong specification of time-dependence usually leads to bias for other coefficients of interest. (Yatchew and Griliches, 1985).[24] The question now becomes how to allow for temporal dependence in binary data without being too restrictive concerning the form of that dependence.

Since Beck, Katz, and Tucker (1998, denoted as BKT below), the use of time dummies or splines has become the standard method to model time-dependence in binary data. Recently, another interesting alternative has been proposed: using t, t^2, and t^3, which serves as a third-order Taylor series approximation to the hazard. Now in order to make a sound choice to deal with time-dependence in the thesis, these three methods will be examined individually.

The first way to deal with the problem is by using time dummies. That is, to

[23] Cox proportional hazard model, the semi-parametric method, differs from parametric duration models such as the Weibull in that the baseline hazard is not specified in the Cox formulation; parametric approaches require the researcher to fully specify the baseline hazard, for which we don't have any information. Thus proportional hazard model avoids those problems.

[24] Beck, Katz and Tucker (1998) argue that the main problem encountered when time dependence is not dealt with is overly small standard errors. This result is obtained when autocorrelation is present in the data (Beck and Katz, 1997).

include a dummy variable for the t-1 time periods under observation.[ii] This method needs no priori functional form to specify the time effect on the hazard. However, regardless of whether one estimates a logit, complementary log-log, probit or a number of other models, two major problems apply when using this method—complete or quasi-complete data separation and inefficiency. If data exhibits either complete or quasi-complete separation, no maximum likelihood estimate exists unless the analyst either drops the problematic variables and some observations or utilizes a more complicated estimation method. (Firth, 1993; Heinze and Schemper, 2002; Zorn, 2005). Inefficiency arises when dealing with data that has maximum duration of greater than 3 or 4, time dummies use more degrees of freedom than other approaches, which result in loss of information. Tested by Monte Carlo iteration using increasing, decreasing and non-monotonic hazard assumption (regardless of hazard shape), separation proves to be a serious problem that suggests the use of time dummies is problematic.[25]

The second approach to treat time-dependence in binary data that BKT advocate is splines. The spline can be thought as a smoother, which is a function that allows us to smooth the relationship between two variables, say a dependent variable y and time t. Most splines allow one to specify points in t where the relationship with y radically changes. Those points are referred to as “knots”. Fewer knots will lead to a smoother relationship but may miss important changes in the relationship while specifying more knots allows for more changes to be modeled but may end up picking up on idiosyncratic changes in the relationship, not general trend. Although splines are not necessarily problematic like the time dummies, the approach have the issues such as knot selection and the choice of the type of splines, which are computationally

[25] David B. Carter, and Curtis S. Signorino, 2007 “Back to the Future: Modeling Time Dependence in Binary Data”.

intensive and not necessary. Actually implementing the approach takes the risk of having problems as serious as obtaining a biased hazard.

The third approach is time cubed approach, which includes t, t^2 and t^3 as regressors. Using this approach, the complementary log-log would take the form

$$p_{i,t} = 1 - \exp[-\exp(x'_{i,t}\beta + \gamma_1 t_i + \gamma_2 t_i^2 + \gamma_3 t_i^3)]$$

Where $\gamma_1 t_i + \gamma_2 t_i^2 + \gamma_3 t_i^3$ is a cubic approximation to the hazard. This cubic approximation can be inclusive of linear, non-linear and non-monotonic function thus can be largely accommodating of hazard shape. Monte Carlo results also support that t, t^2 and t^3 do just as well, if not better than either time dummies or splines in a variety of substantively interesting settings.26 Thus the time cubed approach is my choice when dealing with time-dependence.

Based on that, I will model the adoption in the following specification:

$$p_{i,t} = 1 - \exp[-\exp(x'_{i,t}\beta + \gamma_1 t_i + \gamma_2 t_i^2 + \gamma_3 t_i^3)]$$

[26] David B. Carter, and Curtis S. Signorino, Work in Progress "Back to the Future: Modeling Time Dependence in Binary Data" P20-25.

4 Empirical Analysis of State GHG Emission Targets

4.1 General Description of State GHG Emission Targets

A. General Description

A greenhouse gas emissions target refers to the emission reduction levels that states set out to achieve by a specified time. These targets typically consist of a state-wide inventory of greenhouse gas emission sources together with a list of potential mitigation actions.

As mentioned before, the plans for different states are coming out in various titles. In order to outline the basic components of this policy, I scrutinize State GHG emission target in a coastal state, Maine, also being the first adopter of State GHG emission target in the form of law, as an example.

B. The case of State GHG Emission Target in Maine

On June 26, 2003, Maine passes a law that sets a statewide target for reducing greenhouse gas emissions. The law in Maine, called An Act to Provide Leadership in Addressing the Threat of Climate Change, requires the state to develop a climate action plan to reduce greenhouse gas emissions to 1990 levels by 2010 and to 10 ten percent below 1990 levels by 2020.[27] The legislation also states that its aim is to achieve a “reduction sufficient to eliminate any dangerous threat to the climate,” which may eventually require reductions of 75% to 80% below 2003 levels.

Other than the specified target and aims in the legislation, Maine has embodied more detailed implementation plans. On December 1, 2004, Maine released its followed up Climate Action Plan of 54 actions developed by the state’s Department of Environmental Protection (DEP). The plan addresses reductions in transportation, industrial, commercial, institutional, and residential sectors in cost-effective ways,

[27] http://www.pewclimate.org/

and encourages sustainable management in forestry, agricultural, and other natural resource activities to sequester GHGs.

On top of that, duties of DEP are also included in the law. The legislation states that: by January 1, 2006 and every two years thereafter, the DEP must evaluate the state's progress toward meeting the reduction goals and amend the action plan as necessary to assure that the goals are met. After January 2008, the DEP could suggest to the legislature that the reduction goals be increased or decreased. In addition to drafting the climate action plan, the law requires the DEP to create an inventory for greenhouse gas emissions associated with state-owned facilities and state-funded programs and to create a sub-plan for reducing those emissions to below 1990 levels by 2010. The DEP is also required by the law to create an annual statewide greenhouse gas emissions inventory. In addition, the DEP must seek to establish carbon emission reduction agreements with at least 50 businesses and non-profit organizations by January 1, 2006.

Other than DEP's involvement, a Stakeholder Advisory Group is informed about the development of the Climate Action plan. It turns out that usually DEP provides the staffing for the effort, and some outside organizations that specialize in climate change policy lend support to the workgroups. Various sector-wise planning groups have formed to examine the steps that can be taken.

C. Analysis of Basic Components of State GHG Emission Targets

The detailed ways to achieve the established state GHG Emission Target vary for different states. However, those State GHG Emission Targets do share a common setup which contributes to the basic components of state GHG Emission Targets: baseline reduction level and reduction amount, usually in percentage terms of the baseline level.

Usually, all adopting states have an organization to develop the state climate action plan. The plan develops a standard level which all future reduction calculations are based upon. The base is typically chosen to be 1990 levels, but varies among states. For Arizona, it chooses 2000 levels as its base, which has very different implications from if it adopted 1990 levels, since Arizona starts to build up a significant amount of carbon dioxide emission in the last decade. Thus by using 2000 levels, it is a much lighter target base than if the target base was set at 1990 levels. Among 20 states which adopt the state GHG emission targets, 6[28] of them choose a baseline other than 1990 levels.

After the base is chosen, a reduction target follows. The reduction target varies from 10% to 80%. Just by looking at those numbers along does not give us too much information about how committed the state is to carbon dioxide emission. The number should be taken into account together with the baseline standard. For example, 10% reduction amount is widely chosen by states with 1990 levels and 80% is widely chosen by states with base year after 2000.

Ideally, for empirical analysis, a state's effort should be treated differently based on its specific baselines and reduction amount. However, because of data availability, for analysis of this thesis, if a state adopts the reduction target, no matter what baseline year is chosen and how much is the reduction target amount, it is treated equally as all other states which have adopt the reduction target.

D. Diffusion of State GHG Emission Target at a Glance

a. Aggregate Diffusion Trend

There are two ways to examine the pattern of adoption of State GHG Emission Target. One is to look at how many states get involved as time goes by, while the

[28] Arizona [2000], New Mexico [2000], Minnesota [2005], Connecticut [2001], New Jersey [2006], Virginia [business levels, not in years], Colorado [2005].

other is to look at how much population are influenced over the years. Combining those two, we can get the idea of how diffusion of policy changes over time more comprehensively.

The first graph shows the change of percent of states, as in total 50 states, with State GHG Emission Target over time.

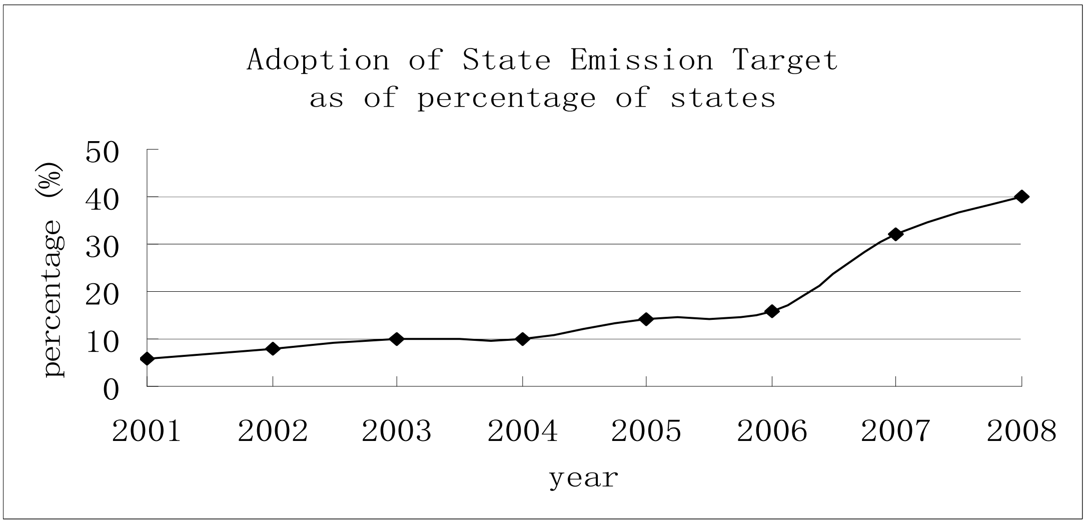

Figure 2: Percent of States with State GHG Emission Target over time

Total Number of States=50.

Source: Pew Center climate website, http://www.pewclimate.org/.

The second graph shows the change of percent of population, as in total population, with State GHG Emission Target over time.

