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Understanding public perceptions of global warming

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DEDICATION

To my husband, two sons, and parents

for their sacrifice, support, encouragement

and patience

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

In this dissertation, I investigate the determinants on Americans' perceptions of global warming and individuals' environmentally significant behaviors to reduce global warming. Specially, I examine how contextual variables, primarily represented by local weather and climate, attitudinal variables, and socio-demographic characteristics affect public opinion towards global warming, personal voluntary actions and willingness to address global warming.

The research of this dissertation reveals some important findings. First, local weather and climate—represented by long-term temperature trends—is found to have significant effects on public perceptions of global warming and private-sector environmentally significant behaviors. In particular, the summer temperature trend over the past 10 years has consistently shown to have positive effects on public acceptance of anthropogenic global warming and concern for global warming. In other words, individuals are most sensitive to summer temperature and more likely to translate increasingly hot summers into perceptions of anthropogenic global warming and their concern for this issue. Second, consistent with the results of previous studies, global warming has become a politically polarized issue. Specifically, Democrats and political liberals are more likely than Republicans and political conservatives to accept the notion of anthropogenic global warming, show higher level of concern for global warming, and participate in private-sector environmentally significant behaviors to reduce global warming. Third, attitudinal variables play an important role in affecting public perceptions of global warming and individuals' environmentally significant behaviors. For instance, personal attitudes toward scientists are found to be a strong group of predictors on public opinion toward global warming. In addition, attitudinal variables—including individuals' environmental views and perceptions of

global warming—outperform socio-demographic characteristics and contextual forces in explaining the variance of personal actions and public willingness to pay more to reduce global warming. Finally, objective macro-economic conditions, represented by county-level unemployment rate in this dissertation are not found to have any consistently significant effect on either public perceptions of global warming or individuals' environmentally significant behaviors.

CHAPTER 1 INTRODUCTION

Background

Despite decades of scientific research on climate change and global warming,[1] there was no universal public awareness of climate change until the "greenhouse summer of 1988"(Ungar 1992, p.483). This is when Americans experienced the most serious drought in about 50 years and 1987 was declared the hottest year on record (Ungar 1992). Meanwhile, in his testimony to the US Congress, NASA's scientist James Hansen made a radical claim that he was "'99 percent certain'" that the warmer temperatures were the result of fossil fuel consumption (Boykoff 2008). The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the United Nations Environment Program (UNEP) and World Meteorological Organization (WMO).

Against this backdrop, media coverage of global warming went on the upswing. The quantity of media coverage on global warming is on an upward trend, with small ebbs and flows throughout the years (Boykoff 2008). There are certain influential events that are associated with the pattern of media coverage of global warming. For instance, as Boykoff (2008) notes, the media heavily covered the 1992 UN Framework Convention on Climate Change, the 1997 Kyoto Protocol, the releases of IPCC Second and Third assessment reports in 1995 and 2001, Hurricane Katrina in 2005, and Al Gore's Movie "An Inconvenient Truth" in 2006. Given media coverage

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[1] Climate change is a technical term used in the scientific context. It refers to "any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer)." (EPA, dhttp://www.epa.gov/climatechange/glossary.html) In comparison, global warming refers to "an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns." (EPA, http://www.epa.gov/climatechange/glossary.html) These two terms basically refer to the same thing. Because global warming generates more visceral reactions, it is commonly used in mass media and most familiar to the public. The relevant questions in the surveys of which the data are used in this dissertation use the term "global warming." Even though climate change is more accurate, these two terms are used interchangeably in this dissertation since it investigates public attitudes.

of these events, the salience of climate in the minds of American public has no doubt increased over time.

Accordingly, public awareness of global warming has grown steadily over the past 20 years, from a low 39% of the population that had heard or read about the “greenhouse effect” in 1986 to a peak of 91% in 2006, according to a wide range of polls (Nisbet and Myers 2007). Unlike the steady growth of public awareness of global warming, public risk perceptions of this issue have been shown to fluctuate throughout the years. The CBS News and New York Times survey series include one item asking “Do you think global warming is an environmental problem that is causing a serious impact now, or do you think the impact of global warming won't happen until sometime in the future, or do you think global warming won't have a serious impact at all?” The trends in responses to this item are graphed in Figure 1.1. When CBS News and New York Times Survey asked this question in June 2001, the public was primarily divided between “impact now” and “impact in the future”. The public was then leaning towards “impact now” responses from 2003-2009. Meanwhile, the percentage of the public who do not think that global warming will have a serious impact has been growing steadily over the past 10 years until it arrived at its peak (49.32% in April, 2010). Further, the Pew Research Center for the People and the Press asks one question “In your view, is global warming a very serious problem, somewhat serious, not too serious, or not a problem?” in its surveys from 2006 to 2010.

Figure 1.2 demonstrates how the public concern of global warming changed during the time period. The similar pattern that Figure 1.1 and Figure 1.2 share is that the concern about global warming has decreased among the population since 2006, particularly in the most recent years.

In the meantime, as Figure 1.3 demonstrates, the national unemployment rate has grown immensely from 4.2 percent (January 2001) to 9.4 percent (December 2010) over the past 10 years, particularly since 2008. Accordingly, public concern once reserved for the environment has shifted to the economy. To the question, “Should strengthening the nation's economy be a top priority, important but lower priority, not too important, or should it not be done?” asked in the Pew surveys from January 2001 to January 2011, the percentage of the population who give the response “top priority” hit its lowest point (66%) in 2006, which roughly coincides with the low point of unemployment. The percentage of “top priority” responses has picked up and been steadily increasing since then (see Figure 1.4). On the other hand, as one can see from Figure 1.5

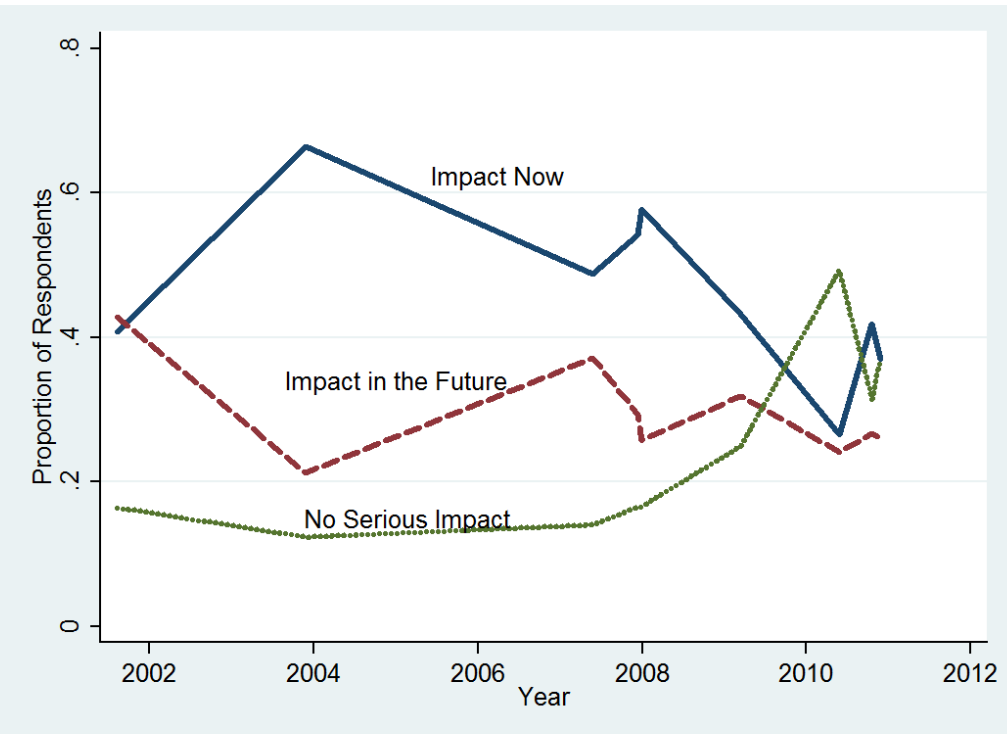

Figure 1.1 Public Perception of Global Warming Urgency, 2001-2010 (Data source: CBS Survey Series)

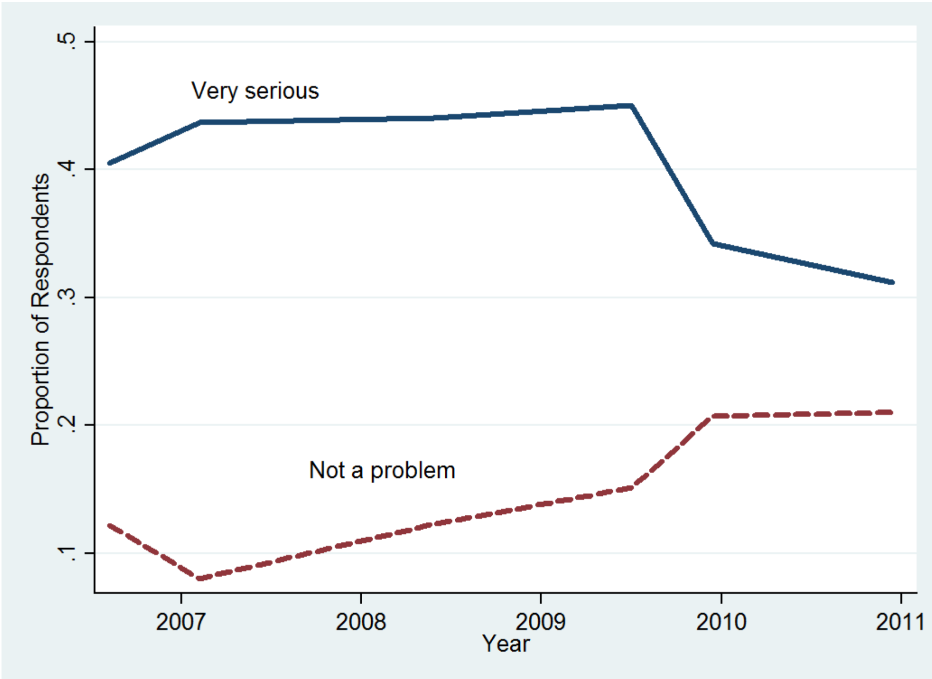

Figure 1.2 Public Perception of Global Warming Severity, 2001-2010 (Data source: Pew Research Center for the People and the Press)

the percentage of the population who respond that dealing with global warming is a priority has declined from its apex (38% in January 2007) to 26% (January 2011) as the economy worsens, according to the Pew surveys. Is it a coincidence that public concerns about global warming and the economy experience opposite patterns over the past 10 years?

The scientific community was originally conservative in its opinions about global warming. For instance, the United Nations Intergovernmental Panel on Climate Change (IPCC) reported that global warming *might* have very negative consequences for the world's ecosystems in 1992 (Krosnick, Holbrook and Visser 2000). But in 1995, the IPCC dramatically changed its judgment on this issue from being "uncertain" to "real"(Krosnick et al. 2000). In its most recent assessment report (Solomon et al. 2007), the IPCC used the word "unequivocal" to describe warming of the climate system, and further the IPCC chose the words "very likely" when attributing the temperature rise to human induction. IPCC is not the only authoritative organization that came to this conclusion. A "state of knowledge" report from the U.S. Global Change Research Program— *Global Climate Change Impacts in the United States*— shares the same sentiment; this report concludes that "global warming is unequivocal and primarily human-induced"(Karl 2009, p. 12) Oreskes (2004) analyzed 928 abstracts of articles published in peer-review scientific journals between 1993 and 2003 that are listed in the ISI database with the key words "climate change." She finds that 75% of these papers either explicitly or implicitly accept the consensus and, remarkably, none of them cast doubt on the consensus. On the other hand, the public is still divided on the existence and cause of global warming. According to the Pew General Public Science Survey (2009), the public is split over whether human activity is the cause of global warming, with 50.3% population attributing global warming to human activity and 37.3% population believing that global warming is due to natural changes. Furthermore, the majority of the public still thinks that there is a lot of disagreement among scientists about the causes of global warming (Nisbet and Myers 2007). Given these findings, it is clear that there is still a wide gap between scientific facts about global warming and public understanding of this issue.

As the bridge between the science community and the public, the mass media plays an indispensable role in delivering scientists' messages to the public. The description of scientific research and portrait of scientists by the mass media have direct impacts on public attitudes towards science and scientists as well as corresponding indirect effects on the perspectives toward scientific issues held by the mass public. One journalistic norm commonly expected in

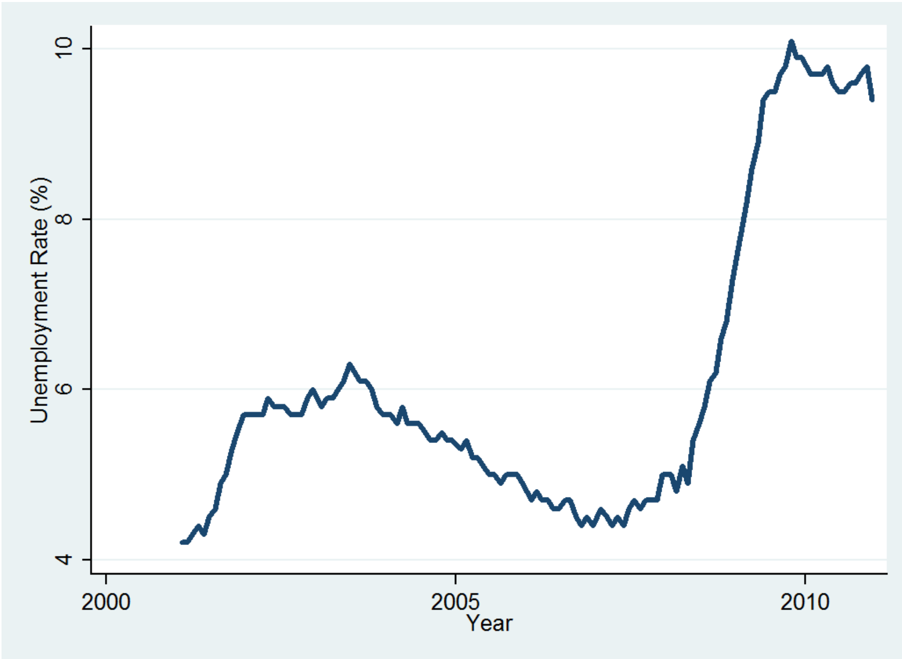

Figure 1.3 National Unemployment Rate, 2001-2010 (Data source: U.S. Bureau of Labor)

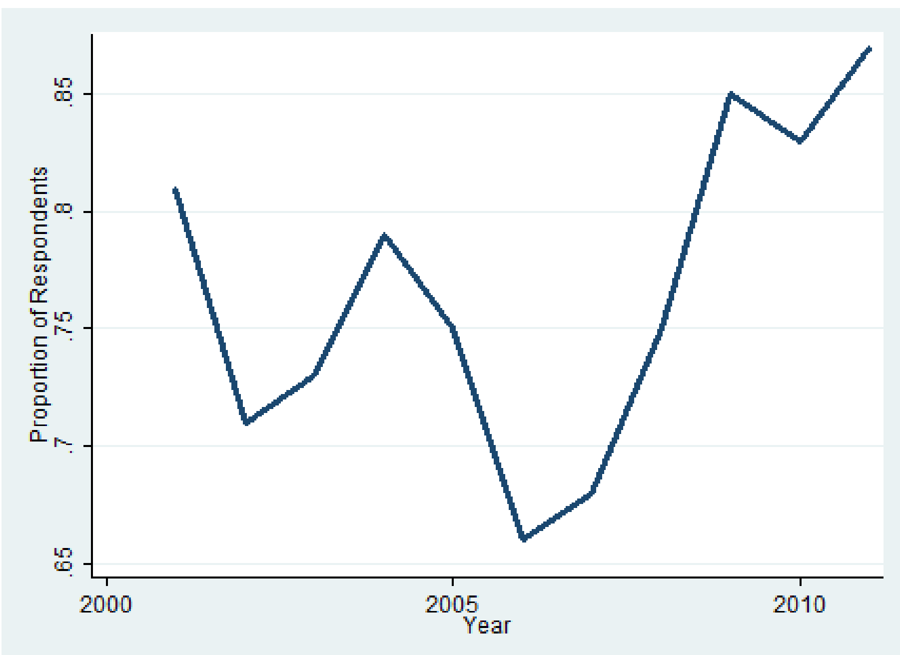

Figure 1.4 Percentage of Population who think "strenthening the nation's economy should be the top priority", 2001-2011(Data source: Pew Research Center for the People & the Press).