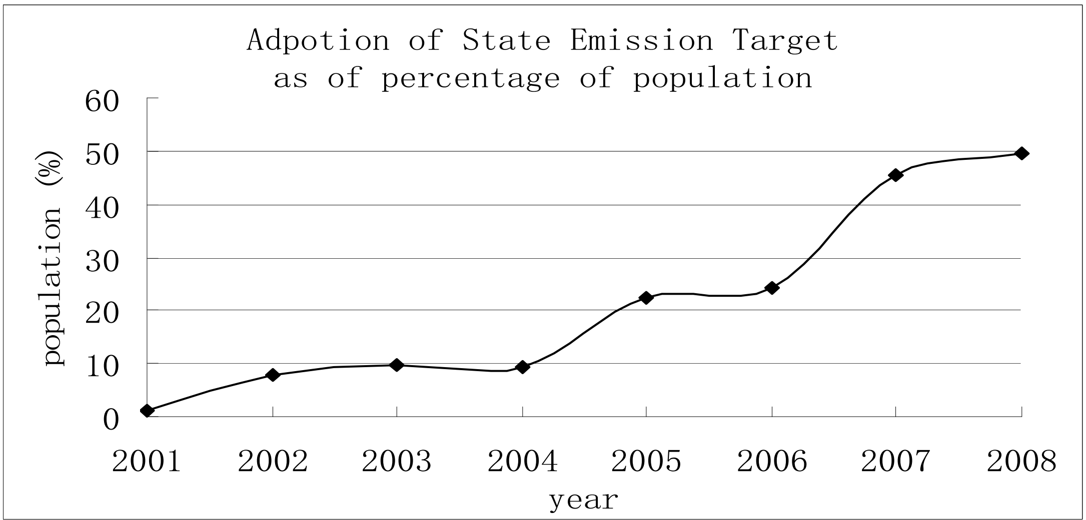

Figure 3: Percent of Total Population with State GHG Emission Target over time

Source: Pew Center climate website and U.S. Bureau of the Census, current population estimates (Compiled by Empire State Development, State Data Center)

Both graphs show the number of states that adopted State GHG Emission Target has been pretty fast increasing since 2001. It means the State GHG Emission Target is diffused among states fairly quickly for the recent 8 years. Right now, about 40% of the states have adopted the policy and nearly half of the total population is involved in it. Also, it is easy to observe that adoption as in percentage of population increases even more rapidly. This indicates that State GHG Emission Target influences more people at an even faster rate, especially from 2004 onwards (shown from figure 2).

b. Geographic Diffusion Trend

I choose to show geographic diffusion trend of adoption of State GHG Emission Target in 4 most representative years. 2001 is the starting point of the analysis, also is basically the beginning of this policy diffusion. 3 states adopt the policy in that year or before. The adoption of State GHG Emission Target takes place on east coast states. As you can see in the first figure below:

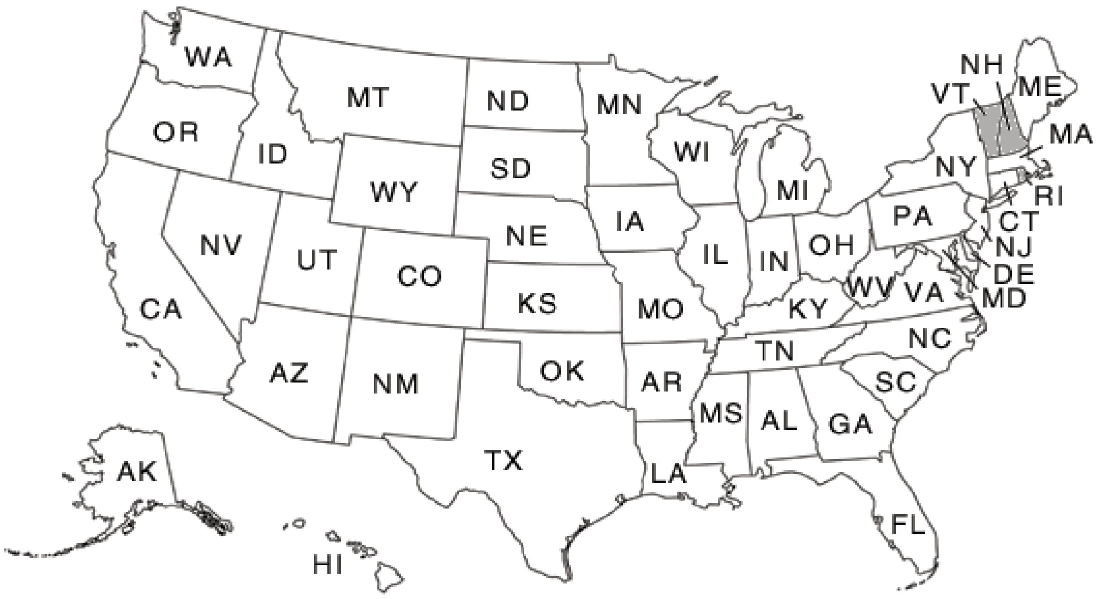

Figure 4: States with State GHG Emission Target in 2001

Source: Pew Center climate website, http://www.pewclimate.org/.

Then we jump to take a look at adoption situation in 2005. Compared to that in 2001, more east coast states have adopted the policy. However, more interestingly, South West States begin adopting State GHG Emission Target too, initiated by

California and New Mexico. As you can see in the second figure:

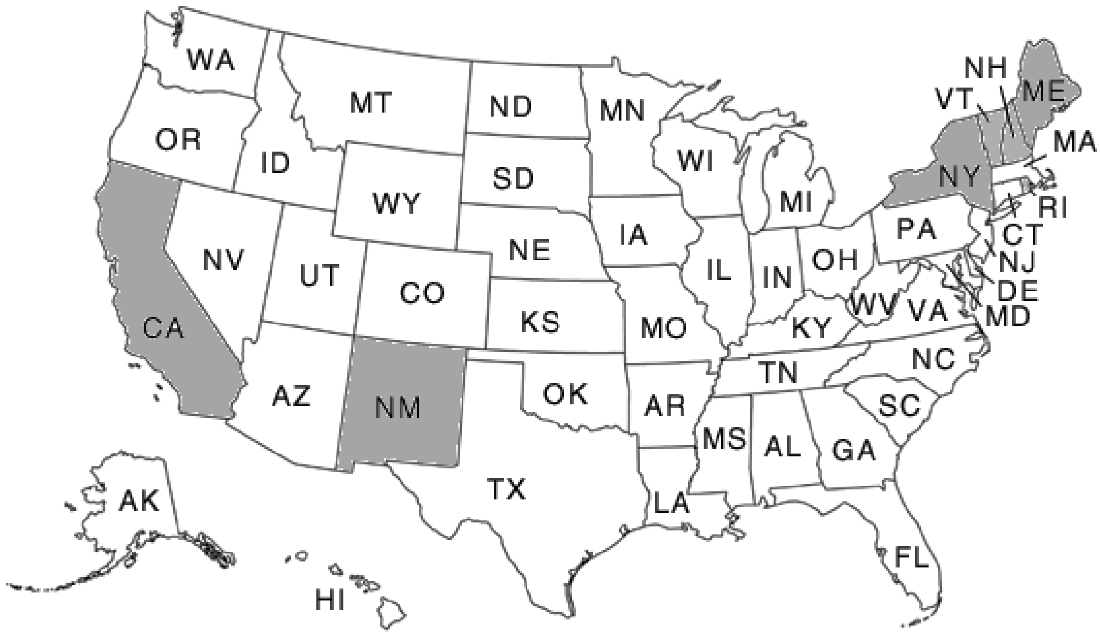

Figure 5: States with State GHG Emission Target in 2005

Source: Pew Center climate website, http://www.pewclimate.org/.

Then I show adoption situation of State GHG Emission Target in 2007, as there are comparatively a large number of states (8) adopting the policy in that year. More east coast states and west coast states continue to adopt and states in the middle start to adopt also, initiated by Minnesota, Illinois and Georgia. As you can see from the figure below:

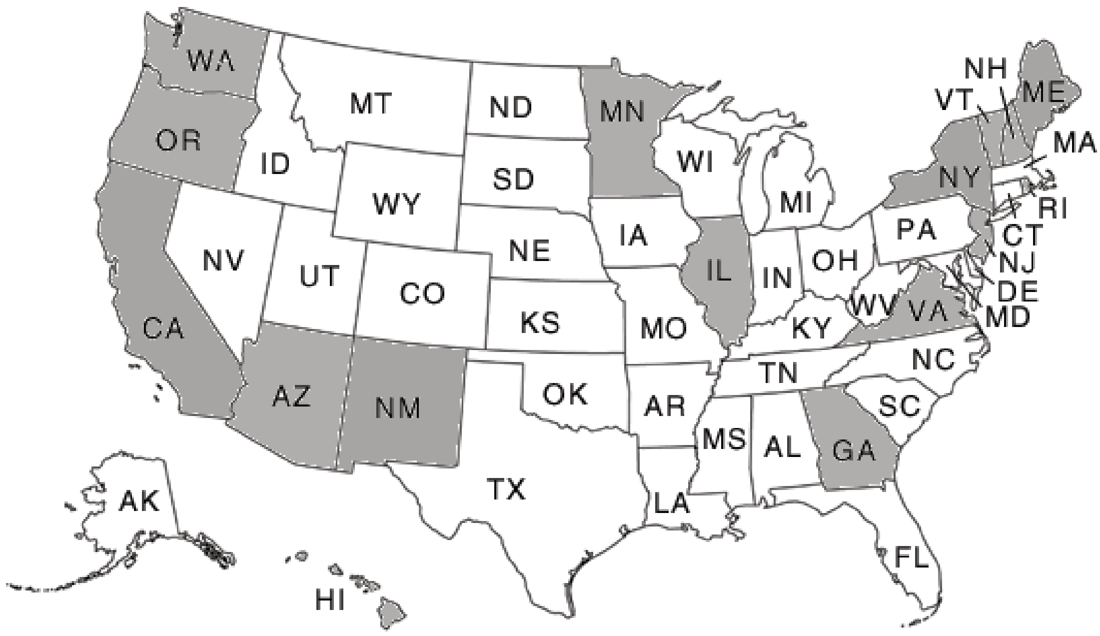

Figure 6: States with State GHG Emission Target in 2007

Source: Pew Center climate website, http://www.pewclimate.org/.

Then I show the adoption situation in 2008 as it is the concluding adoption situation for the analysis in this thesis. Four more states adopt the policy in 2008. They are Colorado, Connecticut, Massachusetts and Utah, bordering at least one state that adopted the policy previously. As you can see from the following figure:

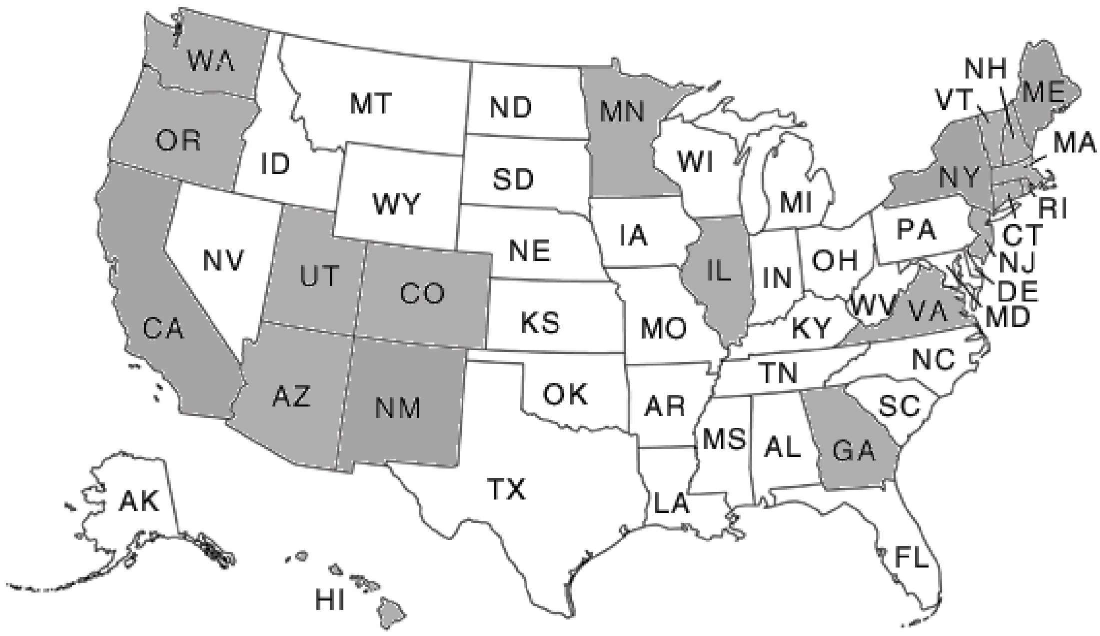

Figure 7: States with State GHG Emission Target in 2008

Source: Pew Center climate website, http://www.pewclimate.org/.

4.2 Description of the Data

I have collected data of variables from 1999 to 2008 for 50 states (Washington D.C. is excluded). The time frame for dependent variable, dummy variable being one to indicate a state has adopted GHG emission target, is from 2001 to 2008. The year 2001 is considered to be the starting point of significant adoption of GHG targets among states. In order to apply data into the theoretical model described above, once a state adopts the GHG emission target, it drops out of the sample. That is to say, for a state that has not adopted GHG emission target, it will have 8 observations; while for a state that adopted the target in 2001, it will only have 1 observation in the dataset. Using this specific method to treat data, I end up having a dataset of 352 observations.

For variables included in model, I have grouped them into 5 categories: 1.time trend variables, to account for the year effect; 2. interest group variables, considering relative strength of policy related groups within a state; 3. spatial variable, populated neighboring index constructed by the author, to pick up the spatial pattern we observe in the adoption of GHG emission targets; 4. political variables, important when trying to model adoption of policies; 5. control variable, I include typical control variables for policy models, like, education level, per capita income, population change and population density. Table 1 presents the descriptive statistics of these variables. The data were assembled from various sources including the Pew Center on Global Climate Change, the U.S. Census Bureau, the Bureau of Economic Analysis and Sierra Club. Complete data sources could be found in Appendix C.

Table2: Variable Names and Summary Statistics, N=352. (For data resources, see Appendix C)

Variable Name	Definition	Mean	St. Dev.	Min	Max
Dependent Variable					
target	target=1 if state has GHG emission target	0.057	0.23	0	1
Independent Variables					
recode_yr	year-2001	3.3125	2.2618003	0	7
neigh_ 1	proportion of bordering states with GHG emission target weighted by population	0.0424376	0.1493836	0	1
carbon_2	summation of ag, oil&gas, utility and coal	0.0683556	0.0896399	0.0103722	0.6781761
Sierra	proportion of sierra members in terms of state population	0.0022114	0.0013133	0.00035921	0.0067252
renewable	proportion of electricity generated from hydro, nuclear, geothermal and biomass	0.2633142	0.2138873	0	0.9207631
PENM_tv_d	Percent of presidential election net margin won by Democrat	-0.0908055	0.1665775	-0.5482203	0.290759
ctrl_2	ctrl_2=1 if Democrat dominates both houses	0.3352273	0.4727418	0	1
GPA	GPA=1 if governor is Democrat	0.4346591	0.4964178	0	1
edu	percent of population (25 years or older) with a bachelor's degree or higher	25.8301136	4.7756328	15.1	40.4
perin_s	percapita income in one thousand	31.4543835	5.4558089	21.007	54.984
stdp	Proportion of population change in terms of state population	0.0094576	0.0085155	-0.0517394	0.0514892
density	population per square mile land	172.242793	232.481595	1.1070179	1166.66

4.3 Regression Results

A. Overall performance of the model

a. Model Assessment Based on Standard Statistics

Table 3:Model Fit Statistics

Criterion	Intercept only	Intercept and Covariates
AIC	155.557	132.405
SC	159.421	182.632
-2LogL	153.557	106.405

The table above gives various measurements used to assess the model fit. The first two, Akaike Information Criterion (AIC) and Schwarz Criterion (SC) are deviants of negative two times the Log-likelihood (-2LogL). AIC and SC penalize the log-likelihood by the number of predictors in the model. AIC is used for the comparison of models from different samples or non-nested models. Like AIC, SC penalizes for the number of predictors in the model and the smallest SC is the most desirable and the value itself is not meaningful. These statistics are more useful when making a choice among the competing models. There is some other way to exam the model fit and from which a conclusion about whether these variables are desirable for the model or not can be drawn. The following table further tests the hypothesis that all the coefficients of explanatory variables are not significantly different from zero.

Table 4:Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr>ChiSq
Likelihood Ratio	47.1529	12	<0.0001
Score	52.6982	12	<0.0001
Wald	39.0491	12	0.0001

There are three asymptotically equivalent Chi-Square tests. They test against the null hypothesis that at least one of the predictors' regression coefficients is not equal to zero in the model. The difference between them is where on the log-likelihood function they are evaluated.

Chi-Square is the Chi-Square test statistic, Degrees of Freedom (DF) and associated p-value (Pr>ChiSq) corresponding to the specific test that all of the predictors are simultaneously equal to zero. The DF defines the distribution of the Chi-Square test statistics and is defined by the number of predictors in the model. Typically, Pr>ChiSq is compared to a specified alpha level, our willingness to accept a type I error, which is often set at 0.05 or 0.01. The small p-value from the all three tests would lead us to conclude that at least one of the regression coefficients in the model is not equal to zero.

Thus, for the full model, based on the asymptotically equivalent Chi-Square tests, I can reject the null hypothesis with confidence, which means at least one of the coefficients of explanatory variable is significantly different from zero.

b. Model Assessment Based on In-sample Predictions

From the model estimates, I get the predicted probability of adoption for each observation of the dataset. If the predicted probability is larger than 0.5, which means the predicted chances of adopting the policy is greater than 50%, I count the predicted response for that observation to be “adopting the policy,” otherwise, I will count the predicted response for that observation to be “not adopting the policy”. Then I can the predicted responses for all the observations. After that, I compare the predicted response with original dependent variable observation by observation. When I proceed in that manner, the rate of right prediction would be 94.89%. Generally speaking, it is hard to predict rare events and prediction just by following the mode performs really well thus it would be really difficult to compete with. By following the mode, the correct prediction rate is 94.32%, which is given by 332/352 [the number of observations that take the value of 0/the total number of observations], it follows that my model’s in-sample prediction is better than the naïve but hard-to-compete mode prediction.

B. Empirical Findings

The following tables provide the results of logistic regressions with cloglog specifications under four model setups. Model 1 contains only time trend and neighboring index variable. Model 2 contains political variables on top of variables from model 1. Model 3 adds interest group variables from model 2. And model 4 contains all 12 explanatory variables.

Table 5: Logistic Models of the Adoption of State GHG Emission Target

	Expected Sign	Model 1 Basic	Model 2 Basic+ Political	Model 3 Basic+ Political+ Interest Groups	Model 4 Full
Intercept		-4.4802***	-4.9213***	-6.3658***	-7.5600***
		(0.6286)	(0.7229)	(1.0657)	(2.3017)
Time Trend					
recode_yr	+	0.3276***	0.3998***	0.4824***	0.5202***
		(0.1176)	(0.1293)	(0.1394)	(0.1970)
External Demand					
neigh_1	+	2.7725***	0.7793	0.9333	1.5343
		(0.7432)	(1.0338)	(1.0071)	(1.2030)
Internal Demand					
Interest Groups					
carbon_2	-			-9.7314	-2.7862
				(11.6365)	(11.6668)
sierra	+			489.7***	102.3
				(184.3)	(271.5)
renewable	+			0.2767	1.2385
				(1.0325)	(1.1026)
Political Variables					
PENM_tv_d	+		4.8694**	0.8403	5.1532
			(2.0773)	(2.6835)	(3.5976)
Ctrl_2	+		0.6106	0.6690	0.5186
			(0.5292)	(0.5470)	(0.5816)
GPA	+		0.3595	0.2380	0.1997
			(0.5054)	(0.5209)	(0.5282)
Demographics					
edu	+				0.1290
					(0.0861)
perin_s	+				-0.0721
					(0.0922)
stdp	+				65.8146
					(35.2953)
density	+				-0.00112
					(0.00177)
Schwarz Criterion (SC)		149.539	155.479	164.11	182.632

Note: numbers presented are maximum likelihood estimates and their corresponding standard errors in the parentheses. *** significant at 1%; **significant at 5%; *significant at 10%.

Model 1 includes only the variables of recode_yr and external policy demand proxy, which is population weighted neighboring index. Recode_yr is included to take care of time-dependence. Population weighted neighboring index is included to take into account of horizontal dimension of interstate competition. Consistent with previous findings from state politics scholars, states with a higher percentage of adopting states as neighbors are more likely to adopt State GHG Emissions Target. They are both significant as the only two explanatory variables in the empirical model.

Mode 2 adds variables to capture liberalism of a state's political system. Consistent with expectation, states with more liberalism in political institutions are more likely to adopt State GHG Emissions Targets and states with more liberal governors are more likely to adopt State GHG Emissions Targets. PENM_tv_d is pretty significant in this model setting, suggesting that inter-party competition is a comparatively good proxy of the political influence to adoption of State GHG Emissions Target.

On top of variables from model 2, model 3 adds variables to capture the relative strength of advantaged and disadvantaged interests that relates to the policy. Consistent with previous literature, states with strong environmental groups are more likely to adopt State GHG Emissions Targets; states with strong carbon industries are less likely to adopt State GHG Emissions Targets and states with more natural resource endowment are more likely to adopt State GHG Emissions Target. Sierra is significant at 1%, suggesting the strength of environmental group is very influential to the adoption of State GHG Emissions Target.

Model 4 adds variables to capture demographic characteristics of a state on top of variables of model 3. Consistent with previous analysis, higher education level and population change is positively correlated with the adoption of the policy. Surprisingly, higher personal income and density is negatively correlated with the adoption of the policy based on the data in this analysis. It may due to the correlation between the explanatory variables; education attainment level is highly correlated with personal income and population change is correlated with population density.

Generally lack of significance for the explanatory variables in the full model casts some doubts on explanatory power of the variables included in the model. Then a group-wise Likelihood Ratio Test would help us determine whether, at the level of groups of explanatory variables, the group contributes to the modeling or not. The following table shows the results of group-wise Likelihood Ratio Test.

Table 6: Step-wise Likelihood Ratio Test for Adoption of State GHG Emissions Target

	Null Model	Model 1	Model 2	Model 3	Model 4
-2LogL	153.557	131.948	120.297	111.337	106.405
DF	1	3	6	9	13
Null Hyp.		Explanatory power of recode_yr and population weighted index is not significant.	Explanatory power of political variables in addition to variables in Model 1 is not significant.	Explanatory power of interest variables in addition to variables in Model 2 is not significant.	Explanatory power of control variables in addition to variables in Model 3 is not significant.
LR		21.609	11.651	8.96	4.932
Chi(5%)		5.991464547	7.814727764	7.814727764	9.487729037
Comparison		LR>Chi	LR>Chi	LR>Chi	LR<Chi
Conclusion		Reject the null.	Reject the null.	Reject the null.	Fail to reject the null

The likelihood ratio tests confirm the explanatory power of recode_year, population weighted index, political group variables and interest group variables to be significant. The test also shows that a lack of significance for control variables. The results are also consistent with the previous analysis that external pressure, relative strength of interest groups and liberalism of political system are influential to the policymaking process of State GHG Emissions Target.

Then the generally lack of significance for the explanatory variables in the full model may be caused by relatively high correlation among those variables. Also, it may due to the fact that the measurements that used in the model to capture the influences are not good enough. Better measurements of those influences may change the regression results significantly.

C. Discussions and Conclusions

Based on my empirical findings, there are several main points worth noticing. First, time trend is the single significant variable in all four model setups. It basically states the fact that with the time goes by, it is increasingly likely for a state to adopt State GHG Emissions Target. Given the consensus on importance of climate change issues, the generally significance is easy to interpret.

Second, neighboring effect is quite significant before adding political, interest group and control variables. It suggests that neighboring effect exists to a large extent but correlates with lots of social characteristics of a state. If better measurement of neighboring effect could be proposed to capture the sole geographic diffusion, I would expect a rise of significance of neighboring effect in the model.

Third, Presidential Election Net Margin (PENM_tv_d) is the most significant variable in the group of political variables. And the political group itself turns out to add to explanatory power of the model distinctly. PENM_tv_d contains information about not only by how much a party wins in the presidential election, but also which party wins. Its significance suggests that the inter-party competition within a state is influential to the adoption of State GHG Emissions Target.

Fourth, Sierra Club membership is the most significant variable in the group of interest variables, which turn out to be influential to adoption of State GHG Emissions Target in general. Sierra Club is America’s oldest, largest, and most influential grassroots environmental organization. Inspired by nature, they are about 1.3 million of U.S. people working together to protect the communities and the planet. Sierra Club has long been known to be active and influential in lots of environmental policies, both at the federal levels and state levels. Now with a clear focus on climate change, Sierra Club has developed a Climate Recovery Agenda, a set of initiatives that will help cut carbon emissions 80% by 2050, reduce the dependence on foreign oil, create a clean energy economy and protect the natural heritage, communities and country from the consequences of global warming. Indeed, we could expect with great confidence that Sierra Club will continue to be influential in adoption of State GHG Emissions Target at the state level.