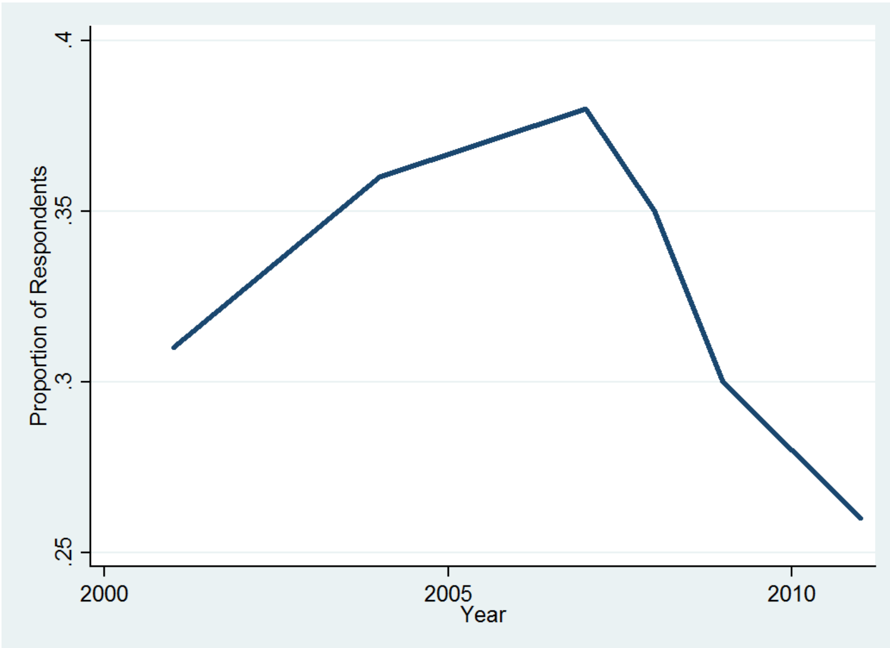

Figure 1.5 Proportion of population who think “dealing with global warming should be top priority”, 2001, 2004, 2007, 2008, 2009, 2010, and 2011 (Data source: Pew Research Center for the People & the Press)

media coverage about science issues is balance, thereby giving equal time to experts on both sides of the debate. However, some scholars suggest that balance in reporting about anthropogenic contribution to global warming has actually created bias because balance suggests that the scientific community is evenly split on the issue, when in reality it is not (Boykoff and Boykoff 2004). In other words, interviewing one of the main stream scientists and one contrarian creates the inaccurate perception of equal division in the minds of the public. Some recent headline stories in the mass media were believed to have an adverse impact on public trust in climate science and scientists. The coverage of “Climategate”(Revkin 2009), IPCC’s careless overestimate of the Himalaya glacier melting rate(Rothensa 2010), and its inaccurate information about the Netherlands (PBL) all raised public skepticism of climate science and scientists. Trust in scientists is found to be an important moderating force on public opinion towards global warming. Among individuals who trust scientists, more self-reported knowledge about global warming leads to higher level of concern for this issue. Whereas, more self-reported knowledge does not translate into higher level of concern among people who do not trust scientists (Malka, Krosnick and Langer 2009). Likewise, Krosnick et al. (2006)find that television exposure is positively associated with belief in the existence of global warming only among individuals who have high level of education and show more trust in scientists.

Meanwhile, the cold winter in the northern hemisphere in 2009-2010 happened to provide great support for global warming skeptics (Economist 2010). As such, the public has become uneasy about the notion of global warming. On the other hand, a more recent poll finds that a large majority of Americans attribute weather extremes in recent years such as unusually warm winter, above normal hot summer and some other weather disasters to global warming (Leiserowitz 2012). In the literature, a few studies investigated the effect of local weather and climate on public perception of climate change (Brody et al. 2008, Egan and Mullin 2012, Hamilton and Keim 2009, Krosnick et al. 2006). Specifically, self-stated personal experience of temperature trends in recent years exerts positive effects on the perceptions of global warming(Krosnick et al. 2006). Winter warming trends over the past 40 years is positively correlated with public perception of local climate change (Hamilton and Keim 2009). Individuals consider recent weather fluctuations as evidence of global warming (Egan and Mullin 2012). However, one study shows that temperature trends are not related to climate change risk perception (Brody et al. 2008).

Following the environmental orientation of the Republican Party since the Reagan administration, global warming has become a politically polarized issue with a widening gap between Republicans and Democrats (Dunlap and McCright 2008). Multiple studies find that Republicans and conservatives are more likely to be skeptical of anthropogenic global warming than Democrats and liberals, and therefore express lower levels of concern about global warming than Democrats and liberals (McCright and Dunlap 2011b, Dunlap and McCright 2008, Pew 2006, Pew 2007, Gallup 2008, Gallup 2012).

According to many scientists, the impact of global warming is large-scale and profound. The areas that will be affected by global warming include but are not limited to fresh water resources, ecosystems, food, coastal systems, low-lying areas, settlements, and human health (Parry et al. 2007). To meet this unprecedented challenge facing the entire human society, environmentalists and many scientists suggest that we need to take immediate and comprehensive measures. However, no international agreement on curbing the emission of greenhouse gases has been accomplished. As one of the biggest contributors of carbon dioxide on earth, the United States has not yet passed a national comprehensive legislature to deal with global warming. While some scientists have started to take technological approaches (i.e., geo-engineering) to mitigating the effects of global warming, nearly all scientists agree that the best solution is to reduce the emission of carbon dioxide (Specter 2012). To reduce the emission of carbon dioxide requires strict regulation on the emission of carbon dioxide and individuals' behavior change.

The public has been shown to be an essential force in driving policy (Page and Shapiro 1983). In the realm of environmental planning and policy, the public has brought more influence on policy outcomes (Peacock, Brody and Highfield 2005). Attitudinal factors are one important type of causal variables that predict environmental behaviors (Stern 2000).General environmental beliefs and risk perceptions of climate change in particular are found to have significant effects on the public behavior intentions (O'Connor, Bord and Fisher 1999). Hence it is important for scholars to develop an understanding of the determinants of public attitudes towards global warming and public environmentally significant behaviors to address this issue.

Research Questions

In this dissertation, I attempt to provide answers to the following questions:

(1). What are the determinants of public opinion about the existence and cause of global warming? Specifically, which factors have strong effects from among socio-demographic characteristics, predisposition and attitudinal variables, and local weather and climate?

(2). How do local weather and climate, and objective economic condition affect public risk perceptions of global warming over the past decade (2001-2010)? Specifically, do long-term climate trends or short-term weather fluctuations affect public risk perceptions more? Does the public show lower level of concern for global warming when unemployment rate rises?

(3). What are the determinants of individuals' environmentally significant behaviors? Which factors account for more explanatory power predicting environmentally significant behaviors, from among attitudinal variables, personal capability, and geographic factors?

Plan of Dissertation

In this dissertation, I investigate how attitudinal variables, socio-economic characteristics, geographic factors such as local weather and climate, and economic conditions affect American public opinion towards global warming, personal voluntary actions, and willingness to address global warming. Specifically, this dissertation consists of three sections, each of which represents a paper that is being prepared as a journal article. A complete list of references is included at the end of this dissertation. The first two papers focus on public opinion towards global warming, and the third one addresses the determinants of public voluntary behaviors and willingness to address the issue of global warming. Combined, these papers are the first in-depth studies investigating the effects of long-term climate trends and short-term weather fluctuations on public opinion towards global warming and individuals' environmentally significant behaviors.

Chapter 2 provides a literature review on public risk perceptions of global warming and environmentally significant behaviors to address global warming. Specifically, I first examine the three major streams of literature on determinants of public perceptions of global warming: socio-demographic characteristics, predisposition and attitudinal variables, and geographic factors. I then explore studies examining effects of attitudinal variables, personal capability, and geographic factors on individuals' environmentally significant behaviors.

In Chapter 3, I examine how local weather and climate, personal attitudes toward science and scientists, and socio-demographic characteristics affect public perceptions of the existence and cause of global warming. The results show that two local weather measures–summer and spring seasonal temperature trends over the past 10 years–have significant effects on what individuals' perceive about the existence and causes of global warming. In addition, personal attitudes towards scientists play an important role shaping public opinion towards global warming.

In Chapter 4, I investigate how socio-demographic characteristics (as the individual-level independent variables), and local weather and climate and unemployment rate as (the contextual independent variables) affect public risk perceptions of global warming over the past 10 years (2001-2010). Compiling two series of national survey data sets from 2001-2010 expands the temporal scale of this analysis. This study is the first to systematically examine the effects of physical context (local weather and climate) and socio-economic context (unemployment rate) on public risk perceptions of global warming over a relatively long period of time. Party identification and political ideology, as well as other socio-demographic characteristics, consistently show strong effects on public risk perceptions of global warming throughout years. Summer temperature trends over the past 10 years are found to be the most consistently significant predictor of public risk perceptions of global warming. The objective economic condition—represented by county unemployment rate over the month prior to the interview date—is not found to have significant effects on public risk perceptions of global warming.

In Chapter 5, I investigate the effects of general attitudes towards environment, risk perception of global warming, local weather and climate, the monthly county unemployment rate with socio-demographic variables on individual voluntary behaviors and willingness to address global warming. Attitudinal variables are found to outperform socio-demographic characteristics and contextual forces in explaining either individual voluntary behaviors or willingness to address global warming.

The final chapter (Chapter 6) provides an overall interpretation of the dissertation results. It also outlines the significance and contribution of the research presented here to other programs.

Data

The data used in this dissertation come from multiple sources. The survey data come from two primary sources: Pew Research Center for the People and the Press Polls and CBS News/New York Times Polls. I search particular survey questions relevant to global warming at the Roper Center for Public Opinion Research (http://www.ropercenter.uconn.edu/) and identify surveys that include survey questions I am interested in. Because the Roper Center does not provide geocode information for each survey respondent, I then proceed to the original places that store the survey datasets. I download the CBS News/New York Times Polls from the website of Inter-university Consortium for Political and Social Research (ICPSR) (http://www.icpsr.umich.edu/icpsrweb/ICPSR/). The ICPSR provides state and county fips codes for the CBS/New York Times Polls. I download the Pew Polls from the Pew Research Center for the People and the Press (http://www.people-press.org/). The Pew Research Center provides zip codes for each respondent in the survey datasets. For reasons of confidentiality, the Pew Research Center strips out geo information that could potentially be identifiable in combination with other info (phone exchanges, zip codes, etc.) from surveys conducted after late 2009. However, the Pew Research Center makes the geographic information available for individual researchers who agree to respect the confidentiality issues. To obtain the two survey datasets with zip codes, which are October 2009 Political Survey (October 1, 2009) and October 2010 Political Survey (October 13, 2010), I had to sign Pew Research Center Special Dataset Use Agreement.

The climate data come from the United States Historical Climatology Network (USHCN). The USHCN provides “a high-quality data set of daily and monthly records of basic meteorological variables from 1218 observing stations across the 48 contiguous United States" (USHCN, http://cdiac.ornl.gov/epubs/ndp/ushcn/background.html). I extract monthly-averaged mean temperature and monthly total precipitation data from the USHCN. As for the county monthly unemployment rate data, I purchased it from the U.S. Bureau of Labor. The data of state carbon dioxide emissions from fossil fuel combustion comes from the U.S. Environmental Protection Agency (http://www.epa.gov/statelocalclimate/resources/state_energyco2inv.html).

To merge the survey data with climate data, I first use spatial join in ArcMap to identify the USHCN weather station that is located closest to each survey respondent represented by the centroid of the Zip Code Tabulation Area (for Pew survey data sets) or the county (for CBS/New York Times survey data sets), in which an individual resides. I then attach climate data associated with the weather stations to each respondent. The average distance from a Zip Code Tabulation Area to its closest USHCN weather station in the contiguous U.S. is approximately 20 miles. The standard deviation of the distance is around 12 miles. The average distance from a fips county to its associated USHCN weather station is around 22 miles. The standard deviation of the distance is approximately 14 miles.

CHAPTER 2 LITERATURE REVIEW

Public Opinion towards Global Warming

In the growing body of studies on public opinion towards global warming or climate change, there are three major streams of research that comprise the efforts to explain variation in the views of the public on global warming. These three research streams are: socio-demographic effects, cognitive effects, and geographic effects. I will discuss these three main theories in detail.

Socio-demographic Effects

The social bases of environmental concern have been widely studied in the social sciences. The effects of social characteristics such as gender, age, race, education, and income on environmental perceptions have been studied extensively over the past three decades (Vanliere and Dunlap 1980, Jones and Dunlap 1992, Dietz, Stern and Guagnano 1998). In the special case of public perception of climate change, there are a large number of studies identifying socio-demographic factors as possible influences on public attitudes toward climate change (Dietz, Dan and Shwom 2007, Dunlap and McCright 2008, Hamilton and Keim 2009, Krosnick et al. 2006, Leiserowitz 2006, McCright and Dunlap 2011b, McCright and Dunlap 2011a, McCright 2009). These studies altogether depict an unclear picture of the effects of these socio-demographic variables on public opinion toward climate change. First, scholars have explored the effects of race and gender on risk perception. The “white male effect” has been well documented in the social science literature (Finucane et al. 2000, Marshall 2004).This notion suggests that white people and males tend to judge risks at a lower level than non-whites and females. Research on racial differences on risk perception links greater concern for the environment among racial minorities to the excessive burden of environmental distress (Mohai and Bryant 1998). As for gender differentiation, scholars attribute it to the different roles that men and women play in society (Davidson and Freudenburg 1996). Specifically, women show higher level of concern for the environment and health risks because they are generally nurturers and care providers. On the other hand, men are more involved with economic activities and with industry, and therefore take into consideration economical tradeoffs when judging environmental risks. Even for women who are involved in economic activities and industry, they continue to assume major household responsibilities and contribute more time than men to their families (Hochschild 1989). In the special study area of concern for climate change, "white male effects" appear to be unstable across studies. Racial minorities and females are found to have higher levels of public concern about climate change (Leiserowitz 2006, Malka et al. 2009, McCright and Dunlap 2011a),while white males surprisingly show more concern for climate change in one study(Kellstedt, Zahran and Vedlitz 2008).

Education, income and other variables relating to social class have been usually hypothesized to be positively associated with environmental concern, indicating that individuals with higher education and income should show more concern for the environment (Vanliere and Dunlap 1980). According to the hierarchy of human needs based on the theory of Maslow (1943), the basic material needs (i.e., food, shelter, and economic stability) have to be satisfied before men pay attention to the luxury needs such as arts and environmental quality (Vanliere and Dunlap 1980). Therefore, individuals associated with higher social class tend to show more concern for the environment than those who are still struggling to have their basic needs met. However, there is a lack of evidence to support strongly the assertion that the associations between education and income, on one hand, and concern for climate change, on the other, are simply positive. Some studies (Brody et al. 2008, Kellstedt et al. 2008) demonstrate that there is no significant relationship between education/income and concern for climate change. Others have found that individuals with higher education attainment show lower level of concern for global warming (Malka et al. 2009, McCright and Dunlap 2011b). Hamilton (2008) shows that education is positively associated with public concern for polar results of global warming. Some studies (Hamilton and Keim 2009, McCright and Dunlap 2011b) find income has negative effects on the risk perception of climate change. Finally, Hamilton (2008) finds that people with higher income are more likely to show concern for sea level and melting ice caps— two important indicators of global warming.

Age is usually found to be a strong negative predictor on environmental concern (Vanliere and Dunlap 1980). However, age is not always included in the models of public attitudes towards climate change. Among those studies that do take age into consideration, the effect of age on global warming attitudes is not consistent. Age has negative effects on climate change in some studies (Kellstedt et al. 2008, Krosnick et al. 2006, Malka et al. 2009, McCright and Dunlap 2011b). However, Hamilton and Keim (2009) do not find a significant effect of age on public risk perception of climate change.

Predispositions and Attitudes

As early suggested by Van Liere and Dunlap (1980), cognitive determinants of environmental perception should be included in studies of environmental concern, since demographic variables have limited power explaining variation of environmental views. Dietz et al. (1998) found the social psychological variables, including attitudes, beliefs, and worldviews have more substantial effects on environmental concern.

As (Zaller 1992, p.6) wrote, in *The Nature and Origin of Mass Opinion*,

> "Every opinion is a marriage of information and predisposition: information to form a mental picture of the given issue, and predisposition to motivate some conclusion about it."

I consider here the former part of the quote that determines public opinion: information. Because the scale of global warming goes beyond personal experience, public knowledge and exposure to information is mainly reliant on a variety of information sources. As Zaller (1992)suggests, these information sources include elite discourses from politicians, higher-level government officials, journalists, some activists, and many kinds of experts and policy specialists. Scientists were the major information source when global warming started to arise as a scientific problem. However, more players such as politicians, economists, and interest groups participate in the policy debate as global warming evolved into a social problem (McCright and Dunlap 2000).The conservative movement that challenges global warming as a problem has garnered attention and produced effects that undermine the scientific consensus (McCright and Dunlap 2000). Meanwhile, the mass media, taking the major role of an interface of science and policy, mediates a social relationship among scientists, policy makers and the public (Boykoff 2008). Through the process of translation, the mass media intentionally or unintentionally presents global warming a complex issue to the public. The mass media's pursuit of being "objective" by employing "dueling scientists" to cover both sides actually exaggerates the degree of scientific disagreement on global warming(Dunlap 1998). Boykoff and Boykoff (2004) find that the norm of "balance" commonly adopted by journalists has transformed global warming from being a highly certain scientific topic to a controversial social issue. High scientific uncertainty of this issue has been constructed to be salient by the media (Boykoff 2008), through "various, sometimes unintentional, processes, including representation of controversy, new research topics, and an expanding problem domain" (Zehr 2000, p.98).