Now I can answer my research questions raised in Chapter 1 in regard of State GHG Emissions Target, which are: Why do states behave differently in adopting climate change policies and what are the factors that influence states’ policymaking behavior? How are states affected by those factors?

For State GHG Emissions Target, the factors that could explain the difference in adopting the policy are time trend, neighboring effect, interest group influence, political characteristics and demographics for a specific state. I find neighboring effect, inter-party competition and Sierra Club to have influential impact on states’ behavior in general.

5 Empirical Analysis of State Renewable Portfolio Standards

5.1 General Description of State Renewable Portfolio Standards

A. General Description

Renewable Portfolio Standards is a policy tool widely adopted by state governments to promote renewable electricity generation. An RPS requires a certain percentage of a utility's power plant capacity or generation to come from renewable sources by a given time. Though climate change may not be the prime motivation behind some of the standards, the use of renewable energy are believed to contribute to significant GHG reductions.

In order to outline the basic components of this policy, scrutinize RPS in Texas, the state with historically important role in development of fossil fuel, as an example.

B. The Case of RPS in Texas

Given its historic role in fossil fuel development and use, Texas might not appear to be one of the early movers toward a RPS. However, since 1999, Texas has begun its effort to build up its renewable energy capacity although the formal adoption of RPS is in 2005. The effort has triggered a massive increase in the supple of renewable that is being provided at prices highly competitive with conventional sources. In fact, the early attempt has proven so successful and so popular that the Texas Legislature overwhelmingly endorsed the formal legislation of RPS, which was signed into law by Republican Governor Ricky Perry on August 1, 2005[29].

RPS adopted in 2005 elevated the levels of energy produced from renewable sources required by 2007 and 2009 and specified continued expansion into the next decade. The legislation Section 39.905 of the Texas Utilities Code requires that "The cumulative installed renewable capacity in this state shall total 5,880 megawatts by

[29] Texas Senate Bill 2005, 20.

January 1, 2015"[30]. The legislation also includes two "targets". Although they are premature and flexible, and will have to be more carefully defined through rule-making by the Public Utility Commission of Texas (TPUC), they are viewed to be the guides of future development. One requires the Commission to establish a target, after September 1, 2005 of "having at least 500 megawatts of capacity from a renewable energy technology other than a source using wind energy." The other created a non-binding target of 10,000 megawatts of installed renewable capacity by January 1, 2025.

A potentially more important section of the 2005 bill involves a series of mechanisms designed to improve transmission capacity due to unexpectedly rapid development of wind energy in remote sections of Western Texas. Texas faces a particularly acute challenge and the 2005 legislation calls upon the TPUC "to provision may be the single most important factor in determining effectiveness of the new RPS.

C. Analysis of Basic Components of RPS

The standards among states range from modest to ambitious, and definitions of renewable energy vary. However, similar fashion of RPS could be found in all adoption cases: the percentage of energy generation, ranging from 10% to 30% and the year to accomplish, from 2000 to 2025. On top of that, many states adopt in-state requirement, which usually gives extra credit for in-state renewable generation or does not allow credit trading.

The basic components in the RPS legislation are the following: definition of eligible renewable resources, special incentives (like extra REC for in-state resource), rules regarding cost of renewable production, cost recovery mechanism, contract

---

30 Texas Senate Bill 20, Section 3a, 2005.

requirement, special funds, flexibility and penalties. States have really different definition of eligible renewable sources, depending on their natural endowment. However, hydroelectric, nuclear, geothermal and biomass resources are generally viewed to be eligible. Special incentives are often adopted by states which care a lot about local job creation effect from RPS, which has been termed as “in-state requirement” and adopted by states like Arizona, New York, Texas. With in-state requirement, RPS will benefit the local economic growth more than RPS without. Like other climate change policies, RPS is flexible in the way to achieve the specified percentage amount of renewable energy, using credit multipliers to discount the amount into the future or allowing credit trading. Unlike most of the climate change policies, RPS usually specifies the penalties if the requirement has not been met. For example, California set the penalty amount at an annual cap of $25 million per utility.

The same as State GHG Emission Target, it is the best if states’ effort could be treated differently based on the difference in their RPS requirement. However, data containing the information are not available. So again, if a state adopts the RPS, no matter how much percentage of the energy is required, by which year it shall be completed and how different it is in all the basic components than other states, it is treated equally as all other states which have adopt RPS.

D. Diffusion of State GHG Emission Target at a Glance

a. Aggregate Diffusion Trend

The same as that in State GHG Emission Target, the first graph shows the change of percent of states, as in total 50 states, with RPS over time.

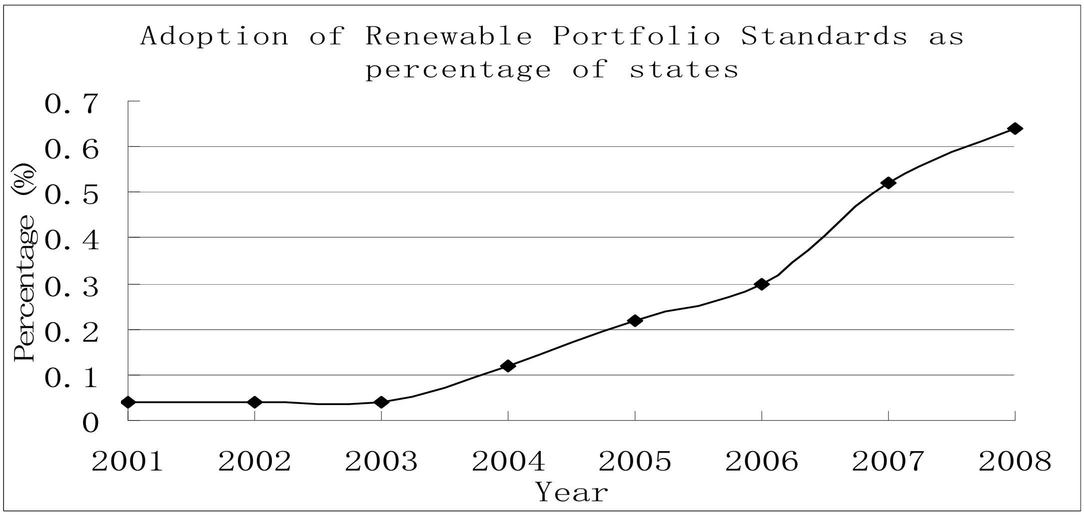

Figure 8: Percent of States with RPS over time

Total Number of States=50.

Source: Pew Center climate website, http://www.pewclimate.org/.

The second graph shows the change of percent of population, as in total population, with State GHG Emission Target over time.

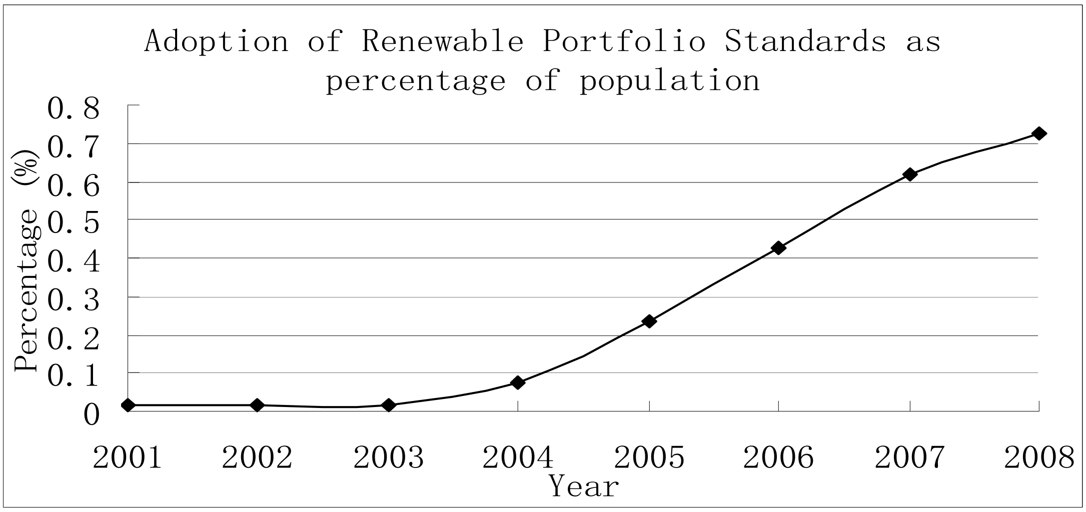

Figure 9: Percent of Total Population with RPS over time

Source: Pew Center climate website and U.S. Bureau of the Census, current population estimates (Compiled by Empire State Development, State Data Center)

Both graphs show the number of states that adopted RPS has been increasing since 2001, especially starting from 2003. Right now, over 60% of the states have adopted the policy and more than 70% of the total population is involved in it. It further proves that RPS is the most influential and popular climate change policy in the United States.

b. Geographic Diffusion Trend

I choose to show geographic diffusion trend of adoption of RPS in 4 most representative years. 2001 is the starting point of the analysis, also is basically the beginning of this policy diffusion. 2 states adopt the policy in that year or before. One is the east coast state, Maine and one is the state in the middle of United States, Iowa. As you can see from the figure below:

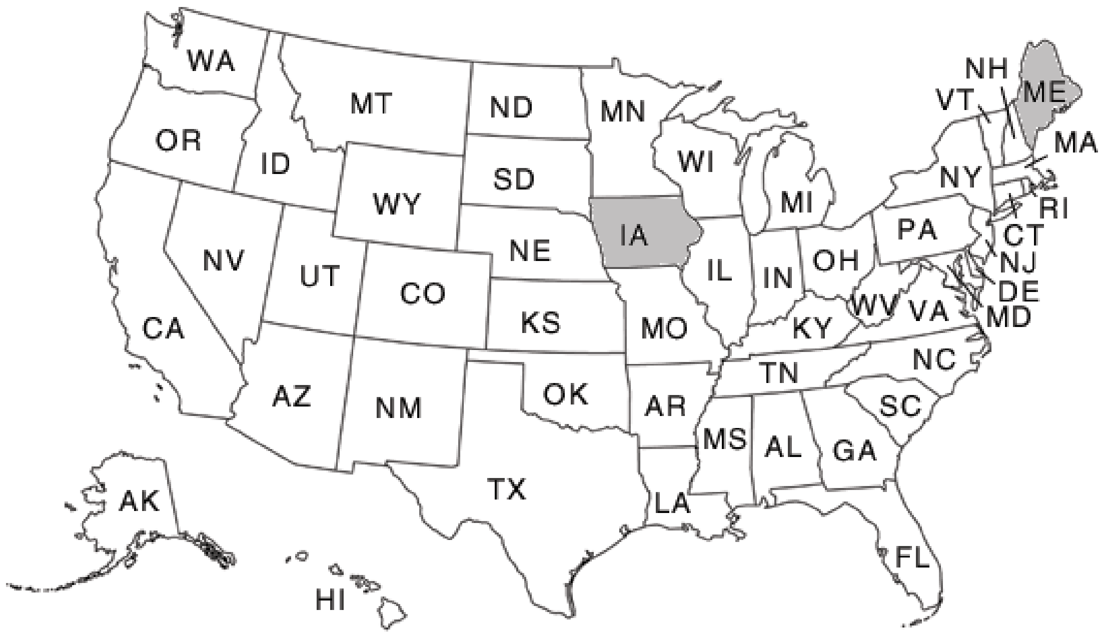

Figure 10: States with RPS in 2001

Source: Pew Center climate website, http://www.pewclimate.org/.