Meanwhile, the disconnection between the science community and the public about the reality of global warming also lies in two different ways to perceive risks. In his influential article on risk perception, Slovic (1987, p.280) begins by stating that, "the ability to sense and avoid harmful environmental conditions is necessary for the survival of all living organisms." Most animals make decisions out of visceral reaction rooted in their instincts when facing risks. The activation of strong feelings involves the paleo-cortical brain structures found in all vertebrates (Marx et al. 2007). Since humans have additional capability, there are two different ways for humans to make decisions when encountering risks: personal experience and statistical description (Weber 2006). Analytic and experiential processing systems work together. However, "personal experience and vivid descriptions are often favored over statistical information" (Marx et al. 2007). Decades of research on individuals' perceptions of risk demonstrates that risk consists of two basic components: unknown and dread characteristics. The mass public locates its perceptions of a particular risk on the coordinate depicted in Slovic (1987, p. 282). Experts and professionals, who have been trained for years to process particular information in an analytic way, "appear to see riskiness as synonymous with expected annual mortality" (Slovic 1987, p. 283). In the particular case of climate change, climate scientists— by virtue of education and professional training— arrive at conclusion on climate change based on systematical analysis of a large amount of objective data. In contrast, members of the public are more likely to rely on their personal daily life experiences to make judgments on climate change. Here, several important dichotomies arise, including climate vs. weather, global vs. local, and scientific data vs. memory. Thus, the distinction of judgments on climate change between scientists and the public can be partly attributed to these dichotomies existing between these two groups of people.

The reliance on elite discourse raises two issues: attention and trust (Weber 2010b). Zaller (1992, 42) illustrates the possible effects of attention in his Reception Axiom:

> "The greater a person's level of cognitive engagement with an issue, the more likely he or she is to be exposed to and comprehend – in a word, to receive – political messages concerning that issue."

By "cognitive engagement", Zaller here means "political attentiveness" or "political awareness." This assertion demonstrates that the reception of political messages about one issue for one individual is positively associated with his or her attention to that issue. To capture this concept of cognitive engagement, scholars use different measurements. Some are more direct and objective, such as assigning respondents the score of engagement based on the test of their knowledge, and some are more indirect and subjective, such as asking respondents to self-reflect how much attention they give to global warming. For instance, (Malka et al. 2009, p.637)measure *knowledge volume* by asking the survey question: "How much do you feel you know about global warming—a lot, a moderate amount, a little, or nothing?" Kellstedt *et al.* (2008, p.118) measure information by asking respondents "how informed do you consider yourself to be about global warming and climate change?" (Wood and Vedlitz 2007, p.560) measure attention to the issue of global warming on a scale from 1 to 5, by asking respondents to react to the following statement: "I often stop and think about Global Warming and Climate Change." They also include another variable called Global Warming IQ to capture how informed individuals are about the science of global warming based on three global warming science questions. In all, these studies come to different conclusions on how cognitive engagement with global warming affects public concern for this issue. Kellstedt et al. (2008) find that the level of information about global warming is negatively associated with concern about this issue. In contrast, Wood and Vedlitz (2005) find that respondents who score higher on Global Warming IQ and are more attentive to global warming have higher levels of concern about this issue. Trust and confidence in these information sources comes into play as an important moderating force (Malka et al. 2009). The more knowledge individuals claim to have about global warming, the more concerned they are with this issue, and they are among those who trust scientists. However, among people who do not trust scientists, more self-reported knowledge about global warming does not lead to higher level of concern.

I now turn to the second component suggested by Zaller (1992) that affects opinion: predispositions and attitudes. Predispositions, which include ideology, world views, values, and knowledge, serve as a filter when individuals process information from the outside world. As for the effect of political predispositions, Zaller (1992) demonstrates how individuals form their opinions on a particular political/social issue through the Receive-Accept-Sample mechanism. The second axiom in this RAS model refers to resistance:

> "People tend to resist arguments that are inconsistent with their political predispositions, but they do so only to the extent that they possess the contextual information necessary to perceive a relationship between the message and their predispositions" (Zaller 1992, p. 44).

In addition, social psychologists demonstrate how group influence such as political party positions has significant effects on attitude changes among the public (Cohen 2003). Members within one social group tend to assume that other members share common goals, social values and identities, and they thus view the judgments of group representatives and leaders on issues as diagnostic (Cohen 2003). Party elites sort information and provide political cues to the voters (Fiorina and Abrams 2008, Layman, Carsey and Horowitz 2006). The so-called group influence is clearly illustrated in the Fall 1997 debate about global warming, which exposed the public to competing party positions on the issue and persuaded Democrats to endorse the Clinton administrations and Republicans to define their own policy preferences (Krosnick et al. 2000). The significant role that political and ideological predispositions play in determining the belief by individuals in the existence of global warming and its causes has been well documented. The implication of accepting anthropogenic global warming is multi-faceted, but mostly it requires effective government regulation on the emission of carbon dioxide. American conservatives, in contrast to liberals, favor individual freedom and private property rights over collective rights, as well as the free market over governmental intervention (McCright and Dunlap 2011). Thanks to the discrepancy in their respective pursuing ideals, conservatives and liberals are divided on the issue of global warming. Republicans and conservatives are more likely to be skeptical of anthropogenic global warming than Democrats and liberals, and therefore show lower level of concern about global warming than Democrats and liberals (Dunlap and McCright 2008, Gallup 2008, McCright and Dunlap 2011b, Pew 2006, Pew 2007).

Even more interestingly, education has strikingly different effects on risk perception of global warming among Democrats and Republicans (McCright and Dunlap 2011; Hamilton 2010; Hamilton and Keim 2009; Pew Research Center 2007). While concerns about global warming increase with education among Democrats, such concerns decrease with education among Republicans (McCright and Dunlap 2011b, Hamilton 2011, Hamilton and Keim 2009).

Other psychological determinants have been increasingly included in the models of public opinion toward global warming. For instance, Leiserowitz (2006) investigates the role of affect, imagery, and values in public climate change risk perception and finds that these three factors overwhelm traditional demographic variables in explaining public risk perception and policy support of global warming. Drawing on a century of work in psychology, Krosnick et al. (2006) adopt the ACE model and define the significant effect of beliefs on public concern for global warming. Knowledge has been found to be an important factor on public opinion toward climate change. Malka et al. (2009) demonstrate that the interaction between knowledge and party identification has significant effects on concern for climate change. McCright and Dunlap (2011) find that the effects of self-reported understanding of global warming on beliefs about climate science and concern about global warming vary across the spectrum of political ideology and party identification.

Geography

The third major stream of literature concerns the role of geography in determining public attitudes towards climate change. Environmental views have been found to vary from place to place (Hamilton, Colocousis and Duncan 2010). For example, residents in rural counties with growing population more often favor environmental restriction, and those in counties with low unemployment favor conserving resources over using them to create jobs (Hamilton et al. 2010).

When many scholars are focused on revealing the effects of social and psychological factors on environmental views, some scholars have started to apply sophisticated research tools such as Geographic Information Systems (GIS) to explore relationships between geography and environmental perception. For instance, Peacock et al. (2005) find that location within expertdefined high hurricane wind risk areas raises the awareness of risk. Location-based factors such as sense of place, neighborhood settings, and sources of pollution seem to have significant effects on air quality perceptions in Houston and Dallas, TX (Brody, Peck and Highfield 2004). Proximity to two creeks in San Antonio affects residents' knowledge and perception of the water bodies and the level of water pollution in them(Brody, Highfield and Alston 2004).

In the particular case of perceptions of climate change, Brody et al. (2008) include a more comprehensive set of geographic variables such as distance to coastline, elevation, and proximity to sea level rise in their model of climate change perceptions, and they conclude that the relationship between real risk and perceived risk relies on specific physical experiences.

The effects of local weather and climate have been estimated in several studies. Self-reported local weather (Krosnick et al. 2006), personal observation of local weather (Borick and Rabe 2010), short-term weather fluctuation (Egan and Mullin 2012), long-term (1970-2007) winter temperature trend (Hamilton and Keim 2009) have all been found to have significant effects on public perception of global warming. Hamilton and Keim (2009) even find an interesting geographic pattern, in which the effect of winter warming on perceiving climate change is most prominent in snow country.

Environmentally Significant Behaviors

First, what is environmentally significant behavior? According to Stern (2000, p.408), the definition of environmentally significant behavior should be based on its impact—i.e., "the extent to which it changes the availability of materials or energy from environment or alters the structure and dynamics of ecosystem or the biosphere itself." Stern (2000, p.421) lists three major types of environmentally significant behaviors. These include: (1) *environmental activism,* such as getting involved in environmental organizations; *(2) nonactivist behaviors in the public sphere,* such as environmental citizenship and policy support; *and (3). private-sphere environmentalism,* such as consumer purchase behaviors, maintenance of household equipment, changes in equipment use and lifestyle, and waste disposal behaviors. Those decisions and choices made through individuals' careers are categorized under *other environmentally significant behaviors*.

Stern (2000) attributes environmentally significant behaviors to four types of causal variables: *attitudinal factor*, *contextual forces, personal capabilities,* and *habit or routine.* In this dissertation, I only include representatives from the former three types of independent variables.

Attitudinal Variables

Attitudinal variables include "norms, beliefs, and values" (Stern 2000, p.416). Scholars have found that individual values such as self-transcendence and openness to change have positive effects on pro-environmental behaviors, while values such as self-enhancement and conservation have negative influences on pro-environmental behaviors (Karp 1996). Similarly, Leiserowitz (2006)finds that personal values have noticeable effects on American risk perception and policy support for climate change, with egalitarianism being associated with support for national policies and individualism and hierarchism being associated with opposition of the policies.

General environmental beliefs are found to be strong predictors of environmental behavior intentions (O'Connor et al. 1999). Belief in the national seriousness of global warming also leads to support for policies to reduce global warming (Krosnick et al. 2006). The level of concern with global warming is found to be an important indicator of climate- relevant behavior change (Semenza et al. 2008). Greater concern for global warming is associated with climate-relevant environmental action (Jaeger et al. 1993). Furthermore, trust in environmentalists, distrust in industry, and recognition of consequences of global warming have positive effects on the support of climate change relevant policies (Dietz et al. 2007).

Contextual Forces

Contextual forces include "interpersonal influences…government regulations; other legal and institutional factors… and various features of the broad social, economic, and political context" (Stern 2000, 417). Objective economic conditions have a positive effect on public support for environmental spending (Elliott, Regens and Seldon 1995, Elliott, Seldon and Regens 1997). Cultural rules and social networks are positively associated with climate relevant environmental action (Jaeger et al. 1993). In addition to social, economic, and political context, some studies include physical contextual variables. For instance, Zahran et al. (2006)examine the association between natural hazard casualties, sea-level rise risk, carbon dioxide emissions, and temperature trend, on the one hand, and climate change policy support. They find that these physical contextual forces are stronger predictors of policy support than social contextual variables. Likewise, physical vulnerabilities to climate change significantly increase the likelihood that a locality commits to climate change policy (Zahran et al. 2008).

Personal Capabilities

Personal capabilities refer to "literacy, social status, financial resources, and behavior-specific knowledge and skills" (Stern 2000, 421). Socio-demographic variables are usually used as proxy variables for these personal capabilities. Women are found to be more likely to get involved in daily activities to reduce the effects of global warming, but less likely to support policies to address global warming (O'Connor *et al.* 1999). To the contrary, some studies find that women are more likely than men to support national policies on global warming (Leiserowitz 2006; Zahran *et al.* 2006). Women are also more likely to support more public environmental spending (Elliott *et al.* 1997).

For the effect of age on environmental behaviors, the literature provides an unclear picture. Older people are more likely to vote for governmental interventions to address global warming (O'Connor *et al*. 1999); however, they are less likely than young people to take voluntary mitigation actions (Semenza *et al*. 2008). Meanwhile, Jaeger et al. (1993) find that older cohorts, compared to younger ones, tend to take action to combat climate change.

As for the effects of education and income, previous studies show that these two variables have consistent positive effects on environmental behaviors. Individuals with higher level of education are more likely to favor public policies that require public sacrifice to reduce the effects of global warming (O'Connor *et al*. 1999; Zahran *et al*. 2006), to support more public environmental spending (Elliott *et al*. 1997), to back tax policies (Leiserowitz 2006), and to take voluntary action to address the issue of global warming (Jaeger et al. 1993; Semenza *et al*. 2008). Income is also found in some studies to be a significant predictor of public support for expanding environmental spending in general (Elliott *et al*. 1997), and for climate change policy in particular (Dietz et al. 2007). As individuals' incomes increase, they are more likely to support climate change policy and environmental spending. These findings resonate with the theory of human motivations (Maslow 1943). Human beings tend to satisfy their basic needs such as food, shelter, and safety before they turn their attention to aesthetical needs such as environmental quality and appreciation for arts.

Racial minorities are often found to be more likely to support environmental policies, since they are more exposed to degraded environment. For instance, non-whites tend to support more environmental spending (Elliott *et al*. 1997), to favor higher taxes to mitigate global warming (Leiserowitz 2006), and to endorse climate change policies (Dietz *et al*. 2007).

Not many studies include party identification and political ideology in their models predicting environmental significant behaviors. But those studies that have these two variables find that being Democrats and liberals increases the likelihood that one supports environmental policies (Dietz *et al*. 2007; Elliott *et al*. 1997; Leiserowitz 2006).

These three types of independent variables have different effects on environmental significant behaviors. Jaeger *et al*. (1993) suggest that cultural rules and social networks, compared to knowledge and concern about climate change, and socio-demographic variables such as gender, age, and education, are stronger predictors of climate relevant environmental actions. Zaharan *et al*. (2006) conclude that risk perception outperforms physical vulnerability in explaining climate policy support.

To sum up, the literature provides that the foundation of perceptions of global warming mainly comes from three sources: socio-demographic characteristics, attitudes and predispositions, and geographic factors. Likewise, attitudinal variables, personal capabilities—socio-demographic variables are usually used as proxies—, and contextual forces—geographic factors—constitute the three primary causal variables predicting environmentally significant behaviors to reduce the effects of global warming.

CHAPTER 3 SCIENCE, SCIENTISTS, AND WEATHER AND CLIMATE: FACTORS THAT INFLUENCE PUBLIC OPINION OF GLOBAL WARMING

Introduction

The scientific evidence of anthropogenic global warming is mounting (Oreskes 2004). The public is still uncertain of the cause of global warming, as shown in the Pew 2009 General Public Science Survey (Table 3.1). Meanwhile, the majority of the public believes that there is no scientific consensus on the existence and cause of global warming (Nisbet and Myers 2007, see Tables 3.2 and 3.3). According to Table 1, the public is evenly split over whether human activity is the cause of global warming, with only 50.3% attributing global warming to human activity. Moreover, according to Table 2 only small majorities are "completely" or "mostly" convinced that global warming is occurring. Furthermore, as Table 3 indicates, the majority of the public still thinks that there is a lot of disagreement among scientists about the global warming fact. Given these findings, it is clear that there is still a wide gap between scientific facts about global warming and public understanding of this issue.

Table 3.1 Individuals' perceptions of global warming, Pew Research Center for the People and the Press April 2009 General Public Science Survey[a]

	Proportion (%)
The earth is not getting warmer	12.5
The earth is getting warmer because of natural changes in the atmosphere	37.2
The earth is getting warmer because of human activity	50.3

a. The question is: "which of these three statements about the earth's temperature comes close to your view?"

Global warming has far transcended the scientific realm and become an unprecedented challenge facing the entire human society. To meet this challenge, it calls for immediate and comprehensive political actions at the macro level, and profound lifestyle change at the individual level. However, we have yet to date witnessed an international agreement reducing global warming. Public opinion has been shown to be an essential force in driving policy outcomes (Page and Shapiro 1983). In the realm of environmental planning and policy, the public has brought more influence on policy outcomes (Peacock et al. 2004). The main objective of this chapter is to investigate the determinants of public opinion towards global warming.

Table 3.2 Individuals' beliefs in the fact of global warming and greenhouse effect, Nisbet and Myers (2007, p.451)[a]

	ABC	
	06/05	09/05
Completely convinced (%)	23	23
Mostly convinced (%)	36	33
Not so convinced (%)	24	22
Not at all convinced (%)	16	17
No opinion (%)	2	4
N	1,002	1,019

a. The question is: "how convinced are you that global warming or the greenhouse effect is actually happening—would you say that you are completely convinced, mostly convinced, not so convinced, or not convinced at all?"

Table 3.3 individuals' beliefs in the scientific consensus on global warming, Nisbet and Myers (2007, p.453)[a]

	OSU		ABC	
	10/97	02/98	03/06	04/07
Most agree (%)	35	30	35	40
A lot of disagreement (%)	62	67	64	56
No opinion (%)	3	3	1	3
N	688	753	1,002	1,002

a. The question is: "Do you think most scientists agree with one another about whether or not global warming is happening, or do you think there is a lot of disagreement among scientists on this issue?"

Previous studies have identified three major clusters of determinants of public opinion towards global warming. They are: socio-demographic characteristics, predisposition and attitudinal variables, and geographic factors. Multiple studies have examined the effects of socio-demographic factors on public attitudes toward climate change (Brody et al. 2008, Dietz et al. 2007, Dunlap and McCright 2008, Hamilton and Keim 2009, Krosnick et al. 2006, Leiserowitz 2006). The "white male effect", suggesting that white people and males tend to judge environmental risks at lower level and therefore show less concern for the environment, has been well documented in the social science literature (Finucane et al. 2000, Marshall 2004). "White male effects" appear to be unstable across studies on public perception of global warming. Racial minorities and females are found to have higher levels of public concern about climate change (Leiserowitz 2006, Malka et al. 2009, McCright and Dunlap 2011b), while white males surprisingly show more concern for climate change in one study (Kellstedt et al. 2008). The effect of age on public attitudes towards global warming is usually found to be negative, indicating older individuals tend to show lower level of concern for global warming (Kellstedt et al. 2008, Krosnick et al. 2006, Malka et al. 2009, McCright and Dunlap 2011b).

Education, income and other variables relating to social class have been usually hypothesized to be positively associated with environmental concern (Vanliere and Dunlap 1980). The results from Hamilton (2008) demonstrate this hypothesis, showing that higher levels of education and more income are associated with greater concern for some impacts of global warming. Meanwhile, some studies show that education has a negative effect on public concern for global warming (Malka et al. 2009; McCright and Dunlap 2011), and income has a negative effect on public risk perception of global warming (Hamilton and Keim 2009; McCright and Dunlap 2011).

The second cluster of determinants of public opinion towards global warming is predisposition and attitudinal variables. Predispositions, which include ideology, world views, values, and knowledge, serve as a filter when individuals process information from the outside world. The implication of accepting anthropogenic global warming is multi-faceted, but mostly it requires effective government regulation on the emission of carbon dioxide. American conservatives, in contrast to liberals, favor individual freedom and private property rights over collective rights, as well as free market over governmental intervention (McCright and Dunlap 2011). Thanks to the discrepancy in their respective pursuing ideals, conservatives and liberals are divided on the issue of global warming. Republicans and conservatives are more likely to be skeptical of anthropogenic global warming than Democrats and liberals, and therefore show lower level of concern about global warming than Democrats and liberals (McCright and Dunlap 2011; Dunlap and McCright 2008; Pew Research Center 2006, 2007; Gallup 2008). Even more interestingly, education has different effects on risk perception of global warming among Democrats and Republicans (McCright and Dunlap 2011; Hamilton 2010; Hamilton and Keim 2009; Pew Research Center 2007). While concerns about global warming increase with the level of education among Democrats, such concerns decrease with the level of education among Republicans (McCright and Dunlap 2011; Hamilton 2010; Hamilton and Keim 2009; Hamilton 2011). In addition, knowledge has been found to be an important factor on public opinion towards climate change (Malka et al. 2009; McCright and Dunlap 2011).

Because the scale of global warming transcends personal experience, public understanding of this is mainly reliant on a variety of information sources. As Zaller (1992) suggests, these information sources include elite discourses from politicians, higher-level government officials, journalists, some activists, and many kinds of experts and policy specialists. Scientists are the original information source about global warming. Due to its large-scale and profound implications, global warming has evolved into a social problem from a scientific problem, with the involvement of politicians, economists, and interest groups in the policy debate (McCright and Dunlap 2000). The mass media, as an interface of science and policy, mediates a social relationship among scientists, policy makers and the public (Boykoff 2008). The mass media's pursuit of "balance" by employing "dueling scientists" to cover both sides has constructed high scientific uncertainty surrounding global warming (Boykoff 2008; Boykoff and Boykoff 2004; Dunlap 1998). Reliance on elite discourse raises two issues, attention and trust (Weber 2010a).Previous studies produce confusing results about the effect of attention on public perception of global warming. For instance, Kellstedt et al. (2008) find that the level of information about global warming is negatively associated with concern about this issue. In contrast, Wood and Vedlitz (2007)find that respondents who are more attentive to global warming have higher level of concern about this issue. Trust in these information sources comes into play as an important moderating force (Malka et al. 2009). Among individuals who trust scientists, more self-reported knowledge about global warming leads to higher level of concern for this issue. Whereas, more self-reported knowledge does not translate into higher level of concern among people who do not trust scientists. Likewise, Krosnick et al. (2006) find that television exposure is positively associated with belief in the existence of global warming only among individuals who have high level of education and show more trust in scientists. Surprisingly, Kellstedt et al. (2008) find that individuals with more confidence in scientists feel less personally responsible for global warming and therefore show lower level of concern for this issue.

The public reliance on information sources about global warming does not exclude the possibility that individuals also take into consideration their personal observation of local weather when making judgments about global warming. Therefore, the third major stream of literature concerns the role of local weather in determining public attitudes towards global warming. The effect of local weather on public perception of global warming has been estimated in several studies. Self-reported local weather (Krosnick 2006), personal observation of local weather (Borick and Rabe 2010), short-term weather fluctuation (Egan and Mullin 2012), and long-term (1970-2007) winter temperature trends (Hamilton and Keim 2009) have all been found to have significant effects on public perception of global warming. Hamilton and Keim (2009) even find an interesting geographic pattern, in which the effect of winter warming on perceiving climate change is most prominent in snow country.

In this chapter, I investigate the determinants of public perception of global warming. Specifically, I examine how socio-demographic characteristics, political predisposition, attention to the media, attitudes towards science, perception of scientists, and local weather affect public opinion towards global warming. I adopt a comprehensive list of long-term and short-term local weather indicators in my model. No previous research has systematically examined whether individuals' attitudes towards global warming or local weather affect public judgments about global warming. In addition, the objective measures of local weather included in this model provide insights into how the public forms risk perceptions based on the environmental reality.

Data and Methods

This study explores the effects of demographic and socioeconomic attributes, cognitions, predispositions and attitudes, and geography on individuals' attitudes toward global warming.

My strategy is to combine survey data with aggregate weather and climate data linked to the geographic areas within which survey respondents reside.

The study area is the contiguous United States. As Figure 3.1 shows, the green dots represent each survey respondent, the purple dots represent each United States Historical Climatology Network (USHCN) weather station, and the polygons represent each zip code area. The survey data used in this study are from the 2009 Pew Research Center for the People & the Press General Public Science Survey, and I supplement these survey data with local weather and climate data consisting of monthly temperature and precipitation data from the USHCN. The Pew survey was conducted nationally in April 2009 and involves the collection of data for a representative random sample of 2,001 individuals 18 years old or older (http://www.people-press.org/2009/07/30/may-2009-science-survey/). This survey has a rich set of variables that fit my interest of study very well. It includes items that specifically ask respondents' opinions about global warming, science and scientists. Thus, I am able to use improved measures of attitudes towards science and scientists, along with a group of demographic and attitudinal variables identified by previous studies to test my hypotheses. In addition, this survey has zip code information of each respondent, and this helps to identify the geographic context of which each respondent resides and merge the weather data with survey data. Specifically, the center point of each zip code polygon is used to represent the location of respondents identified by corresponding zip codes.

Because my dependent variable is categorical, in the first part of the analysis in this chapter I estimate my models using ordered-logit regression. Moreover, to present the geographic pattern of the effects of each significant independent variable on public opinion towards global warming, I use Geographically Weighted Regression (GWR). GWR is a technique used to explore spatial relations. I provide more details about this technique in the section that describes the GWR results.

Geographic techniques are used to integrate the two different layers of data. Specifically, the weather station that is located closest to each respondent is spatially joined to each respondent. Some respondents share the same weather station, which raises some complications in regression analyses. Merging two datasets with different levels of analysis—aggregate (weather station) and individual-level—violates one important statistical assumption. Specifically, the error terms are not independent for observations that share the same weather station, and this can affect standard errors for regression estimates. To correct this, there are two major approaches – clustered standard errors and multilevel modeling. Because I do not have a sufficient number of observations per weather station to estimate a multilevel model[2], I employ clustered standard errors which require fewer assumptions and less intensive computation than multilevel modeling (Primo, Jacobsmeier and Milyo 2007).

Modeling Determinants of Public Opinion towards Global Warming

I begin with a discussion of the variables used in my model of public opinion towards global warming. A brief summary of the variables used in this analysis and their coding can be found in Table 3.4.

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[2] Even though a number of weather stations have more than one respondent that is associated with, many weather stations only have one respondent.

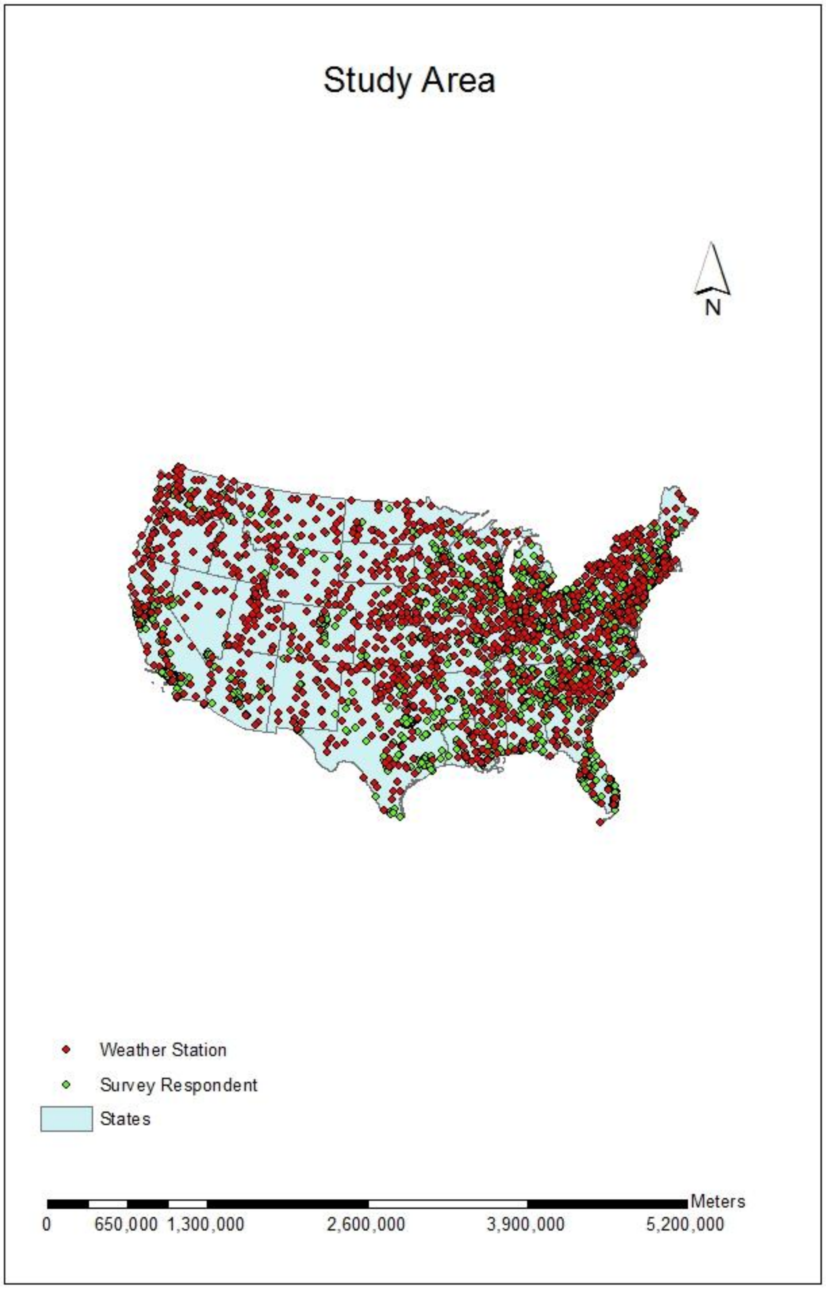

Figure 3.1 Study Area—the Contiguous United States with Respondents from National Survey Sample and USHCN Weather Stations

Dependent Variable

The dependent variable is based on responses to the following question asked in the 2009 Pew General Public Science Survey: "Which of these three statements about the earth's temperature comes closest to your view?" The original survey has two forms. The order in which the response choices are offered varies between the forms. One form puts "the earth is not getting warmer" the first in order, whereas the other puts this option last. The effects of changing the order of response choices have been found to be substantial, especially among less-educated adults (Krosnick and Alwin 1987). However, the descriptive statistics drawn from the two forms do not indicate changing the response order is substantially effective (see Appendix A). Thus, I combined the data from two forms after recoding "the earth is not getting warmer" as 0, "the earth is getting warmer mostly because of natural changes in the atmosphere" as 1, and "the earth is getting warmer mostly because of human activity such as burning fossil fuels" as 2. "Don't know/refused" responses are recoded as missing data.

Independent Variables

Media Use: I capture this hypothesized effect with a series of independent variables that are designed to reflect how attentive one is to the outside information. The first and second variables—which I call general media and attention to science news, respectively— are, derived from the following two items: (1) How much do you ENJOY keeping up with the news – a lot, some, not much, or not at all? (2) How much do you ENJOY keeping up with news about science – a lot, some, not much, or not at all? I create two four-point scales for these two variables, with each ranging from 0 (not at all) to 3(a lot). Considering the "balance norm" widely adopted by the mainstream media— which, actually creates the portrait of global warming as highly uncertain and controversial (Boykoff and Boykoff 2004)— I hypothesize the more attentive one is to the mainstream media, the less likely one is to believe in the existence and anthropogenic cause of global warming. The third variable, referred to as scientific media use, is based on three items, all of which are coded 0 (not regularly) and 1(regularly): (1) Do you regularly watch television programs or channels about science such as Nova or Discovery Channel, or not? (2) Do you regularly visit science web sites and blogs, such as NOAA.gov or ScienceDaily.com, or not? (3) And do you regularly read science magazines, such as Popular Science or Scientific American, or not? These items load on a single dimension (eigenvalue = 1.418, variance explained = 0.473). I hypothesize that the coefficient for this variable is positive, indicating that individuals who regularly keep up with science news from science sources are more likely to perceive global warming and that it is induced by human activity.

Attitudes towards scientists. The public's attitude towards scientists can have important effects on their perception of global warming. I include three independent variables in the model to capture the effects. The first variable scientists' contribution is based on the following item: Do scientists contribute a lot, some, not very much, or nothing at all to the well-being of our society? This variable is coded from 0 (nothing at all) to 3(a lot). I hypothesize this variable to be positively associated with the dependent variable.

The second variable, scientists' ideology, is based on the following item: Just your impression: Do you think of scientists as a politically liberal group, a politically conservative group or as neither in particular? The resulting variable is a three-point scale ranging from -1 (liberal) to 1 (conservative). I am not sure whether this variable has positive or negative effects on the dependent variable. Therefore, my hypothesis for this variable is non-directional.

Whether people think there is scientific consensus about global warming is hypothesized to have important effects on their perception of this issue. Specifically, I assume that people who believe there is a consensus on global warming among scientists would be more likely to accept global warming and the argument that global warming is mainly caused by humans. As a result, my third variable in this cluster, scientists' consensus, is based on the following item: from what you've heard or read, do scientists generally agree that the earth is getting warmer because of human activity, or do they not generally agree about this? I code "no" responses as 0 and "yes" responses as 1.

Attitudes towards science. I include several items in the Pew Science Survey that capture the attitudes of the mass public towards science. The first variable science effect is derived from three items: (1) science effects on society, which I create a three-point scale from -1 (mostly negative) to 1 (mostly positive); (2) science effects on life, which is coded from -1 (more difficult), 0(no effect), to 1(easier); and (3) science effects on the environment, which is also a three-point scale ranging from -1(mostly negative) to 1(mostly positive). All three items load on one factor (eigenvalue = 1.513; variance explained = 0.504). I speculate that people who perceive that science has positive effects will be more likely to believe global warming is occurring and anthropogenic.

Another indication of the public's attitudes toward science, investment in science, can be found on the item: In your opinion, do government investments in basic scientific research usually pay off in the long run, or are they not worth it? I create a binary variable based on this item, coded 0 for responses of "no, aren't worth it" and 1 for "yes" responses. I speculate that the

Table 3.4 Coding, Mean, and Standard Deviation for Variables in the Study and VIF Values for the Independent Variables

Variable	Coding	Mean	SD	VIFs
Global warming belief	0 (the earth is not getting warmer); 1 (the earth is getting warming due to natural changes); 2 (the earth is getting warmer due to human activities)	1.38	.70	
General media use	0 (not at all) to 3 (a lot)	2.39	0.88	1.13
Attention to science news	0 (not at all) to 3 (a lot)	2.11	0.87	1.31
Scientific media use	-1.11 to 2.52	1.2	1.00	1.43
Scientists' contribution	0(nothing at all) to 3(a lot)	2.66	0.62	1.16
Scientists' ideology	-1(liberal) to 1(conservative)	-0.11	0.53	1.06
Scientists' consensus	0(no); 1(yes)	0.60	0.49	1.15
Science effects	-4.15 to .54	-2.47	1	1.20
Investment on science	0(no); 1(yes)	0.80	0.40	1.16
Knowledge	0(wrong answer and "don't know"); 1(right answer)	0.68	0.47	1.13
Party Identification	0(Democrat) to 4(Republican)	1.70	1.66	1.40
Ideology	0 (very liberal) to 4 (very conservative)	2.20	0.95	1.37
Age	Number in actual years (18-99)	51.37	17.58	1.14
Gender	0 (male) to 1 (female)	0.50	0.50	1.16
Education	0 (none, or grade 1-8) to 6 (post grad)	3.62	1.69	1.40
Annual Income	1 (less than $10,000) to 9 (over $150,000)	5.21	2.36	1.38
Race (white)	0 (other) to 1 (white)	0.56	0.50	1.03
Church attendance	0(never) to 5(more than once a week)	2.68	1.59	1.14
Winter temperature trend	-8.32 to 5.10	-0.57	2.12	1.64
Spring temperature trend	-4.42to 3.03	-0.70	0.89	1.45
Summer temperature trend	-3.39 to 4.47	0.61	1.08	1.61
Fall temperature trend	-2.61 to 4.81	0.30	1.04	1.34
Winter precipitation trend	-38.21 to 33.47	5.29	10.63	1.42
Spring precipitation trend	-31.12 to 44.84	0.62	11.21	1.33
Summer precipitation trend	-44.70 to 47.65	3.87	13.34	1.27
Fall precipitation trend	-48.52 to 37.25	0.51	11.47	1.50
Average temperature departure from normal temperature	-1.67 to 1.97	0.03	0.53	1.67
Average precipitation departure from normal precipitation	-1.74 to 3.34	0.18	0.91	1.36

more confidence Americans have in science generally, and in scientific research particularly, the more likely they are to believe in anthropogenic global warming.