Then we jump to take a look at adoption situation in 2005. Compared to that in 2001, more east coast states have adopted the policy. However, more interestingly, West and South West States begin adopting RPS too, initiated by Oregon, Nevada and Texas. Montana also adopts the RPS in 2005. As you can see in the second figure:

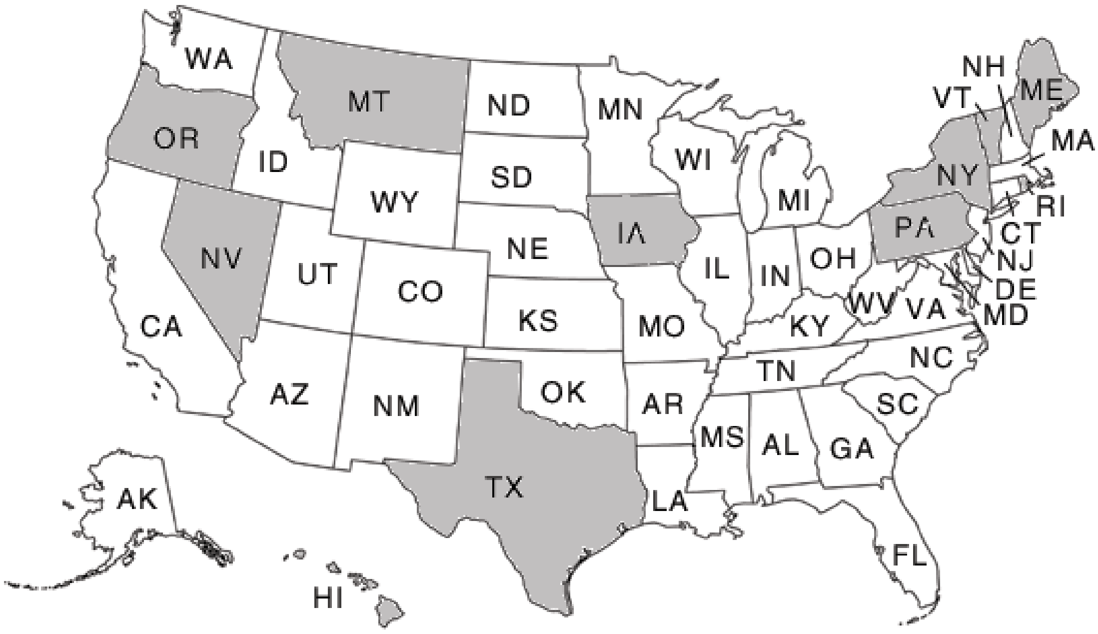

Figure 11: States with RPS in 2005

Source: Pew Center climate website, http://www.pewclimate.org/.

Then I show adoption situation of RPS in 2007, as there are comparatively a large number of states (11) adopting the policy in that year. More east coast states and west coast states continue to adopt and so do their neighbors. As you can see from the figure below:

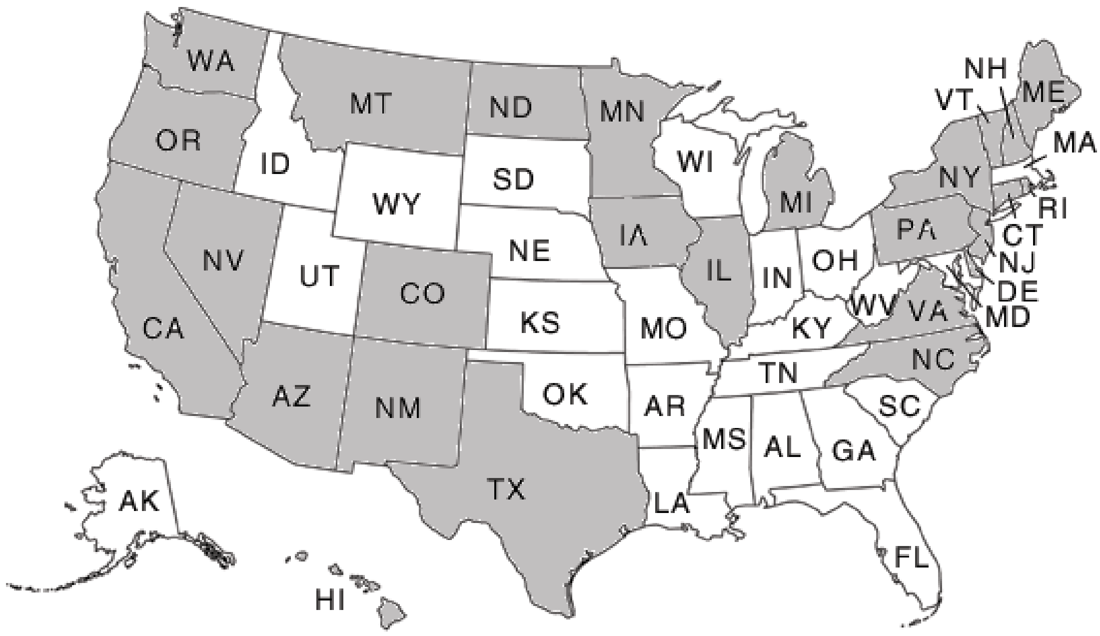

Figure 12: States with RPS in 2007

Source: Pew Center climate website, http://www.pewclimate.org/.

Then I show the adoption situation in 2008 as it is the concluding adoption situation for the analysis in this thesis. Six more states adopt the policy in 2008. They are Massachusetts, Maryland, Missouri, Ohio, South Dakota and Utah, bordering at least one state that adopted the policy previously. As you can see from the following figure:

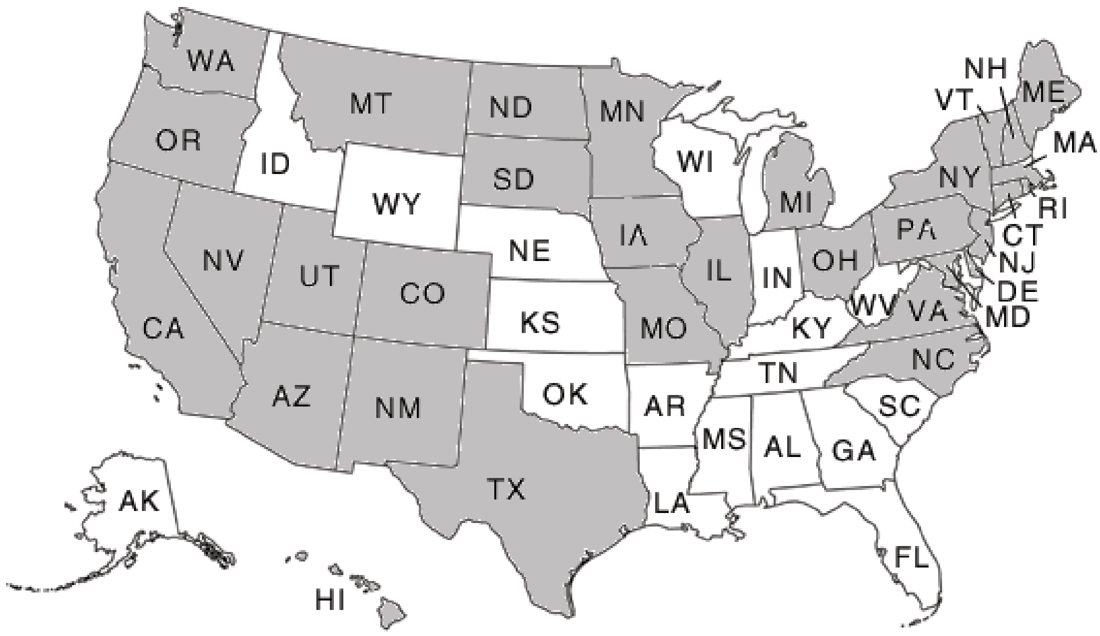

Figure 13: States with RPS in 2008

Source: Pew Center climate website, http://www.pewclimate.org/.

5.2 Description of the Data

I have collected data of variables from 1999 to 2008 for 50 states (Washington D.C. is excluded). The time frame for dependent variable, dummy variable being one to indicate a state has adopted Renewable Portfolio Standard, is from 2001 to 2008. Having the same data organization as that of State GHG Emissions Target, I end up having a dataset of 336 observations. Variable category and data source are the same as those of State GHG Emissions Target also. The following table contains information about summary statistics of variables included in the model.

Table 7: Variable Names and Summary Statistics, N=336. (For data resources, see Appendix)

Variable Name	Definition	Mean	St. Dev.	Min	Max
Dependent Variable					
rps	rps=1 if state has Renewable Portfolio Standards	0.0952381	0.2939813	0	1
Independent Variables					
recode_yr	year-2001	3.0863095	2.1761921	0	7
neigh_ 1	proportion of bordering states with GHG emission target weighted by population	0.00652434	0.1623635	0	1
carbon_2	summation of ag, oil&gas, utility and coal	0.0681314	0.0914949	0.0103722	0.6781761
Sierra	proportion of sierra members in terms of state population	0.0022519	0.0013386	0.000359209	0.0067252
renewable	proportion of electricity generated from hydro, nuclear, geothermal and biomass	0.2759537	0.226028	0	0.9306014
PENM_tv_d	Percent of presidential election net margin won by Deomocrate	-0.0864564	0.1741828	-0.5482203	0.290759
ctrl_2	ctrl_2=1 if Democrate dominates both houses	0.2886905	0.4538296	0	1
GPA	GPA=1 if governor is Democrate	0.4136905	0.4932288	0	1
edu	percent of population (25 years or older) with a bachelor's degree or higher	26.3244048	4.6040345	17.1	40.4
perin_s	percapita income in one thousand	31.2024613	5.2642177	21.007	51.468
stdp	Proportion of population change in terms of state population	0.0092678	0.0082162	-0.0517394	0.0514892
density	population per square mile land	182.423009	241.7143617	1.1070179	1164.92

5.3 Regression Results

A. Overall performance of the model

a. Model Assessment Based on Standard Statistics

Table 8:Model Fit Statistics

Criterion	Intercept only	Intercept and Covariates
AIC	213.339	177.524
SC	217.156	227.146
-2LogL	211.339	151.524

The table gives Akaike Information Criterion, Schwarz Criterion and negative two times the Log-likelihood. As pointed out in the analogue part of analysis in last chapter, the values by themselves are not really meaningful. They will be used in likelihood ratio tests later on. The second way to assess model fit is to test the null hypothesis that all the estimate coefficients are not significantly different from zero. The following table contains value of relative statistic to test that.

Table 9:Testing Global Null Hypothesis: BETA=0

Test	Chi-Square	DF	Pr>ChiSq
Likelihood Ratio	59.8150	12	<0.0001
Score	56.4755	12	<0.0001
Wald	35.0745	12	0.0005

Based on the three asymptotically equivalent Chi-Square tests, I can reject the null hypothesis with confidence, which means at least one of the coefficients of explanatory variable is significantly different from zero.

b. Model Assessment Based on In-sample Predictions

Proceeding in the steps described in the analogue part of analysis in Chapter 4, I get the rate of right prediction under this model setting to be 91.67%, which is greater than that of mode prediction of 90.48%, given by 304/336, [the number of observations that take the value of 0/the total number of observations]. It follows that my model's in-sample prediction is better than the naïve but hard-to-compete mode prediction.

B. Empirical Findings

The following tables provide the results of logistic regressions with cloglog specifications under four model setups. Model 1 contains only time trend and neighboring index variable. Model 2 contains political variables on top of variables from model 1. Model 3 adds interest group variables from model 2. And model 4 contains all 12 explanatory variables.