Knowledge. Malka et.al (2009) find a complex relationship between self-reported knowledge and concern about global warming. Instead of measuring self-reported knowledge, the Pew Science Survey has one item that specifically measure respondents' knowledge about global warming. This item asks respondents questions about the basic scientific fact. This question is: what gas do most scientists believe causes temperatures in the atmosphere to rise? I recode the right answer for the question as 1, the wrong answers as 0. In addition, instead of recoding "don't know/refused" responses as missing data (as I do for all other items), here I, treat this option as an incorrect answer and recoding it as 0. I speculate that individuals with more knowledge about global warming are more likely accept anthropogenic global warming.

Demographic characteristics. These variables serve as control variables in my models. First, I posit that public opinion of global warming is shaped by race and gender. The risk assessment literature has identified the "white males" effects, which indicates that racial minorities and women are more sensitive to and concerned about risks due to their vulnerabilities. Thus, I create two binary variables to represent race ("white" = 1; "other" = 0) and gender ("women" = 1; "men" = 0). I hypothesize that the coefficients for these two variables are positive.

In addition, I include education, income, and age, all of which are common demographic variables widely examined in the social science studies. I measure Education on a scale from 0 (respondent has completed 8 grades or less and no diploma) to 6 (respondent has earned a post-graduate degree). I measure Income on a scale ranging from 1 ("less than $10,000") to 9

("$150,000 or more"). I measure respondents' age in years, ranging from 18 to 95 years. As indicated by previous research, I speculate that older people with less education and more income are less likely to believe in anthropogenic global warming.

Furthermore, I include two political attitudinal variables: Party identification and ideology. These two variables have been shown to be important indicators of perception of global warming. I measure ideology on a five-point scale from 0 (very liberal) to 4 (very conservative). The measure of party identification is based on two items: party affiliation and party lean. This variable is on a five-point scale from 0 (Democrat) to 4 (Republican). I hypothesize that people who are conservative and are republicans are more likely to be skeptical of anthropogenic global warming. I also include two interaction terms in models. They are: one interaction between party identification and education, on the one hand; one between political ideology and education, on the other hand as suggested by previous studies. I also include two interaction terms: one interaction between knowledge and party identification, on the one hand; one interaction between knowledge and political ideology, on the other hand.

Lastly, I include church attendance. This variable is measured on a scale ranging from 0 (never attend services) to 5 (more than once a week). The frequency of attending religious service has a negative effect on the public perceiving local effects from climate change (Hamilton and Keim 2009). McCright and Dunlap (2011) find that the more often people go to church, the less likely that their beliefs about global warming are consistent with climate science. Furthermore, individuals who attend church more often tend to show lower level of concern about global warming (McCright and Dunlap 2011). Thus, I posit that individuals who attend religious services more often are less likely to believe in anthropogenic global warming.

Local weather and climate. I create four seasonal temperature and four seasonal precipitation trends including Winter (December, January, February), Spring (March, April, May), Summer (June, July, August), and Fall (September, October, November) trends. These trend variables are calculated using data over the past 10 years prior to the survey date. Considering that the survey was conducted from April 28th – May 12th, 2009, for winter and spring, I calculate trends from 2000 – 2009; for summer and fall, I calculate trends from 1999 – 2008 to capture the long term temperature trend. Specifically, I regress the average of a particular season of each year on year, and use the bivariate regression coefficient to represent seasonal trends. Because there is an inadequate number of previous studies on the effects of local weather and climate on public opinion towards global warming, my hypotheses on all these long-term local weather and climate indicators are non-directional except two—winter temperature trend and summer temperature. As noted in Hamilton and Keim (2009), warming winter is associated with public perceptions of global warming. I speculate that residents that experience rising winter temperatures over the past 10 years are more likely to believe that global warming is occurring and mainly human induced. Likewise, summer is usually a season in which people are sensitive to rising temperatures. Therefore, I speculate that individuals that experience increasingly hot summers over the past decade tend to believe in anthropogenic global warming.

In addition, I include two weather measures to capture short-term weather fluctuations. They are: average temperature departure from normal temperature over the month prior to the survey date, and average precipitation departure from normal precipitation over the month prior to the survey date. To account for relative weather fluctuation in different regions, these departures are normalized (measured in standard deviation units). I calculate these two measures:

DNT_i = (temperature$_i$-normal temperature$_i$)/standard deviation of temperature (1981-2010) ,

DNP_i = (precipitation$_i$-normal precipitation$_i$)/standard deviation of precipitation (1981-2010),

where DNT_i / DNP_i is the local temperature/precipitation experienced by respondent i, temperature$_i$ /precipitation$_i$ is the respondent i's local average temperature and total monthly precipitation over the month before his or her interview, normal temperature$_i$ / normal precipitation$_i$ are the normal average of mean temperature normal average of total precipitation for April, calculated over the period 1981-2010 (current normal period in climatology), and standard deviation of temperature/precipitation is the standard deviation of monthly mean temperature and monthly total precipitation calculated based on the monthly average over the period 1981-2010[3].

The codes, means, and standard deviations of all the independent variables are summarized in Table 3.4. Additionally, I conducted regression diagnostics for multicollinearity among the independent variables for each model. In no case are the variance inflation factors (VIFs) sufficiently large to suggest a problem with multicollinearity.

[3] Considering that this survey was conducted between late April (April 28) and mid-May (May 12th) in 2009, I extract the temperature and precipitation data on April 2009, and calculate the average of normal temperature and precipitation on April over the period 1981-2010.

Empirical Results

Analysis I. Social and Psychological Structure

As a starting point, I estimate my model of individuals' perceptions of global warming to include media use, attitudes toward scientists, attitudes toward science, demographic variables, knowledge variable and predisposition variables. As demonstrated in Table 3.5, I include three models in my study. The first is a simple additive model without interactions (Model 1) and the second and third are multiplicative models and hence include interactions (Models 2 and 3). Three models do a fairly good job in portraying public perceptions of global warming. In logistic regression, there is not an equivalent of R^2 (variance explained) as in linear regression. Unlike a linear regression model, a logistic regression model arrives at its estimates through maximum likelihood estimation which is an iterative process. However, several pseudo R-squareds have been developed and used to indicate the goodness-of-fit of logistic models because they are on a scale ranging from 0 to 1 with higher values meaning better model fit. The pseudo R^2 in ordered-logit model is the McFadden's pseudo R^2 value. The pseudo-R^2 for the models are 0.216, 0.220, and 0.219, respectively, and as one can see Model 2 (with the interaction for party identification and education, and the interaction for party identification and knowledge) and Model 3 (with the interaction for ideology and education, and the interaction for ideology and knowledge) slightly improves the pseudo-R^2, compared to Model 1. Variables representing most of the clusters of independent variables are found to have significant effects on the dependent variable.

Turning first to Model 1, the cluster of media use turns out to be an insignificant predictor of the dependent variable. This is surprising, but theoretically interesting. One would expect media use to have a strong effect on individual perceptions of global warming, since for most Americans the media would be the source of information about the scientific consensus relating to climate change. The null findings for the media variables actually convey an important message about media effects. The often-confusing media reporting on global warming news— which, presents all three views on global warming, following the fairness principle— do, not clarify this issue for the public, but rather complicate it. Therefore, media attention to this highly complicated and controversial issue does not help determine an individual's position on global warming.

The cluster of independent variables reflecting attitudes towards scientists stands out among all clusters of variable. All the coefficients for the independent variables within this cluster are positive and statistically significant. Individuals who perceive that scientists make contributions to the well-being of society tend to believe in the existence and human-induced global warming. To demonstrate this point most vividly, I generate predicted probabilities for different values on this scale, based on the ordered logit estimates from Table 3.5, model 1 while holding the values of all other independent variables constant at their means. As Figure 3.2 demonstrates, individuals who think scientists do not make contributions to the well-being of society have the highest chance (54.3%) of believing in natural global warming. In contrast, people who think scientists make a lot of contribution to the well-being of society have 55.7% chance of believing in anthropogenic global warming.

Secondly, the coefficient for scientist ideology is positive, suggesting individuals who think scientists are conservative are more likely to believe in anthropogenic global warming (by 60.4 percent holding the values of other independent variables constant at their means). The predicted probability of accepting anthropogenic global warming decreases to 47.5% for those who think scientists are liberal. I speculate that this is probably because many of the people who are skeptical of global warming are conservatives; as the ideology of scientists moves to the left, these conservatives become less trusting of global warming arguments. The strongest predictor among this cluster of independent variables is respondents' belief in a consensus among scientists. It is surprising to see "belief in a scientific consensus" has a tremendous impact on public perception of global warming, even when controlling for the effects of all other theoretically relevant variables. Using results from Table 3.5, model 1 and holding the values of all other independent variables constant at their means, I estimate predicted probabilities for the two values of science consensus; in Figure 5.3, I present the patterns of predicted probabilities to show the strength of this relationship. I estimate that individuals who think there is a scientific consensus about global warming tend to believe in anthropogenic global warming by a margin of68 percent (to 29 percent, who think otherwise), while individuals who do not think there is a scientific consensus about global warming are more likely to accept that global warming is a natural cycle by a margin of 56 percent (and 30 percent).

Between the independent variables reflecting individuals' attitudes towards science, the variable of investment in science is significant and positively related to the perception of global warming. Using results from Table 3.5, model 1 and holding the other independent variables constant at their means, I estimate the probabilities of three categories of attitudes towards global warming associated with the two points of opinion of investment in science. People who think the government investment in science pay off in a long run tend to accept anthropogenic global warming by a margin of 56 percent (to 38 percent of believing natural global warming). On the

Table 3.5 Ordered logit estimates for models of individuals' perception of global warming, 2009

Model	1		2		3	
Variables	b	z	b	z	b	z
Media use						
General media use [-]	0.018	0.22	0.007	0.08	-0.004	-0.05
Attention to science news [-]	0.041	0.43	0.053	0.55	0.053	0.56
Scientific media use [+]	-0.044	-0.61	-0.053	-0.72	-0.053	-0.73
Attitudes toward scientists						
Scientists' contribution [+]	0.344	2.75**	0.339	2.71**	0.347	2.78**
Scientists' ideology [+/-]	0.270	2.22*	0.273	2.23*	0.285	2.33*
Scientists' consensus [+]	1.592	11.51***	1.578	1.578***	1.589	11.39***
Attitudes toward science						
Science effects [+]	-0.073	-1.00	-0.056	-0.77	-0.068	-0.93
Investment on science [+]	0.709	4.16***	0.707	4.15***	0.687	4.03***
Knowledge [+]	0.226	1.46	0.195	.85	-0.417	-0.97
Demographic characteristics						
Age [-]	-0.011	-2.55**	-0.010	-2.36**	-0.010	-2.51**
Gender [+]	0.286	2.06*	0.275	1.98*	0.272	1.96*
Education [+]	0.156	3.36***	0.284	4.37***	0.417	3.73***
Income [-]	-0.056	-1.68*	-0.060	-1.80*	-0.057	-1.70*
Race(white) [-]	-0.152	-1.16	-0.162	-1.23	-0.151	-1.15
Church attendance [-]	-0.037	-0.85	-0.029	-0.67	-0.028	-0.64
Predisposition						
Party identification [-]	-0.309	-7.03***	-0.064	-0.59	-0.299	-6.72***
Ideology [-]	-0.365	-4.53***	-0.331	-4.06***	-0.147	-0.77
Interactions						
Party *Knowledge [-]	---	---	0.015	0.17	---	---
Party*Education [-]	---	---	-0.071	-2.84**	---	---
Ideology*Knowledge [-]	---	---	---	---	0.277	1.62
Ideology*Education [-]	---	---	---	---	-0.118	-2.55**
N	1143		1143		1143	
Wald Chi^2	471.48		479.67		479.20	
R^2	0.216		0.220		0.219	

***prob<0.001 (one-tail test); **prob<0.01 (one-tail test); *prob<0.05 (one-tail test)

Note: The constant terms are omitted from the table for the sake of brevity.

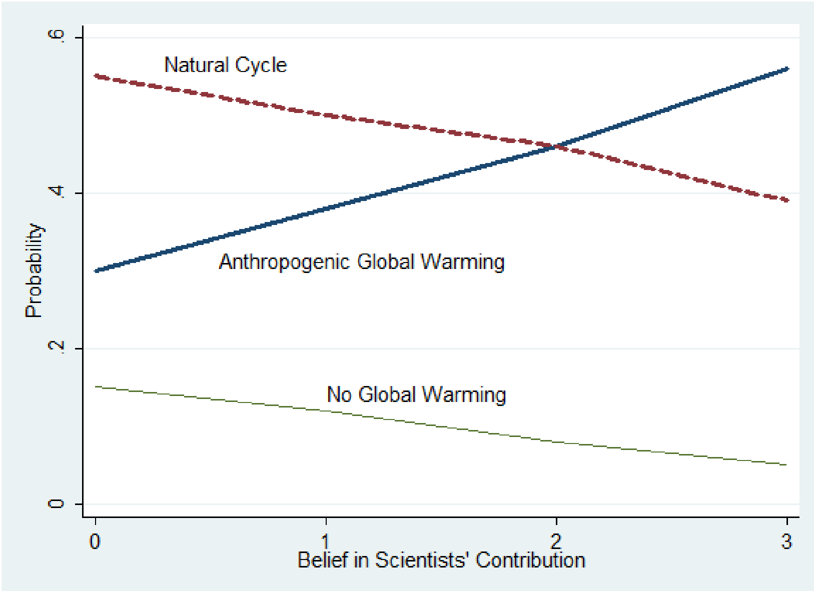

Figure 3.2 Predicted Probabilities of Three Views towards Global Warming, by Scientists' Contribution ranging from 0 (nothing at all) to 3 (a lot).

other hand, people who do not think the government investment in science is worth are predicted to accept natural global warming by a margin of 51 percent (to 39 percent of believing anthropogenic global warming). My interpretation for this is that: individuals having little confidence in the basic science research tend to reject the notion implied by the research. Among the demographic variables, age, gender, education and income are significantly related to perception of global warming found in Table 3.5, model 1. These results are consistent with my hypotheses. The coefficient for education is positive and highly significant, suggesting that well-educated individuals are more likely to believe in anthropogenic global warming than their less-educated counterparts. I estimate the probabilities of three different views towards global warming across the scale of education based on results from model 1, and present the pattern in Figure 3.4. Specifically, respondents who score at the lowest point of 0 on the education scale

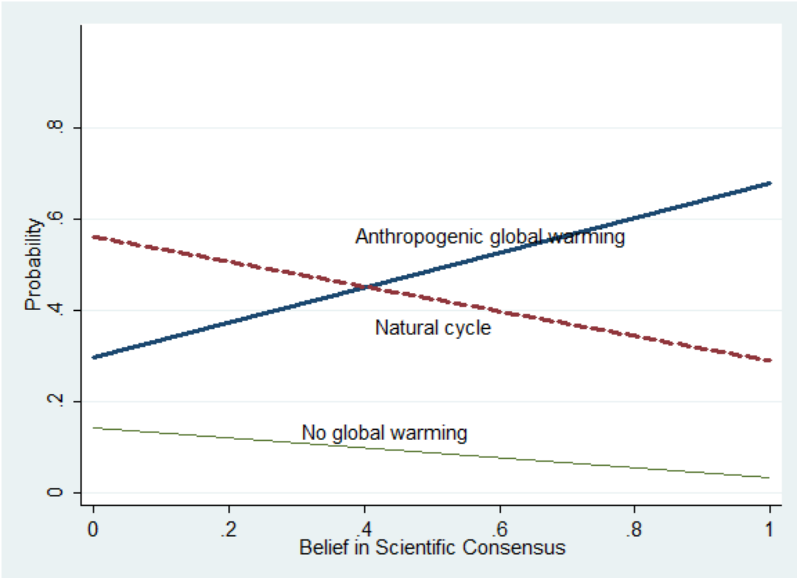

Figure 3.3 Predicted Probabilities of Three Views towards Global Warming, by Scientific Consensus ranging from 0 (no) to 1 (yes).

tend to believe in natural global warming by the margin of 51 percent (to 39 percent of believing in anthropogenic global warming). Whereas respondents who have the highest level of education are more likely to believe in anthropogenic global warming by the margin of 61 percent (to 34 percent of believing in natural global warming). The coefficient for age is negative, which suggests that older people tend not to accept anthropogenic global warming. When one moves from the lowest point (18) on the scale of age to the highest point (93), the probability of believing anthropogenic global warming decreases by 19 percent (from 61 percent to 42 percent), while the probability of believing natural global warming increases by 15 percent (from 34 percent to 49 percent). Gender has positive effects on the dependent variable. It suggests that women are more likely than men to accept the notion of anthropogenic global warming by the margin of 57 percent to 50 percent.