Table 10: Logistic Models of the Adoption of Renewable Portfolio Standards

	Expected Sign	Model 1 Basic	Model 2 Basic+ Political	Model 3 Basic+ Political+ Interest Groups	Model 4 Full
Intercept		-4.0095***	-4.5045***	-5.9703***	-6.9225***
		(0.5095)	(0.5937)	(0.9569)	(2.2653)
Time Trend					
recode_yr	+	0.3805***	0.5534***	0.6357***	0.7429***
		(0.1065)	(0.1237)	(0.1395)	(0.1958)
External Demand					
neigh_1	+	1.4899**	0.6545	0.8007	1.2156
		(0.7221)	(0.8719)	(0.8454)	(1.0843)
Internal Demand					
Interest Groups					
carbon_2	-			-3.1565	-0.7992
				(4.2388)	(4.5462)
sierra	+			428.9**	313.4
				(176.7)	(236.7)
renewable	+			0.000989	0.1575
				(0.8800)	(1.0277)
Political Variables					
PENM_tv_d	+		5.2122***	2.5914	5.9469**
			(1.3855)	(1.8422)	(2.8788)
Ctrl_2	+		-0.3456	-0.2991	-0.4409
			(0.4279)	(0.4448)	(0.5197)
GPA	+		0.4896	0.5352	0.7195
			(0.3691)	(0.3664)	(0.3963)
Demographics					
edu	+				0.0417
					(0.0456)
perin_s	+				-0.0209
					(0.0702)
stdp	+				50.6465
					(31.7843)
density	+				-0.00023
					(0.00150)
Schwarz Criterion (SC)		196.318	194.945	206.079	227.146

Note: numbers presented are maximum likelihood estimates and their corresponding standard errors in the parentheses. *** significant at 1%; **significant at 5%; *significant at 10%.

Model 1 includes only the variables of recode_yr and external policy demand proxy, which is population weighted neighboring index. Recode_yr is included to take care of time-dependence. Population weighted neighboring index is included to take into account of horizontal dimension of interstate competition. Consistent with previous findings from state politics scholars, states with a higher percentage of adopting states as neighbors are more likely to adopt Renewable Portfolio Standards. They are both significant as the only two explanatory variables in the empirical model.

Mode 2 adds variables to capture liberalism of a state's political system. Consistent with expectation, states with more liberalism in political parties are more likely to adopt RPS. Surprisingly, I get a mixed impact on likelihood to adopt RPS from the level of liberalism of political institutions within a state. Based on my regression results, states with Democratic partisan control of state political institution is negatively correlated with the likelihood to adopt RPS; and states with more liberal governor is more likely to adopt RPS. The mixed effect may due to correlation among the three political variables. Note that PENM_tv_d is significant under 1% level and it suggests that PENM_tv_d is a good proxy to capture influence of political system within a state.

On top of variables from model 2, model 3 adds variables to capture the relative strength of advantaged and disadvantaged interests that relates to the policy. Consistent with previous literature, states with strong environmental groups are more likely to adopt RPS; states with strong carbon industries are less likely to adopt RPS and states with more natural resource endowment are more likely to adopt RPS. Sierra is significant at 5%, suggesting the strength of environmental group is very influential to the adoption of RPS.

Model 4 adds variables to capture demographic characteristics of a state on top of variables of model 3. Consistent with previous analysis, higher education level and population change is positively correlated with the adoption of the policy. Surprisingly, higher personal income and density is negatively correlated with the adoption of the policy based on the data in this analysis. It may due to the correlation between the explanatory variables; education attainment level is highly correlated with personal income and population change is correlated with population density.

Other than PENM_tv_d is significant at 5% level, generally lack of significance for the explanatory variables in the full model casts some doubts on explanatory power of the variables included in the model. Then a group-wise Likelihood Ratio Test would help us determine whether, at the level of groups of explanatory variables, the group contributes to the modeling or not. The following table shows the results of group-wise Likelihood Ratio Test.

Table 11: Step-wise Likelihood Ratio Test for Adoption of Renewable Portfolio Standards

	Null Model	Model 1	Model 2	Model 3	Model 4
-2LogL	211.339	178.867	160.042	153.725	151.524
DF	1	3	6	9	13
Null Hyp.		Explanatory power of recode_yr and population weighted index is not significant.	Explanatory power of political variables in addition to variables in Model 1 is not significant.	Explanatory power of interest variables in addition to variables in Model 2 is not significant.	Explanatory power of control variables in addition to variables in Model 3 is not significant.
LR		32.472	18.825	6.317	2.201
Chi(5%)		5.991464547	7.814727764	7.814727764	9.487729037
Comparison		LR>Chi	LR>Chi	LR<Chi	LR<Chi
Conclusion		Reject the null.	Reject the null.	Fail to reject the null.	Fail to reject the null

The likelihood ratio tests confirm the explanatory power of recode_year, population weighted index, political group variables to be significant. The tests remain inconclusive about the explanatory power of variables from interest group and control group. However, sierra, the variable in interest group, is significant even in full model at 10%. Thus, at least we can say sierra contributes to explain the adoption of RPS within a state. The results are also consistent with the previous analysis that external pressure and liberalism of political system are influential to the policymaking process of State RPS.

Then the generally lack of significance for the explanatory variables in the full model may be caused by relatively high correlation among those variables. Also, it may due to the fact that the measurements that used in the model to capture the influences are not good enough. Better measurements of those influences may change the regression results significantly.

C. Discussions and Conclusions

Based on my empirical findings, there are several main points worth noticing. First, time trend is significant in all four model setups. It basically states the fact that with the time goes by, it is increasingly likely for a state to adopt RPS Given the consensus on importance of climate change issues, the generally significance is easy to interpret.

Second, neighboring effect is quite significant before adding political, interest group and control variables. It suggests that neighboring effect exists to a large extent but correlates with lots of social characteristics of a state. If better measurement of neighboring effect could be proposed to capture the sole geographic diffusion, I would expect a rise of significance of neighboring effect in the model.

Third, Presidential Election Net Margin (PENM_tv_d) is the most significant variable in the group of political variables and remains significant in the full model. Containing information about not only by how much a party wins in the presidential election but also which party wins, PENM_tv_d is good proxy to capture inter-party competition characteristics, which is influential to adoption of RPS within a state.

Fourth, Sierra Club membership is the most significant variable in the group of interest variables (5% level in the model with basic, political and interest variables). Sierra Club's Climate Recovery Agenda, a set of initiatives that will help cut carbon emissions 80% by 2050, reduce the dependence on foreign oil, create a clean energy economy and protect the natural heritage, communities and country from the consequences of global warming, seems already has some significantly impact on adoption of State RPS. Thus I could expect Sierra Club will continue to be influential in adoption of RPS at the state level.

Now I can answer my research questions raised in Chapter 1 in regard of RPS. Why do states behave differently in adopting climate change policies and what are the factors that influence states' policymaking behavior? How are states affected by those factors?

For RPS in a state, the factors that could explain the difference in adopting the policy are time trend, neighboring effect, interest group influence, political characteristics and demographics for a specific state. I find there is a clear time trend in adoption of RPS that with years going by, states are more likely to adopt RPS. Also neighboring effect, inter-party competition and Sierra Club seem to have influential impact on states' behavior in adoption of RPS.

6 Conclusion

6.1 Comparison and Discussion of Regression Results from the Two Models

I have presented quantitative empirical analysis of the factors leading states to adopt State GHG Emissions Target and Renewable Portfolio Standards. For those two policies, my results consistently show that time trend, neighboring effect, state political system characteristics, relative strengths of interest groups related to the policy and demographics of a specific state have, maybe not always significant, impact on adoption.

In-depth examination reveals different impacts of those factors to adoption of the two policies. Adoption of Renewable Portfolio Standards seems to be more influenced by time trend than that of State GHG Emission Targets. That is to say, with the passage of time, at least within recent years, the likelihood of adoption of RPS for a certain state increases faster than that of State Emission Targets. Given the present adoptions of those policies, we might expect to see a major development of RPS ahead of a major development of GHG Emissions Target at the state level.

Adoption of State GHG Emissions Target seems to be influenced by neighboring effect more than that of RPS, both in terms of significance and magnitude. This may relates to the fact that when a state adopts RPS, it considers its own needs more than horizontal dimension of interstate competition.

For political variables, PENM_tv_d, which is the percent of presidential election net margin won by Democrat, proves to be a good measure to capture political influence in both of the adoption cases. It seems that PENM_tv_d is more influential to adoption of RPS than it is to adoption of State GHG Emissions Target, both in terms of magnitude and significance. Surprisingly, ctrl_2, the dummy variable taking the value of 1 to indicate Democrat dominates both houses, is negatively correlated to adoption of RPS, which may due to its correlation with other variables. Further analysis may be needed to identity the impact of partisan control of state political institution on adoption of RPS at state level.

For interest group variables, Sierra Club membership proves to be a good measure of environmental group influence to adoption, both for State GHG Emission Target and RPS. It even mains significant in the full model setup for adoption of RPS. Good performance of this variable suggests the fact that environmental group is influential in the policymaking processes of the two policies.

For control variables of demographic characteristics within a certain state, it seems that none of those variables contribute much to the explanatory power of the model, which I suspect to be caused by their correlation with other variables. Better measures may relieve this problem.

6.2 Limitations of the Thesis

Since there is no integrated and comprehensive theory on environmental policy, the variables included in my thesis might not be enough and important variables might be left out.

Also, the methodology adopted in the thesis is event history analysis using logistic regression with cloglog specification. It is ideal for situation like adoptions of State GHG Emissions Target and RPS. However, it is very tricky to choose the time frame for the relevant analysis. In this thesis, I arbitrarily choose the time period of analysis to be from 2001 to 2008 because that is the time frame adoptions of the policies can be observed. I am aware of the fact that some variables that have big impacts on adoptions of these two policies might start to experience major changes that relates to the policies before 2001. Which means the data from 2001-2008 do not contain evolving information of the important variables.

The third limitation would the measures. The measures used in this thesis might not be good enough. It is hard to choose a perfect measure to capture social and political characteristics within a state. The variables that supposed to be time-varying may end up actually not very time-varying at all. For example, I use presidential election data to capture the liberalism in political parties in a state. Because presidential election only happens every four years, I end up having actually two point observations for the liberalism in a specific state.

6.3 Areas for Future Research

Having known the limitations of my thesis, I plan to future research on the following areas.

First, I want to spend some time exploring the literature of environmental policies and try to develop a more sound theory for climate change policy. When doing that, I might find potentially very important variables that have been left out in this thesis.

Second, I could spend time trying to use different time frames to modify my original choice. I may find better time frame for analysis of adoptions of State GHG Emissions Target and RPS.

Third, I could try to use different measures to capture the social and political characteristics within a state. For example, I could use border length weighted neighboring index to capture the neighboring effect; I could use average LCV (League of Conservation Voters) score to capture political liberalism within a state and I could use green index to capture the strength of environmental group.

Appendix A : Basic Setup of Event History Analysis

1. Survival Function

The object of primary interest is the survival function, denoted as S, which is defined as

$$S(t) = \Pr(T > t)$$

Where t is some time, T is a random variable denoting the time of death, and “pr” stands for probability. Survival function is the probability that the time of event is later than some specified time. Usually $S(0) = 1, S(u) \leq S(t)$ if $u > t$.

2. Event distribution function and event density

Related quantities are defined in terms of the survival function. The event distribution function, conventionally denoted as F, is defined as the complement of the survival function,

$$F(t) = \Pr(T \leq t) = 1 - S(t)$$

And the derivative of F, which is the density function of the lifetime distribution is conventionally denoted as f, f is called event density, it is the rate of events per unit time

$$f(t) = F'(t) = \frac{d}{dt} F(t)$$

The survival function is often defined in terms of distribution and density functions

$$S(t) = \Pr(T > t) = \int_t^\infty f(u)du = 1 - F(t)$$

A survival density function can be defined as

$$s(t) = S'(t) = \frac{d}{dt} S(t) = \frac{d}{dt} \int_t^\infty f(u)du = \frac{d}{dt}[1 - F(t)] = -f(t)$$

4. Hazard function and cumulative hazard function

The hazard function, conventionally denoted as λ, is defined as the event rate at time t conditional on survival until time t or later,

$$\lambda(t)dt = \Pr(t \leq T \leq t + d \mid T \geq t) = \frac{f(t)dt}{S(t)} = -\frac{S'(t)dt}{S(t)}$$

The hazard function must be non-negative $\lambda(t) \geq 0$, and the hazard function may be increasing or decreasing, non-monotonic or discontinuous.

Appendix B: Math of Grouped Durations

This appendix derives the grouped duration model. I present it here for completeness of analysis. All basic durations concepts are maintained in this section.

We start with a continuous-time Cox proportional hazard model with the hazard rate specification

$$\lambda_i(t) = \lambda_0(t)e^{x_{i,t}\beta}$$

Where i refers to units, t refers to continuous time, $x_{i,t}$ is a vector of independent variables and $\lambda_0(t)$ is the unspecified baseline hazard.

Let S(t) be the probability of surviving beyond t, we use the basic identity that

$$S(t) = \exp(-\int_0^t \lambda(\tau)d\tau)$$

We only observe whether or not an event occurred between t_{k-1} and t_k (usually the annual data) and we are modeling the probability of the event happening, that is $P(y_{i,t_k} = 1)$, which is the "failure of lasting longer" in event history analysis. This probability is one minus the probability of surviving beyond t_k given survival up to t_{k-1}. Assuming no prior events happening before, we have

$$P(y_{i,t_k} = 1) = 1 - \exp(-\int_{t_k - 1}^{t_k} \lambda_i(\tau)d\tau) = 1 - \exp(-\int_{t_k - 1}^{t_k} e^{x_{i,t_k}\beta}\lambda_0(\tau)d\tau) = 1 - \exp(-e^{x_{i,t_k}\beta}\int_{t_k - 1}^{t_k}\lambda_0(\tau)d\tau)$$

Since the baseline hazard is unspecified and that is unrelated to time, we can treat the integral of the baseline hazard as an unknown constant. For simplicity and comparing purposes, define

$$\alpha_{t_k} = \int_{t_k - 1}^{t_k} \lambda_0(\tau)d\tau,$$

$$k_{t_k} = \log(\alpha_{t_k})$$

Then we have

$$p(y_{i,t_k}=1)=1-\exp(-e^{x_{i,t_k}\beta}\alpha_{tk})=1-\exp(-e^{x_{i,t_k}\beta+k_{t_k}})$$

Which is exactly a binary dependent variable model with a cloglog link function. In this thesis, k takes the value of 3 and k_{ik} are $\gamma_1 t_1$, $\gamma_2 t_2$, $\gamma_3 t_3$ included as time cubed approach to take into consideration of time-dependence.

Appendix C: Data Sources

Variable Name	Data Source
Dependent Variable	
target	Pew Center on Global Climate Change
RPS	Pew Center on Global Climate Change
Independent Variables	
Time Trend Variables	
year	self-constructed
yearsq	self-constructed
yearcu	self-constructed
External Demand Variable	
neigh_1	U.S. Census Bureau
Internal Demand Variables	
Interest Group Variables	
carbon_2	Bureau of Economic Analysis
Sierra	Sierra Club
renewable	Energy Information Administration
Political System Variables	
PENM_tv_d	Dave Leip's Atlas of U.S. Presidential Elections
ctrl_2	The Council of State Governments, Lexington, KY
GPA	National Governors Association
Control Variables	
edu	U.S. Census Bureau
per_in	Regional Economic Information System, Bureau of Economic Analysis
pop_change	Population Estimate Program, Population Division, U.S. Census Bureau
density	U.S. Census Bureau

Appendix D1: Correlation Matrix of Variables for State GHG Emissions Target

	recode_yr	neigh_1	carbon_2	sierra	renewable	PENM_tv_d	Ctrl_2	GPA	edu	perin_s	popc_s	density
recode_yr	1											
neigh_1	0.1964807	1										
carbon_2	0.0796905	-0.119308	1									
sierra	-0.105282	0.2105462	-0.120254	1								
renewable	-0.040981	0.0552034	-0.243809	0.2782653	1							
PENM_tv_d	-0.136122	0.3004046	-0.476109	0.5235908	0.1487155	1						
Ctrl_2	0.0243135	0.2529385	-0.103523	0.1573411	0.0571204	0.3796289	1					
GPA	0.1197342	-0.075097	0.0223047	0.0912752	0.0442077	0.1426788	0.0329024	1				
edu	0.099856	0.3993553	-0.280652	0.5811258	0.2048255	0.4506777	0.113507	-0.033658	1			
perin_s	0.4817059	0.4983868	0.0115214	0.3628986	0.1264156	0.4322253	0.1257233	0.0494231	0.6926607	1		
popc_s	-0.021042	-0.036917	-0.132289	0.1100752	0.0334131	0.0613313	-0.038801	-0.07005	0.0928462	0.0518174	1	
density	-0.018478	0.4827965	-0.289191	0.1890001	0.1396056	0.6249904	0.3219425	0.0136224	0.5245872	0.5959475	0.0290329	1

Appendix D2: Correlation Matrix of Variables for State Renewable Portfolio Standards

	recode_yr	neigh_1	carbon_2	sierra	renewable	PENM_tv_d	ctrl_2	GPA	edu	perin_s	popc_s	density
recode_yr	1											
neigh_1	0.4631868	1										
carbon_2	0.1007794	-0.00241	1									
sierra	-0.156495	0.0008513	-0.11024	1								
renewable	-0.086447	0.0476442	-0.25391	0.32301	1							
PENM_tv_d	-0.18449	0.0459169	-0.46018	0.53757	0.1800906	1						
ctrl_2	0.032123	0.1729181	-0.05802	0.08711	-0.009878	0.33483308	1					
GPA	0.0695346	0.0624825	0.047492	0.08309	0.0141407	0.08555899	0.0649716	1				
edu	-0.031941	0.0562599	-0.23736	0.07569	0.0338574	0.18845371	0.1263388	-0.01498	1			
perin_s	0.4304391	0.3698817	0.020236	0.37442	0.1223312	0.42760655	0.0972172	0.028235	0.0718088	1		
popc_s	-0.044169	-0.154141	-0.16881	0.14597	0.035007	0.09630395	-0.031833	-0.04516	-0.084076	0.0481073	1	
density	-0.040431	0.0946023	-0.29352	0.19938	0.0649311	0.65368269	0.2743813	-0.03619	0.1522761	0.5747078	0.03932	1

References:

Abramowitz, A.I., and K.L. Saunders "Ideological realignment in the US electorate." Journal of Politics (1998):634-52.

Agarwal, A., and S. Narain "The Global Commons and Environmental Justice--Climate Change. Environmental justice: discourse in international political economy. J. Byrne, L. Glover and C. Martinez. New Brunswick." New Jersey, Transaction Publishers 8 (2002):171-99.

Aldrich, J.H., and F.D. Nelson Linear probability, logit, and probit modelsSage Publications Inc, 1984.

Allison, P. "Logistic regression using sas?: theory and application." (1999):

Allison, P.D. Survival analysis using the SAS system: a practical guideSAS publishing, 1995.

Bakvis, H., L. Juillet, and Canada School of Public Service The horizontal challenge: Line departments, central agencies and leadershipCanada School of Public Service, 2004.

Banks, J.S., and B.R. Weingast "The political control of bureaucracies under asymmetric information." American Journal of Political Science (1992):509-24.

Beck, N., and J. Katz "The Analysis of Binary Time-Series--Cross-Section Data and the Democratic." (1997):

Beck, N., J.N. Katz, and R. Tucker "Taking time seriously: Time-series-cross-section analysis with a binary dependent variable." American Journal of Political Science (1998):1260-88.

———"Beyond ordinary logit: Taking time seriously in binary time-series-cross-section models." American Journal of Political Science 42 (1998):1260-88.

Bennett, S. “Know-nothings revisited: The meaning of political ignorance today.” Social Science Qimrfedy, 69 (1989): 47-90.

Bernstein, M.H. "The Jacksonians: A Study in Administrative History, 1829-1861." American Political Science Review 49 (1955):531-4.

———"Regulating business by independent commission." (1955):

Berry, F.S. "Sizing up state policy innovation research." Policy Studies Journal 22 (1994):442-56.

Berry, F.S., and W.D. Berry "Innovation and diffusion models in policy research." Theories of the policy process (1999):169-200.

———"Tax innovation in the states: Capitalizing on political opportunity." American Journal of Political Science (1992):715-42.

———"State lottery adoptions as policy innovations: An event history analysis." The American Political Science Review (1990):395-415.

Berry, W.D., E.J. Ringquist, R.C. Fording, and R.L. Hanson "Measuring citizen and government ideology in the American states, 1960-93." American Journal of Political Science (1998):327-48.

Binder, S.A., and S.S. Smith Politics or principle?: filibustering in the United States SenateBrookings Institution Press, 1997.

Boemke, F.J. "Getting the Odds Right: Casino Gaming Diffusion, the Initiative Process and Expected Voter Support." annual meetings of the Southern Political Science Association, Savannah (November) (1999):

Bosso, C.J. Pesticides and politics: The life cycle of a public issuePittsburgh, PA (EUA). University of Pittsburgh Press, 1987.

Bowman, A.O.M., and J.P. Lester "Hazardous waste management: State government activity or passivity." State and Local Government Review 17 (1985):155-61.

Box-Steffensmeier, J.M., and B.S. Jones "Time is of the essence: Event history models in political science." American Journal of Political Science (1997):1414-61.

Brown, R.D. "Party cleavages and welfare effort in the American states." American Political Science Review (1995):23-33.

Brown, S.R., and N.L. Olson "Innovative State Environmental Programs and Legislation, 1990–1992." (1992):

Carter, D.B., and C.S. Signorino "Back to the future: Modeling time dependence in binary data." University of Rochester (2007):

Chess, C. "Evaluating environmental public participation: Methodological questions." Journal of Environmental Planning and Management 43 (2000):769-84.

Cigler, A.J., and B.A. Loomis "Contemporary Interest Group Politics: More than ‘More of the Same’." Interest group politics 4 (1995):393-406.

Clark, C.F., M.J. Kotchen, and M.R. Moore "Internal and external influences on pro-environmental behavior: Participation in a green electricity program." Journal of Environmental Psychology 23 (2003):237-46.

Cox, D.R. “Partial likelihood.” Biometrika 62 (1975):269–76.

Cyert, R.M., and J.G. March "A behavioral theory ofthe firm." PrenticeHall, EnglewoodCliffs, NJ (1963):

Daley, D.M., and J.C. Garand "Horizontal diffusion, vertical diffusion, and internal pressure in state environmental policymaking, 1989-1998." American Politics Research 33 (2005):615.

Davis, A.J. "The Evolution of the Institution of Mothers' Pensions in the United States." American Journal of Sociology (1930):573-87.

Deyette, J., S.L. Clemmer, D.A. Donovan, and Union of Concerned Scientists Plugging in Renewable Energy: Grading the StatesUnion of Concerned Scientists, 2003.

Dobesova, K., J. Apt, and L.B. Lave "Are renewables portfolio standards cost-effective emission abatement policy?" Environ.Sci.Technol 39 (2005):8578-83.

Downs, A., and Rand Corporation Inside bureaucracyLittle, Brown Boston, 1967.

Dunlap, R.E. "Public opinion and environmental policy." Environmental politics and policy: Theories and evidence (1989):87–134.

Dye, T.R. American federalism: Competition among governmentsFree Press, 1990.

Elliot-Jones, M. "Social and demographic contributions to diminution of value: Additions to the economic analysis of the impact of contamination." Environmental Regulation and Permitting 7 (1997):49-53.

Elliott, E., B.J. Seldon, and J.L. Regens "Political and Economic Determinants of Individuals? Support for Environmental Spending." Journal of environmental management 51 (1997):15-27.

Engel, K.H. "Mitigating global climate change in the United States: a regional approach." New York University Environmental Law Journal 14 (2005):54.

Erikson, R.S., G.C. Wright Jr, and J.P. McIver "Political parties, public opinion, and state policy in the United States." The American Political Science Review (1989):729-50.

Eulau, H., and K. Prewitt Labyrinths of democracyBobbs-Merrill Indianapolis, 1973.

Evans, P.B., D. Rueschemeyer, and T. Skocpol Bringing the state back inCambridge Univ Pr, 1985.

Firth, D. "Bias reduction of maximum likelihood estimates." Biometrika 80 (1993):27-38.

Fischer, C., and R.G. Newell "Environmental and technology policies for climate mitigation." Journal of Environmental Economics and Management (2007):

Fischer, F. "Citizen participation and the democratization of policy expertise: From theoretical inquiry to practical cases." Policy Sciences 26 (1993):165-87.