The coefficients for political ideology and party identification are strongly and negatively related to the dependent variable. Using results from Table 3.5, model 1, I estimate the probabilities of three views toward global warming across the scales of political philosophy and party identification controlling for the effects of all other independent variables at their means, and present the patterns in Figures 3.5 and 3.6. As shown, political ideology and party identification share similar patterns in terms of their effects on public opinion towards global warming. Moving from 0 (liberal) to 4 (conservative) on the ideology variable, I find that the probability of accepting anthropogenic global warming decreases from 71 percent to 37 percent when holding all other independent variables constant at their means. Democrats are more likely to believe in anthropogenic global warming by the margin of 65 percent (to 31percent of believing in natural global warming), while Republicans are more likely to accept natural global warming by the margin of 53 percent (to 36 percent of believing anthropogenic global warming). The readers should note that these effects are observed after controlling for the effects of other independent variables in the model.

Wildavsky and Dake (1990)find in their research that self-reported knowledge have a minimal relationship with risk perception. Surprisingly, the variable of knowledge about global warming in this study does not indicate any significant effect on the public opinion toward global warming.

Table 3.5, model 2 includes the interaction for party identification and education level and the interaction for party identification and knowledge, and the result is a slightly improved

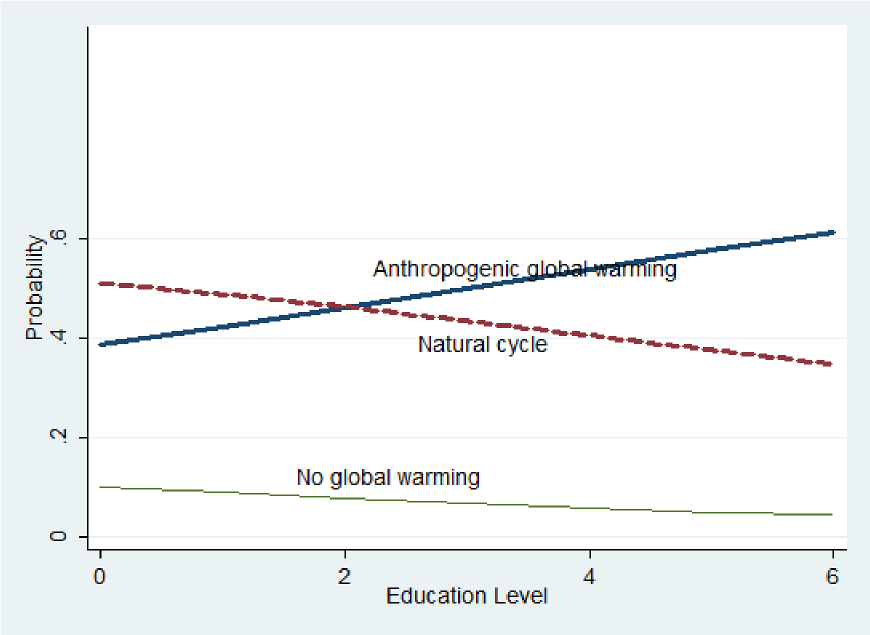

Figure 3.4 Predicted Probabilities of Three Views towards Global Warming, by Education on a scale from 0 (8 grades or less and no diploma) to 6 (post-graduate degree).

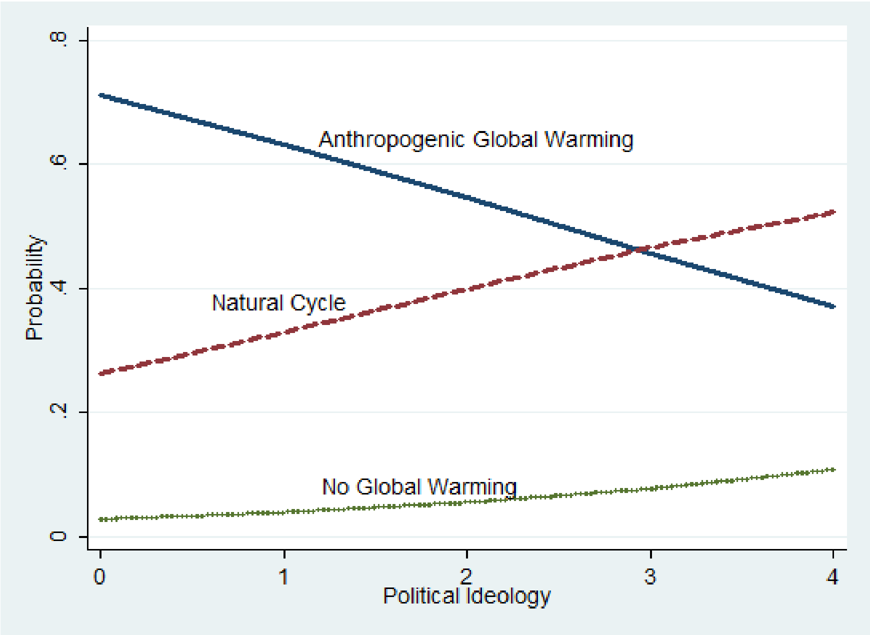

Figure 3.5 Predicted Probabilities of Three Views towards Global Warming, by Political Ideology on a scale from 0 (very liberal) to 4 (very conservative).

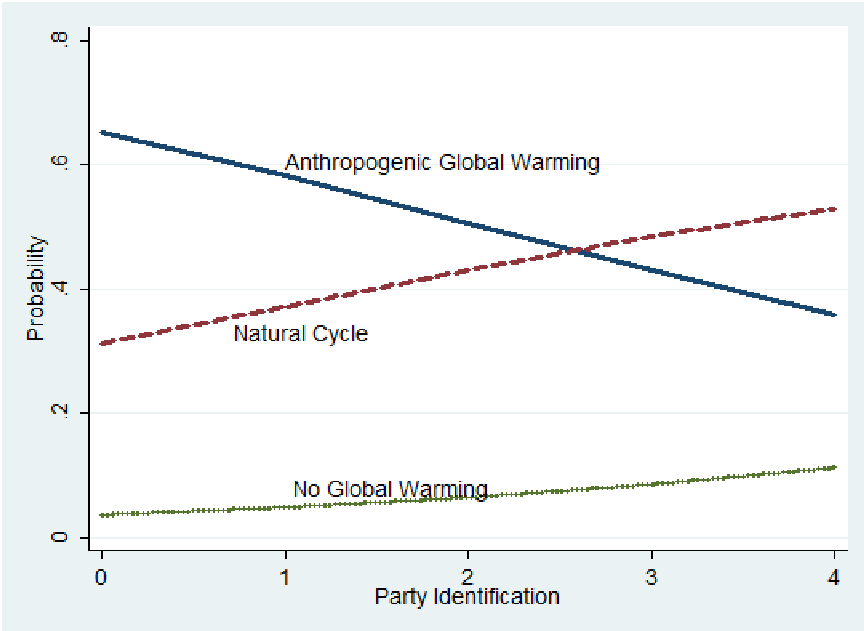

Figure 3.6 Predicted Probabilities of Three Views towards Global Warming, by Party Identification on a scale from 0 (Democrat) to 4 (Republican)

pseudo R^2. The coefficient for the interaction between party identification and education is negative at a highly significant level. The interpretation is that the effect of education on global warming attitudes is affected by partisan identification. As individuals become more Republican, the effects of education on the dependent variable become more negative. Controlling for the effects of all other independent variables at their means, I vividly demonstrate the interaction effect for party and education in Figure 3.7, based on results from model 2. Moving from the lowest point (0) on the scale of education to the highest point increases the probability of believing in anthropogenic global warming by 38 percent (from 40 percent to 78 percent) among strong Democrats. On the other hand, the probability of accepting the notion of anthropogenic global warming barely changes across the scale of education (around 35 percent) among strong Republicans. This finding conforms to previous studies on the interaction effect of party and education on public opinion towards global warming (Hamilton and Keim 2009; Hamilton 2009).

Furthermore, the interaction effect for party identification and knowledge about global warming is shown to be non-significant.

Table 3.5, model 3 includes the interaction for political ideology and education level, and the interaction for political ideology and knowledge, and the result is a slightly improved pseudo R^2. Similar to the result of the interaction for party identification and education in model 2, the coefficient for the interaction between political ideology and education is negative at .01 level. This result indicates that the effect of education on global warming attitudes is affected by political ideology. As individuals become more conservative, the effects of education on the dependent variable become more negative. Using results from model 3, I vividly demonstrate the interaction effect for ideology and education in Figure 3.8. The probability for a strong liberal to accept the notion of anthropogenic global warming is immensely increased from 45 percent to 90 percent, as one moves from the lowest level to the highest level of education. On the other hand, the probability for a strong conservative to accept the notion of anthropogenic global warming is decreased from 32 percent to 26 percent, moving from 0 to 6 on the range of education level. This finding conforms to previous studies (McCright and Dunlap 2011; Hamilton and Keim 2009).

Analysis II. Social and Psychological Structure with Local Weather

In the second part of my analysis, I add the cluster of local weather variables to the original set of independent variables. The empirical results are reported in Table 3.6.The models with the variables of local weather slightly improve pseudo R^2 (0.227 and 0.225, respectively).

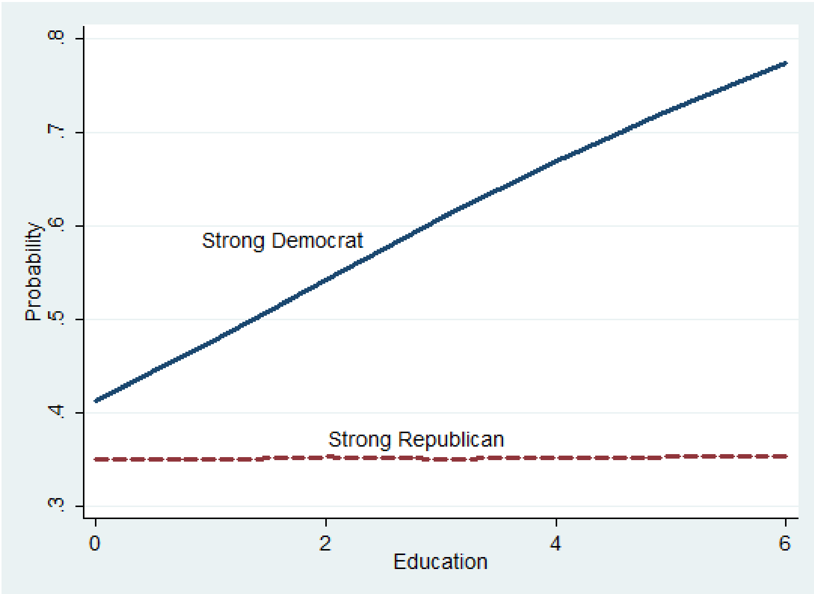

Figure 3.7 Predicted Probability that respondents believe that global warming is mostly due to human activity as a function of education level ranging from 0 (8 grades or less and no diploma) to 6 (post-graduate degree), by party identification on a scale from 0 (Democrat) to 4 (Republican)

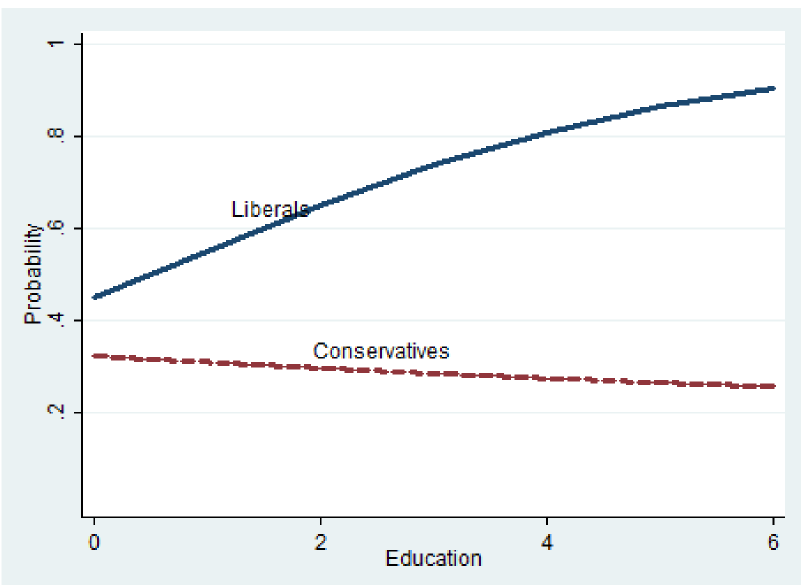

Figure 3.8 Predicted Probability that respondents believe that global warming is mostly due to human activity as a function of education level ranging from 0 (8 grades or less and no diploma) to 6 (post-graduate degree), by political ideology on a scale from 0 (very liberal) to 4 (very conservative)

As Table 3.6 demonstrates, the direction and significance of social and psychological independent variables hardly change. Among all the variables of local weather and climate, the coefficients of spring temperature trend and summer temperature trend over the past 10 years are significant.[4] Specifically, the coefficient of summer trend is positive, which suggests that respondents who experience increasingly hot summers over the past 10 years tend to accept the notion of anthropogenic global warming. Using results from Model 1 of Table 3.6, I generate the predicted probabilities for each category of the dependent variable[5]. As Figure 3.9 demonstrates, residents who experience a decreasing summer temperature trend (quantified by -3 in value) are more likely to believe that global warming is a natural cycle rather than human made phenomenon by the margin of 48.6 percent to 4.27 percent. Whereas for individuals who experience an increasing summer temperature trend (quantified by 4 in value), the predicted probability for them to believe in anthropogenic global warming, on the one hand, is 63.5 percent; the predicted probability for them to believe that global warming is a natural cycle, on the other hand, is 32.6 percent.

Surprisingly, the coefficient for the spring trend is negative, which indicates that respondents that experience increasingly cold spring over the past 10 years are more likely to believe in global warming. Specifically, the probability for one to think that global warming is a

[4] I create seasonal temperature trends over the past 40 years, 30 years, 20 years, and 10 years; and include them in the model, respectively. It turns out that seasonal temperature trends over the past 10 years yield the strongest relationship. The results indicate that individuals are most responsive to near-term trends.

[5] The coefficients for all the local weather and climate variables in model 1 are similar to model 2. The results from model 1 should be similar to those from model 2. Therefore, I just use the results from model 1 here.

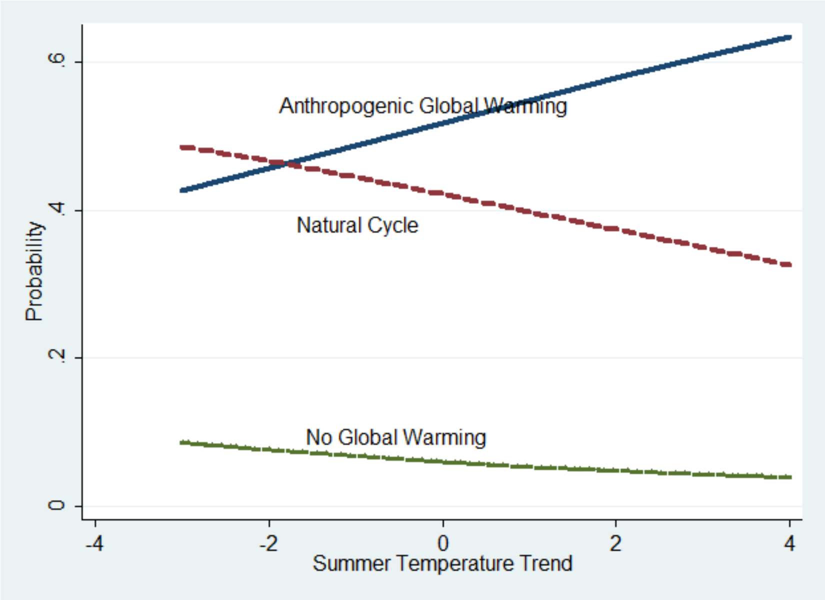

Figure 3.9 Predicted Probabilities of Three Views towards Global Warming, by Summer Temperature Trend on a Scale Ranging From -3.39 to 4.47

natural cycle increases from 29 percent to 52.2 percent, while the probability for one to believe in anthropogenic global warming decreases from 67.7 percent to 36.8 percent, as the indicator for one's experience with temperature during the summer seasons moves from -4 to 3. The two indicators of short-term weather fluctuation do not show significant in the models. Considering the possibility of collinearity among the local weather and climate variables, to test multicollinearity in my model, I use the variance inflation factor (VIF) which shows how the variance of an estimator is inflated in the presence of multicollinearity with higher VIF values indicating increasing collinearity. A good rule of thumb is that a VIF value above 10 indicates collinearity is a problem, but none of the VIFs is above a value of 3 (see Table 3.1).

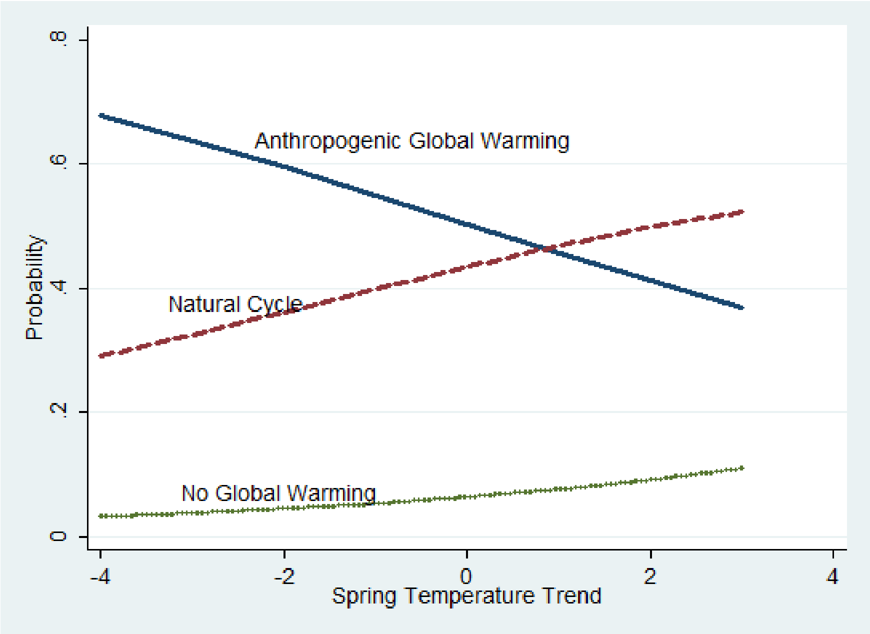

Figure 3.10 Predicted Probabilities of Three Views towards Global Warming, by Spring Temperature Trend on a Scale Ranging From -4.42 to 3.03

Exploration of Spatial Non-stationarity: Geographically Weighted Regression

Unlike physical processes, social processes tend not to be stationary over space. As Fotheringham, Brunsdon, and Charlton (2002: 9) suggest, "the measurement of a relationship depends in part on where the measurement is taken." There are three possible reasons why the measurement of a social relationship varies over space as noted by Fotheringham et al. (2002). First, the variation might lie in the different samples of data used. Second, the variation would exist because "some relationships are intrinsically different across space, perhaps, for example, there are spatial variations in people's tastes or attitudes or there are different administrative, political or other contextual issues that produce differing responses to the same stimuli across space" (Fotheringham, Charlton and Brunsdon 1998, p.1906). Third, the spatial non-stationarity might be due to model misspecification of reality, in which one or more relevant variables are either omitted or are represented by an incorrect functional form.

Table 3.6 Ordered logit estimates for models of individuals' perception of global warming, 2009

Model	1		2	
Variables	b	z	b	z
Media use				
General media use [-]	0.014	0.17	0.006	0.07
Attention to science news [-]	0.058	0.58	0.044	0.44
Scientific media use [+]	-0.055	-0.74	-0.048	-0.64
Attitudes toward scientists				
Scientists' contribution [+]	0.325	2.24*	0.327	2.29*
Scientists' ideology [+/-]	0.269	2.06*	0.271	2.05*
Scientists' consensus [+]	1.585	11.38***	1.580	11.38***
Attitudes toward science				
Science effects [+]	-0.053	-0.61	-0.065	-0.75
Investment on science [+]	0.757	3.92***	0.736	3.78***
Global Warming Knowledge [+]	0.235	1.35	0.238	1.35
Demographic characteristics				
Age [-]	-0.010	-2.49**	-0.011	-2.53**
Gender [+]	0.276	1.87*	0.275	1.87*
Education [+]	0.272	4.51***	0.362	3.21***
Income [-]	-0.062	-1.82*	-0.058	-1.69*
Race(white) [-]	-0.202	-1.42	-0.189	-1.35
Church attendance [-]	-0.020	-0.44	-0.015	-0.34
Predisposition				
Party identification [-]	-0.046	-0.47	-0.294	-6.34***
Ideology [-]	-0.316	-3.78***	-0.001	-0.01
Interactions				
Party*Education [-]	-0.073	-3.08**	---	---
Ideology*Education [-]	---	---	-0.101	-2.02*
Local weather				
Temperature trends				
Winter [+]	-0.036	-1.00	-0.034	-0.95
Spring [+/-]	-0.186	-2.23*	-0.189	-2.29*
Summer [+]	0.124	1.81*	0.127	1.86*
Fall [+/-]	0.110	1.38	0.109	1.36
Precipitation trends				
Winter [+/-]	-0.005	-0.64	-0.005	-0.70
Spring [+/-]	0.005	0.79	0.005	0.88
Summer [+/-]	0.001	0.14	0.000	0.04
Fall [+/-]	-0.004	-0.58	-0.003	-0.47
Departure from normal temperature [+/-]	0.110	0.60	0.117	0.64
Departure from normal precipitation [+/-]	-0.134	-1.55	-0.122	-1.44
N	1143		1143	
Wald Chi^2	448.25		442.41	
R^2	0.227		0.225	

***prob<0.001 (one-tail test); **prob<0.01 (one-tail test); *prob<0.05 (one-tail test)

Note: Z-statistics are based on standard errors estimated with clustering by weather station. The constant terms are omitted from the table for the sake of brevity.

Due to the spatial non-stationarity, a global model trying to capture global relationships between a dependent variable and a set of independent variables in social studies are often not perfectly accurate[6].

A multiple linear regression model may be written:

$Y_i=\beta_0+\beta_1 x_{1i}+\beta_2 x_{2i}+\ldots+\beta_m x_{mi}+\varepsilon_i$ for $i=1\ldots n$

A local model, taking into account the spatial non-stationarity, becomes more appropriate in the case where regional variation is noted[7]. Geographically Weighted Regression (GWR) is a method for "the local analysis of relationships in multivariate data sets" (Fotheringham et al. 2002, p. 27).

A typical GWR version of the OLS regression model is:

$Y_i=\beta_{0i}(u)+\beta_{1i}x_{1i}(u)+\beta_{2i}x_{2i}(u)+\ldots+\beta_{mi}x_{mi}(u)+\varepsilon_i$ for $i=1\ldots n$

, where u denotes the location u.

GWR takes into account Tobler's first law of geography, which is that everything is related to everything else, but near things are more related than distant things (Tobler 1970). Model parameters are estimated at each location. Observations that are nearer to that location are

[6] A global model is a model calibrated with data equally weighted from across a study region that yields global parameter estimates (Fotheringham et al. 2002, p.6)

[7] A local model is a model calibrated with spatially limited sets of data that yields local parameter estimates (Fotheringham et al. 2002, p.6).

given greater weight while observations that are farther away are given less weight in estimation. One thing that is noteworthy about GWR is that it is an exploratory technique. The basic assumption of a global model is that the relationship between variables is universal across the entire study region. However, local models can be used to depict variation across space, and therefore show the falsity of the assumption of the global model (Fotheringham et al. 2002). Therefore, local models are used to explore exceptions or “hot spots” in the study region.

To estimate a GWR model for my data, I include in my model all of the independent variables except the interaction that show significance in the global model. Only including predictor variables that are verified by the global model minimizes violations of regression assumptions, particularly multicollinearity, in local models (Qiu and Wu 2011). I note that the GWR model I apply here is for linear regression due to the unavailability of ordered-logit GWR model software. To ensure applicability, I estimate an Ordinary Least Square (OLS) model to capture the global relations between the dependent variable and all the independent variables, and find that the results are very close to those estimated by the ordered-logit model. I use statistical tests developed by Leung, Mei and Zhang (2000) and Brunsdon, Fotheringham and Charlton (1999) to examine spatial nonstationarity based on the GWR model. None of these tests show that systematical spatial nonstationarity exists, which suggests that the relationship between the dependent variables and the independent variables does not vary significantly across space. However, further tests are needed to examine the existence of a mixed GWR model where some parameters are spatially uniform but others are non-stationary geographically.

As noted by Hamilton and Keim (2009), winter warming presents regional variation in terms of its effects on public perception of climate change[8]. Despite the spatial non-stationarity based on the GWR model I estimate, the variation of the local coefficients for these independent variables display geographic patterns. I present the regional pattern of local coefficients for the two significant local weather indicators – summer and spring temperature trends.

In Figure 3.11, I explore the geographic pattern of the effects of spring temperature trend on public views of global warming. The effects are most evident among southern residents. As one moves from south to north, the effect of spring temperature trend decreases, with residents in the Pacific, Northwest and Great Lakes areas being least responsive to this seasonal temperature trend over the last 10 years. The results indicate that southerners are more likely to associate increasingly cold springs with the notion of anthropogenic global warming.

In Figure 3.12, I explore the geographic pattern of the effects of summer temperature trends on public opinion towards global warming. Residents in the western part of the contiguous U.S. seem to be most affected by summer trends, and this suggests that they are most responsive to increasingly hot summers. In comparison, residents in the middle part of the United States are least affected by increasingly hot summers. Eastern residents' opinions towards global warming are moderately affected by the summer temperature trend.

[8] The authors adopt multi-level model to identify the regional difference in their study.

Conclusion

What have we learned about the determinants of public opinion of global warming in the United States?

First, among these three views on global warming, 87.5 percent of respondents believe in natural and anthropogenic global warming, while only 12.5 percent of individuals do not believe global warming is occurring. This suggests that the majority of the public tends to accept that global warming is a reality. However, for those who believe that global warming is taking place, whether global warming is mainly anthropogenic or natural is hotly debated – 37.2 percent of respondents believe earth is warming mainly because it is a natural cycle, while 50.3 percent of respondents believe earth is warming mainly because of human activities.

Second, exposure to the media does not appear to have a systematic effect on perceptions of global warming. This may be due to how the media covers global warming. There is some evidence that the balance norm practiced by the media conveys competing views on global warming, and this presentation leads to public confusion. Ultimately, media exposure does not help individuals make their decisions on this issue.

Third, I find that attitudes towards scientists play extremely important roles in shaping the public on global warming. When people have more confidence in scientists, believe scientists are conservative, and think there is a science consensus on global warming, they are more likely to accept anthropogenic global warming. This conclusion is both good and bad news to scientists. From a positive perspective, efforts can be directed toward the establishment of positive images of scientists, and this may serve to make their research conclusions more convincing and

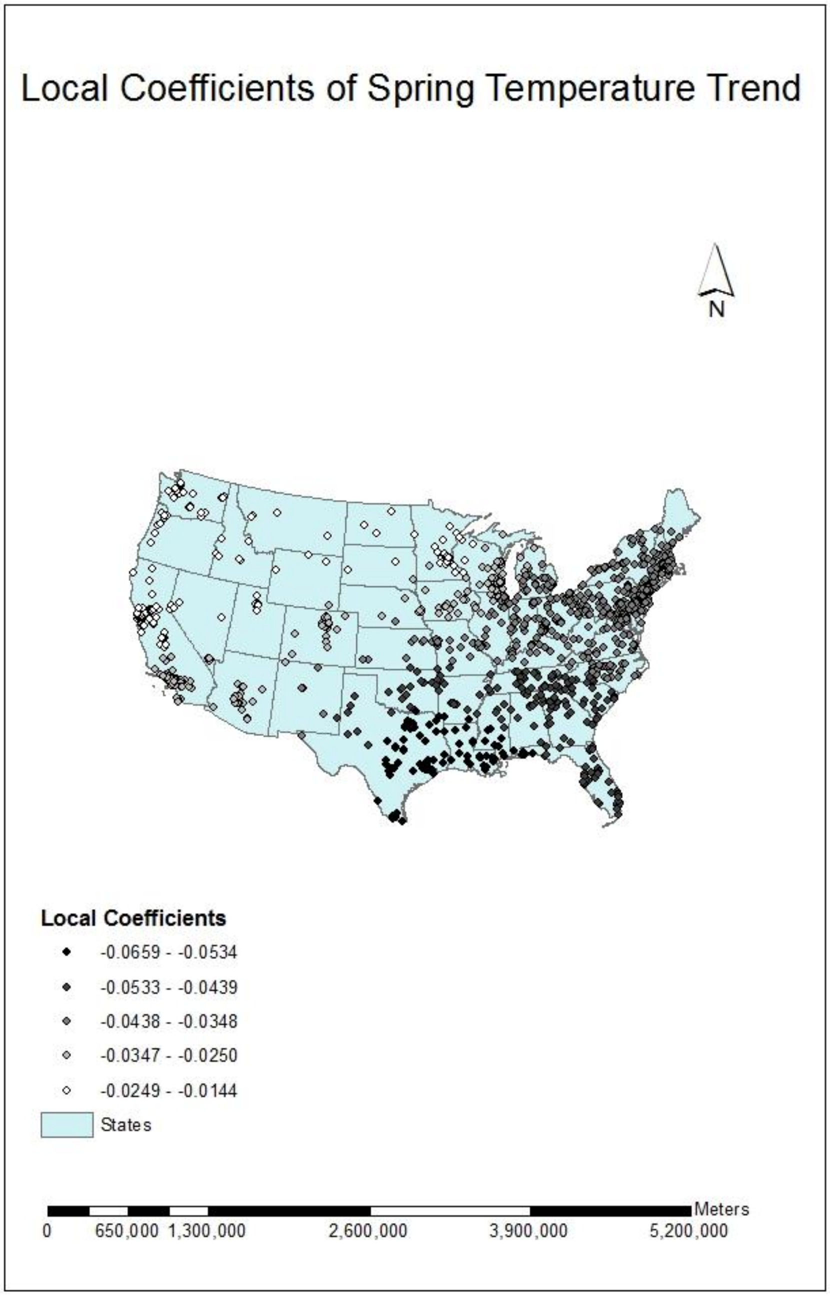

Figure 3.11 Local Effects of Spring Temperature Trend on Public Perceptions towards Global Warming across the Contiguous U.S., using Results from the GWR Model.

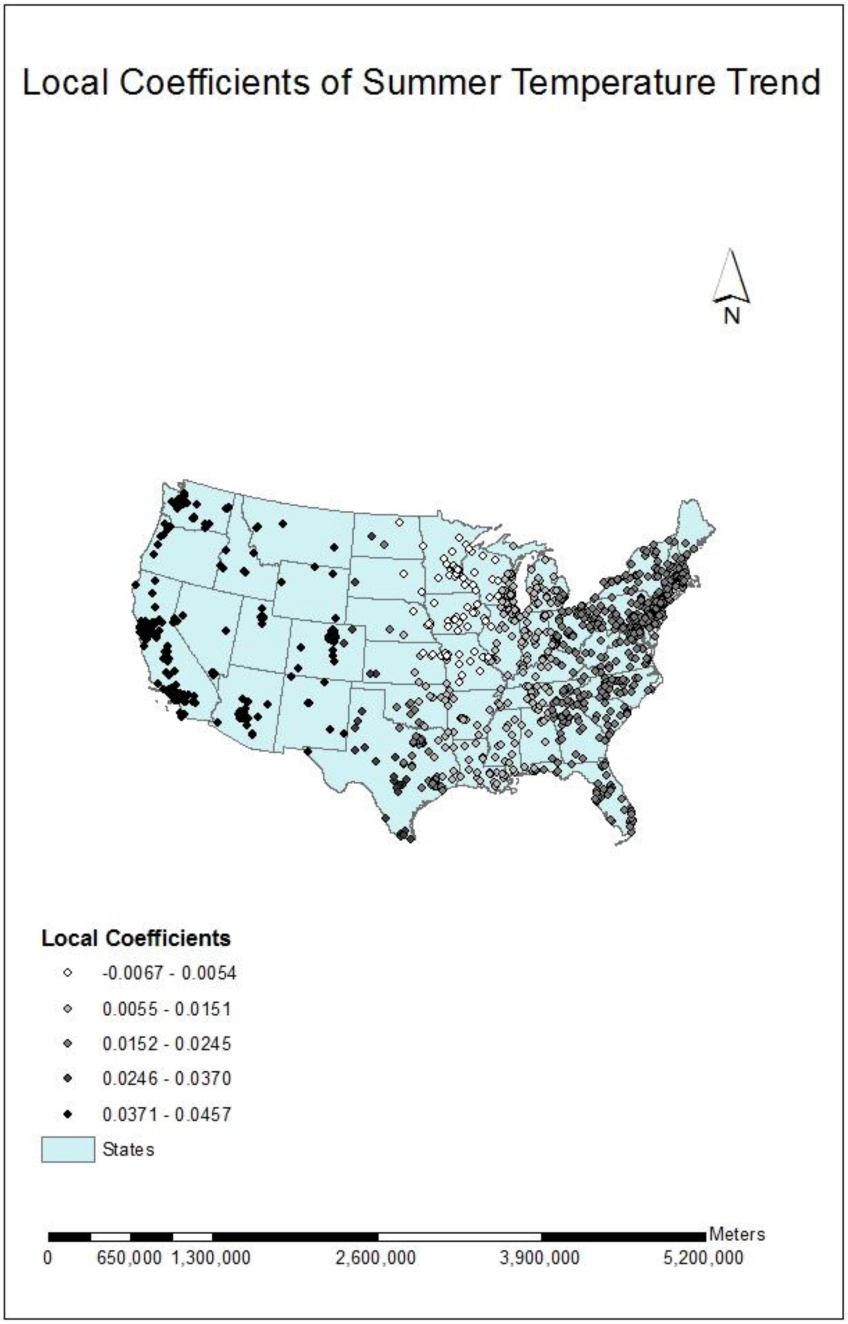

Figure 3.12 Local Effects of Summer Temperature Trend on Public Perceptions towards Global Warming across the Contiguous U.S., using Results from the GWR Model.

acceptable to the public. The bad news is that any event such as Climategate, the careless estimates of the Himalayan ice melting rate, and misstatement about the Netherlands could lead to mistrust of scientists' findings on global warming. Due to the mistakes made by a small number of scientists, the entire scientific community is still recovering from the adverse impacts of these errors.