Fisher, D.R. Bringing the Material Back In: Understanding the US Position on Climate ChangeSpringer, 2006.

Freeman, C. "The economics of innovation." IEE Proceedings A Physical Science, Measurement and Instrumentation, Management and Education, Reviews 132 (1985):213-21.

Glick, H.R., and S.P. Hays "Innovation and reinvention in state policymaking: Theory and the evolution of living will laws." The Journal of Politics (1991):835-50.

Gormley Jr, W.T. "Regulatory issue networks in a federal system." Polity (1986):595-620.

Gray, V. "Competition, emulation, and policy innovation." New perspectives on American politics (1994):230-48.

———"Innovation in the states: A diffusion study." The American Political Science Review (1973):1174-85.

Gray, V., and D. Lowery The population ecology of interest representation: Lobbying communities in the American states. University of Michigan Press, 1996.

Green, W.H. "Econometric Analysis (7 th)." (2007):

Hagerstrand, T. "Quantitative techniques for analysis of the spread of information and technology." Education and Economic Development, Chicago, Aldine (1965):

Hansen, S.B. “The Politics of Taxation: Revenue without Representation.” New York Praeger.

Hedge, D and M. Scicchitano, "Regulating in Time and Space: The Case of Regulatory Federalism," Journal of Politics (1994): 134-53.

Heinze, G., and M. Schemper "A solution to the problem of separation in logistic regression." Statistics in medicine 21 (2002):

Herring, P., and E.P. Herring Public administration and the public interest Russell & Russell, 1967.

Hird, J.A. "The political limits of environmental regulation: Tracking the Unicorn, by Bruce Yandle. New York: Quorum Books, 1989, 192 pp. Price:$ 39.95, cloth." Journal of Policy Analysis and Management 10 (1991):

Hoffman, A.J. Carbon strategies: How leading companies are reducing their climate change footprintUniversity of Michigan Press, 2007.

Holbrook-Provow, T.M., and S.C. Poe "Measuring state political ideology." American Politics Research 15 (1987):399.

Huang, M.Y., J.R.R. Alavalapati, D.R. Carter, and M.H. Langholtz "Is the choice of renewable portfolio standards random?" Energy Policy 35 (2007):5571-5.

Ingram, H., D. Colnic, D.E. Mann, and J.P. Lester "Environmental Politics and Policy: Theories and Evidence." (1995):

Jolly, C.L. "Four theories of population change and the environment." Population & Environment 16 (1994):61-90.

Kahneman, D., and A. Tversky "On the psychology of prediction." Psychological review 80 (1973):237-51.

Kalt, J.P., and M.A. Zupan "Capture and ideology in the economic theory of politics." The American Economic Review (1984):279-300.

Kamieniecki, S. Corporate America and environmental policy: how often does business get its way?Stanford Law and Politics, 2006.

Katz, E., M.L. Levin, and H. Hamilton "Traditions of Research on the Diffusion of Innovation." American Sociological Review (1963):237-52.

Key, V.O. Southern politics in state and nationAA Knopf, 1949.

Kiewiet, D.R., and M.D. McCubbins "Appropriations decisions as a bilateral bargaining game between president and Congress." Legislative Studies Quarterly (1985):181-201.

King, G., and L. Zeng "Logistic regression in rare events data." Political Analysis 9 (2001):137.

Kirchg?ssner, G., and F. Schneider "On the political economy of environmental policy." Public Choice 115 (2003):369-96.

Knittel, C.R., and O.S. Drive "The Adoption of State Electricity Regulation: The Role of Interest Groups." Journal of Industrial Economics 54 (2006):201-22.

Lamothe, S. "Testing the Sensitivity of Event History Analysis in Innovation Research." Presented at the annual meetings of the Southern Political Science Association, Atlanta (Octorber,1998).

Lester, J.P., and E.N. Lombard "Comparative Analysis of State Environmental Policy, The." Natural Resources Journal 30 (1990):301.

Levitt, S.D. "How do senators vote? Disentangling the role of voter preferences, party affiliation, and senator ideology." The American Economic Review (1996):425-41.

Lewis-Beck, M.S. "The relative importance of socioeconomic and political variables for public policy." The American Political Science Review (1977):559-66.

Light, A.R. "Intergovernmental sources of innovation in state administration." American Politics Research 6 (1978):147.

Lombard, E.N. "Determinants of state air-quality management: A comparative analysis." The American Review of Public Administration 23 (1993):57.

Lowry, W.R. The dimensions of federalism: State governments and pollution control policiesDuke University Press, 1992.

Lutsey, N., and D. Sperling "America's bottom-up climate change mitigation policy." Energy Policy (2007):

Lutz, F.W. "Reforming education in the 1980s." Peabody Journal of Education (1986):1-5.

Lutz, J.M. "Symbiosis in manufactures trade in East Asia." East Asia 5 (1986):3-18.

Lyon, T.P., H. Yin, and D. Building "Why Do States Adopt Renewable Portfolio Standards? An Empirical Investigation." Ann Arbor 1001 48109.

Maxwell, J.W., T.P. Lyon, and S.C. Hackett "Self-Regulation and Social Welfare: The Political Economy of Corporate Environmentalism, 583." (2000):

McKibbin, W.J., and P.J. Wilcoxen "Climate Change after Kyoto: A Bluepring for a Realistic Approach." The Brookings review (2002):6-10.

McVoy, E.C. "Patterns of diffusion in the United States." American Sociological Review (1940):219-27.

Medler, J.F. "Governors and environmental policy." Policy Studies Journal 17 (1989):895-908.

Menz, F.C. "Green electricity policies in the United States: case study." Energy Policy 33 (2005):2398-410.

Mills, C. "Wright: The Power Elite." New York (1956):

Mills, C.W., and A. Wolfe "The power elite." (1956):

Mintrom, M., and S. Vergari "Policy networks and innovation diffusion: The case of state education reforms." Journal of Politics (1998):126-48.

Moe, T.M. "The politics of bureaucratic structure." Can the government govern (1989):267–329.

Mooney, C.Z., and M.H. Lee "Legislative morality in the American states: The case of pre-Roe abortion regulation reform." American Journal of Political Science (1995):599-627.

Nash, C. "Developments in transport appraisal in Britain." Evaluation in Planning: Facing the Challenge of Complexity (1998):311.

Olson, M. The logic of collective action: Public goods and the theory of groupsHarvard Univ Pr, 1971.

Osborne, D. Laboratories of democracyHarvard Business School Press, 1988.

Peltzman, S. Regulation of Pharmaceutical Innovation: the 1962 Amendments: The 1962 AmendmentsAmerican Enterprise Institute for Public Policy Research, 1974.

Peterson, P.E., and M. Rom "American federalism, welfare policy, and residential choices." The American Political Science Review (1989):711-28.

Pierce, P.A., and D.E. Miller "Variations in the Diffusion of State Lottery Adoptions: How Revenue Dedication Changes Morality Politics [1]." Policy Studies Journal 27 (1999):

Posner, R.A. "Theories of economic regulation." The Bell Journal of Economics and Management Science (1974):335-58.

Potoski, M. "Clean Air Federalism: Do States Race to the Bottom?" Public administration review (2001):335-42.

Potoski, M., and N.D. Woods "Dimensions of State Environmental Policies: Air Pollution Regulation in the United States." Policy Studies Journal 30 (2002):208-27.

Rabe, B. "Race to the top: The expanding role of us state renewable portfolio standards." Sustainable Dev.L.& Pol'y 7 (2006):10.

Rabe, B.G. Statehouse and greenhouse: The emerging politics of American climate change policyBrookings Institution Press, 2004.

Rabe, B.G., and Brookings Institution Second Generation Climate Policies in the American States Proliferation, Diffusion, and RegionalizationBrookings Institution, 2006.

Ringquist, E.J. "Policy Influence and Policy Responsiveness in State Pollution Control." Policy Studies Journal 22 (1994):

———"Testing theories of state policy-making: The case of air quality regulation." American Politics Research 21 (1993):320.

———Environmental protection at the state level: Politics and progress in controlling pollutionME Sharpe, 1993.

———"Does regulation matter?: Evaluating the effects of state air pollution control programs." The Journal of Politics (1993):1022-45.

Rogers, E.M. Diffusion of innovationsFree Press, 1995.

Rose, G. Feminism and geography: The limits of geographical knowledgePolity P., 1993.

Salisbury, R.H. "The analysis of public policy: a search for theories and roles." Political science and public policy.Chicago: Markham (1968):151-78.

Sam, A., and R. Innes "Voluntary pollution reductions and the enforcement of environmental law: An empirical study of the 33." (2006):

Sapat, A. "Devolution and innovation: The adoption of state environmental policy innovations by administrative agencies." Public administration review 64 (2004):141-51.

Schattschneider, E.E. "The Semi-Sovereign People: A Realist's View of Democracy in America. New York: Holt, Rinehart and Winston." Links (1960):

Schneider, A., and H. Ingram Filling Empty Boxes: A Framework for the Comparative Analysis of Policy DesignsWestern Political Science Association meeting, San Francisco, 1988.

Schreckhise, W.D., and T.G. Shields "Ideological Realignment in the Contemporary US Electorate Revisited*." Social Science Quarterly 84 (2003):596-612.

Scicchitano, M.J., and D.M. Hedge. "From Coercion to Partnership in Federal Partial Preemption: SMCRA, RCRA, and OSH Act." The Journal of Federalism 23 (1963): 107- 121.

Sherrill, S. “Non-structural Measures of Competition: Toward a Synthesis of Alternatives” Economics Letters 12 (1983): 349-353.

Squire, P. "Measuring state legislative professionalism: the squire index revisited." State Politics and Policy Quarterly 7 (2007):211.

Stern, P.C., T. Dietz, T. Abel, G.A. Guagnano, and L. Kalof "A value-belief-norm theory of support for social movements: The case of environmentalism." Book Review Co-Editor International Editor Book Review Co-Editor 6 (1999):81.

Stigler, G.J. "The theory of economic regulation." The Bell journal of economics and management science (1971):3-21.

Stream, C. "Health reform in the states: a model of state small group health insurance market reforms." Political Research Quarterly 52 (1999):499.

Sutherland, E. "The Diffusion of Sexual Psychopath Laws." American Journal of Sociology 56 (1950):142–48.

Teske, P. "The New Role and Politics of State Regulation." Regulation 27 (2004):16-21.

Tiebout, C.M. "A pure theory of local expenditures." The journal of political economy 64 (1956):416.

Vachon, S., and F.C. Menz "The role of social, political, and economic interests in promoting state green electricity policies." Environmental Science and Policy 9 (2006):652-62.

Vietor, R.H.K. "The Synthetic Liquid Fuels Program: Energy Politics in the Truman Era." The Business History Review (1980):1-34.

Vogel, D. Trading up: Consumer and environmental regulation in a global economyHarvard University Press, 1995.

Walker, J.L. "The diffusion of innovations among the American states." The American Political Science Review (1969):880-99.

Weimer, D.L. "The current state of design craft: Borrowing, tinkering, and problem solving." Public administration review (1993):110-20.

Welch, E.W., A. Mazur, and S. Bretschneider "Voluntary behavior by electric utilities: Levels of adoption and contribution of the Climate Challenge Program to the reduction of carbon dioxide." Journal of Policy Analysis and Management (2000):407-25.

Williams, B.A., and A.R. Matheny "Testing theories of social regulation: Hazardous waste regulation in the American states." The Journal of Politics (1984):428-58.

Wright Jr, G.C., R.S. Erikson, and J.P. McIver "Public opinion and policy liberalism in the American states." American Journal of Political Science (1987):980-1001.

Yamaguchi, K. "Event-history analysis." The theory and method 2 (1987):61-82.

Yatchew, A., and Z. Griliches "Specification error in probit models." The review of economics and statistics (1985):134-9.

Zorn, C. "A solution to separation in binary response models." Political Analysis 13 (2005):157-70.