Fourth, global warming, which is originally a scientific issue, has become highly politicized. Ideology and party identification have been shown in this study to be strong significant predictors of individual perceptions of global warming. Conservative and Republican Americans tend to be more skeptical of anthropogenic global warming, whereas liberal and democratic Americans are more likely to accept the notion of anthropogenic global warming. This conclusion strongly supports the hypothesis that people rely on their political predisposition when they interpret evidence about global warming. The political implication of global warming is highly complicated. For instance, Republicans and conservative individuals who are generally more averse to the government intervention tend to reject the strict regulations proposed under the circumstance of anthropogenic global warming. Meanwhile, age, gender, income, and education also have significant effects on public attitudes towards global warming. Individuals who are younger, female, with less income, and have obtained higher education tend to be more supportive of the notion of anthropogenic global warming. Generally, results about socio-demographic variables' effects on public perception of global warming conform to previous studies on environmental concern.

Fifth, seasonal temperature trends in the long-term (i.e., over the past 10 years) show some impacts on public views about global warming. Increasingly hot summers and increasingly cold springs cause people to be more certain of anthropogenic global warming. On the other hand, it seems that seasonal precipitation trends and short-term weather fluctuations do not have significant effects on public attitudes towards global warming. In conclusion, the actual weather is less important than attitudinal variables (e.g., political ideology, party identification, and attitudes towards scientists) in predicting public perceptions of global warming.

Finally, the statistical tests for spatial nonstationarity on the geographically weighted regression model do not display significant nonstationarity. However, it does not exclude the possibility of mixed GWR models, and further significance tests are needed to assess the existence of mixed GWR models. In addition, the local coefficients show geographic variations. Using results from the GWR model, present the geographic patterns for the two local weather indicators. Southerners are more likely to associate increasingly cold springs with the notion of anthropogenic global warming. Residents in the western part of the contiguous U.S. seem to be most affected by summer temperature trend in their belief in anthropogenic global warming.

CHAPTER 4 ECONOMY, WEATHER AND CLIMATE: WHICH AFFECTS THE RISK PERCEPTIONS OF GLOBAL WARMING? (2001-2010)

Introduction

Despite decades of scientists' efforts to send the alarm signal about global warming, there is no public consensus on the cause, existence, and impact of global warming. Global warming is far from being a purely scientific issue. The possible environmental, political and social impacts are believed to be profound to society. Given its complexity, aspects of global warming are selectively interpreted to fit the political agendas of elected officials, interest groups, and even some scientists (Nisbet and Myers 2007).

One of the main implications about global warming is more governmental regulation to reduce the emission of CO2. American conservatives prioritize individual freedom and private property rights, believe in the efficiency of free market, and therefore support limited government, while liberals promote collective rights and, governmental intervention (McCright and Dunlap 2011). Meanwhile, political elites purposefully choose their positions parallel to their ideological lines, which then causes an expansive division among the public (Fiorina and Abrams 2008). Thanks to the discrepancy in their respective pursuing ideals, conservatives and Republicans, on the one hand, and liberals and Democrats, on the other hand, are divided on the issue of global warming. Empirical studies provide evidence to support the assertion that Republicans and conservatives tend to be skeptical of anthropogenic global warming, and therefore less concerned about this issue, compared to Democrats and liberals (McCright and Dunlap 2011; Dunlap and McCright 2008; Pew Research Center 2006, 2007; Gallup 2008). Scholars have also noticed the interaction effects on public risk perception of global warming for party and education, on the one hand, and ideology and education, on the other hand (McCright and Dunlap 2011; Hamilton 2010; Hamilton and Keim 2009; Hamilton 2008; Pew Research Center 2007). As the level of education increases, Democrats and liberals tend to believe in anthropogenic global warming and express greater concern for global warming, while Republicans and conservatives are inclined to being skeptical of anthropogenic global warming and therefore show less concern for this issue. Indeed, these findings have been confirmed in the analyses presented in the previous chapter.

Meanwhile, there are a number of studies that examine the effects of socio-demographic characteristics on public attitudes toward global warming (Brody et al. 2008; Dietz et al. 2007; Dunlap 2008; McCright and Dunlap 2011; McCright 2009; Malka, Krosnick, and Langer 2009; Hamilton and Keim 2009; Krosnick et al. 2006; Leiserowitz 2006). Thanks to females' and racial minorities' perceived vulnerability, they tend to express higher level of concern for global warming than while males (Leiserowitz 2006; Malka et al. 2009; McCright 2009). However, in one study, white males surprisingly show more concern for global warming (Kellstedt et al. 2008). Primarily due to a cohort effect, age is found to have negative effects on public concern for global warming in some studies (Kellstedt et al. 2008; Krosnick et al. 2006; Malka et al. 2009). Education and income relating to social class have been usually hypothesized to be positively associated with environmental concern (Van Liere and Dunlap 1980; Jones and Dunlap 1992). However, there is a lack of evidence to support strongly the assertion that the correlations between education, income and risk perception of global warming are simply positive. As for the effects of income, McCright and Dunlap (2011) find that individuals with high income are more likely to perceive the effects of global warming but less likely to show concern for global warming; Hamilton and Keim (2009) find that people with high income are less likely to perceive local climate change effects. Meanwhile, some studies demonstrate that education attainment is negatively associated with concern for global warming (Malka et al. 2009; McCright and Dunlap 2011), while one study (Hamilton 2008) shows that education is positively associated with public concern for polar results of global warming; McCright and Dunlap (2011) find that people with high education tend to perceive global warming effects, while Hamilton and Keim (2009) show that education has no significant effects on individuals' perception of local climate change effects.

Furthermore, a review of the results of multiple surveys show during the recent economic downturn, public concern for global warming has decreased (Pew Research Center for People and Press, 2001-2010). In his theory of human motivation, Maslow (1943) proposed hierarchies of prepotency, and arguably this provides an explanation for the competing relationship between concern for the environment and economy. Human motivation and human attention are limited resources. People tend to meet their basic physiological needs such as food, shelter, and economic stability before they turn their attention to aesthetic needs such as arts, entertainment, and environmental quality (Maslow 1943). The ability of individuals to meet these needs rests in no small part on the level of economic performance in a political or economic system. Hence it is possible that economic downturns will be perceived as inhibiting individuals' ability to meet their basic needs; while basic needs will be met more easily when the economy is doing well.

There has been some research done on the possible tradeoff between economic conditions and environmental attitudes and perceptions. By using data over 18 years (1973-1990), Jones and Dunlap (1992) fail to find evidence to support the hypothesis of "economic contingency," which indicates that the economically disadvantaged will favor economic growth over environmental protection during an economic downturn. However, the study by Durr (1993)suggests that the personal expectation of economic performance does play a significant role in determining whether to support liberal or conservative policies. Elliott, Seldon, and Regens (1997) find that both individual and macro-economic conditions have significant effects on public support for environmental spending. More recently, Hamilton et al. (2010)find a negative association between unemployment rate (county) and individuals' support for environmental rules. Similarly, Kahn and Kotchen (2010)find evidence to support the assertion that increases in the local unemployment rate (state and county) are associated with the decrease of concern for global warming, and therefore the decrease of intention to mitigate global warming.

A recent poll demonstrates that a majority of Americans link weather extremes to global warming (Leiserowitz 2006). In the literature, the effects of local weather and climate on public perception of global warming have been estimated in several studies. Self-reported local weather (Krosnick 2006), personal observation of local weather (Borick and Rabe 2010), short-term weather fluctuations (Egan and Mullin 2012), and long-term (i.e., 1970-2007) winter temperature trend (Hamilton and Keim 2009) have all been found to be linked to public perception of global warming. However, the research agenda on the effects of local weather and climate on perceptions of climate change is by no means complete.

Page and Shapiro (1992)analyze 50 years of data on subjects covering social issues, economic welfare, and foreign policy, and they come to the conclusion that the public, to the surprise of many observers, behaves rationally when making judgments on important political issues and policy choices. The collective opinion change corresponds to the change of population composition which "follows from shared personal experience or from shared information about events" (Page and Shapiro 1992, p. 31). From this point of view, we surely can correlate changes in public opinion towards global warming with demographic bases, "shared personal experience" (such as local weather and climate), and "shared information about events" (such as unemployment rate).

In this chapter, I first compile two series of survey datasets, each of which has the same survey question about global warming and the same group of socio-demographic variables and political predisposition variables measured repeatedly over time. I then merge the survey data with data on local weather and monthly unemployment rate measured at the county level. I finally conduct a pooled cross sectional analysis to examine how the social base (including age, gender, education, income, party identification, political ideology, race, and church attendance), local weather and climate, and local economic conditions affect public risk perception of global warming.

In this chapter I accomplish two major objectives. First, I examine how socio-demographic characteristics, political predisposition, and local weather and economic condition affect public risk perceptions of global warming. Even though there are a number of studies examining the correlation between socio-demographic characteristics and political predisposition, on one hand, and risk perception of global warming, on the other (i.e. McCright 2009; Hamilton 2010; McCright and Dunlap 2011), none has systematically included economic indicators and local weather and climate measures as the contextual variables in the model predicting public risk perceptions of global warming. Second, by using data from multiple years, I can not only investigate the relationships between the social base, political predisposition, local weather and climate, unemployment rate, and public risk perceptions of global warming in individual years, but also examine these relationships based on the pooled data. By doing so, I increase the temporal breadth of previous studies.

Data and Methods

The survey data for this analysis come from two sources: CBS News/New York Times Polls and Pew Research Center for the People and the Press Polls. The CBS News/New York Times Polls relating to global warming come from Inter-University Consortium for Political and Social Research (ICPSR). They consist of seven surveys:

- CBS News/New York Times Monthly Poll (June 14, 2001-June 18, 2001) (http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/03349)
- CBS News Monthly Poll (September 15, 2003-September 16, 2003) (http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/03920)
- CBS News/New York Times Monthly Poll (April 20, 2007-April 24, 2007) (http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/23443)
- CBS News Monthly Poll (October 12, 2007-October 16, 2007) (http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/24360)
- CBS News/New York Times Monthly Poll (December 5, 2007-December 9, 2007) (http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/24363)
- CBS News Monthly Poll (February 2, 2009- February 4, 2009) (http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/26943)
- CBS News/ New York Times Monthly Poll #1(April 5, 2010-April 12, 2010) (http://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/31569)

These surveys all ask the same question,

> "Do you think global warming is an environmental problem that is causing a serious impact now, or do you think the impact of global warming won't happen until sometime in the future, or do you think global warming won't have a serious impact at all?"

Hence one can explore patterns and determinants of concern for global warming over a one decade period. In particular, this permits us to consider how changing weather patterns influence perceptions of concern with global warming.

The Pew Research Center for the People and the Press Polls relating to global warming consist of six surveys including:

- June 2006 News Interest/Believability Poll (June 14, 2006-June 19, 2006) (http://www.people-press.org/2006/07/12/little-consensus-on-global-warming/)
- January 2007 News Interest Index Poll (January 10, 2007-January 15, 2007) (http://www.people-press.org/2007/01/24/global-warming-a-divide-on-causes-and-solutions/)
- April 2008 Political Survey (April 23, 2008-April 28, 2008) (http://www.people-press.org/2008/05/08/a-deeper-partisan-divide-over-global-warming/)
- April 2009 General Public Science Survey (April 28, 2009-May 12, 2009) (http://www.people-press.org/2009/07/09/public-praises-science-scientists-fault-public-media/)
- October 2009 Political Survey (September 30, 2009-October 4, 2009) (http://www.people-press.org/2009/10/22/fewer-americans-see-solid-evidence-of-global-warming/)

- October 2010 Political Survey (October 13, 2010-October 17, 2010) (http://www.people-press.org/2010/10/27/little-change-in-opinions-about-global-warming/)

These surveys all ask the same question, “In your view, is global warming a very serious problem, somewhat serious, not too serious, or not a problem?”

It is worth noting that the time periods covered in both sets of surveys capture the high- and low-points for attitudes toward global warming. Both the CBS News / New York Times and Pew Surveys begin prior to the precipitous dropoff in public attitudes relating to climate change. Hence this analysis permits me to explore the effects of a wide range of independent variables on attitudes toward climate change at the very time when concern for climate change was on the decline.

The primary focus of this dissertation chapter is public risk perception of global warming based on these two questions. Each survey series also includes the same group of socio-demographic variables. The CBS News series include gender, race, age, education, income, party identification, and ideology, while the Pew survey series has church attendance in addition to those variables mentioned above. The geographic codes provided by the seven CBS datasets are FIPs county and state codes, while the six Pew surveys provide zip codes. This permits me to merge geocoded data with the survey data.

The climate data are from the United States Historical Climatology Network (USHCN) monthly temperature and precipitation data. The USHCN provides a high quality, error-controlled data set of “daily and monthly basic meteorological variables from 1218 observing stations across the 48 contiguous United States" (USHCN, http://cdiac.ornl.gov/epubs/ndp/ushcn/background.html). Data for the monthly unemployment rate was purchased from U.S. Bureau of Labor and is measured at the county level.

I supplement these survey data with long-term climate trends represented by temperature trend and precipitation trend over the past 10 years prior to the interview date, and short-term weather fluctuations represented by the departure from normal temperature/precipitation measured in standard deviation units over the month prior to the interview date. A more detailed description of these data and the variables that are derived from these data can be found below.

Furthermore, I supplement these survey data with unemployment rate data over the month prior to the interview date. I also combine the CBS surveys and Pew surveys into pooled samples, and this permits me to estimate models of global warming perceptions over multiple surveys. Because each of these surveys has a different number of respondents, respondents in smaller surveys cannot be counted collectively as much as those respondents in larger surveys. Therefore, weighting technique—sampling weights— is used to equalize the contribution of each survey due to the various numbers of respondents across surveys. Sampling weights used by Stata are "weights that denote the inverse of the probability that the observation is included." (Stata, http://www.stata.com/help.cgi?weight)

Dependent Variable

The public risk perception of global warming is the primary focus in this chapter. The merged data for the first set of analyses come from the seven CBS surveys. The CBS News/New York Times Poll (June 14, 2001-June 18, 2001) provides three responses to the question of global warming impact: “impact now”, “in the future”, and “no serious impact.” Five surveys including CBS News/New York Times Poll (April 20, 2007-April 24, 2007), CBS News Poll (October 12, 2007-October 16, 2007), CBS News/New York Times Poll (December 5, 2007-December 9, 2007), CBS News Poll (February 2, 2009- February 4, 2009), and CBS News/ New York Times Monthly Poll #1(April 5, 2010-April 12, 2010) provide four responses: “impact now”, “in the future”, “no serious impact”, and “global warming doesn’t exist”. Relatively few respondents indicate that “global warming doesn’t exist” (1.1%, 2.7%, 2%, 4.6%, 10.3%, respectively), and arguably the “no serious impact” and “global warming doesn’t exist” responses convey a similar level of skepticism about global warming. Because of the similar implication of no impact, and in order to create some degree of comparability across all surveys, I combine the response for “global warming doesn’t exist” with the response for “no serious impact”. This permits me to combine these data with the earlier data that has only three responses to the global warming item. The CBS News Poll (September 15, 2003-September 16, 2003) has two items associated with global warming impact. One item asking “Do you think global warming is an environmental problem that is causing a serious impact now, OR do you think global warming isn't having a serious impact?” has two responses: “impact now” and “no serious impact”. The other item asking “Do you think global warming will get more serious in the future, or not?” has two responses: “will get more serious” and “will not”. I combine these two items by coding those who answer “no serious impact” in the first item and “will not” in the second item as 0; those who answer “no serious impact” and “will get more serious” as 1; and those who answer “impact now” and “will get more serious” as 2. To summarize, I measure risk perception of global warming urgency on a scale from 0 (no impact) to 2(impact now).

The pooled data for the second part of the analysis come from the six Pew surveys. The question wording is consistent across all of these surveys, which provide four responses about the seriousness of global warming: “very serious”, “somewhat serious”, “not too serious”, and “not a problem”. I code this variable, risk perception of global warming severity, on a scale from 0 (not a problem) to 3 (very serious).

Independent Variables

Demographic characteristics. I include age, education, income, gender and race (black and Hispanics) in the first set of analyses that use the CBS series data. I add church attendance in the second set of analyses of the Pew series data to the variables included in the first analysis. The responses to most relevant items on these two sets of survey data are somewhat different. Therefore, the corresponding scales I create based on each item are mostly different. Specifically, for both analyses, I measure respondents’ Age in years, ranging from 18 to 99 years. For the first set of analyses that use the CBS series data, I measure Education on a scale from 1 (respondent has not completed high school) to 5 (respondent has earned a post-graduate degree). I measure Income on a scale ranging from 1 (“less than $15,000”) to 5 (“more than $75,000”). As for the second set of analyses that use the Pew series data, I code Education on a scale from 1 (none, or grade 1-8) to 7(Post-graduate training or professional schooling after college), while I measure Income on a scale ranging from 1 (less than $10,000) to 9 ($150,000 or more). As indicated by previous research, I speculate that older people with less education and less income are less likely to perceive global warming as an urgent issue, or as a serious problem.

In addition, I posit that the public risk perception of global warming is shaped by race and gender. The risk assessment literature has identified the “white males” effect, which indicates that racial minorities and women are more sensitive to, and therefore are more concerned about, risks due to their vulnerabilities. Thus, I create three binary variables to represent Black respondents (“black” = 1; “other” = 0), Hispanic respondents (“Hispanic”=1; “other”=0), and Gender (“women” = 1; “men” = 0) for both analyses. I hypothesize that the coefficients for these three variables are positive in predicting the risk perception of global warming.

Finally, for the second set of analyses that use the Pew series data, I include church attendance in my models. This variable is measured on a scale ranging from 0 (never attend services) to 5 (more than once a week). Attending religious service has been found to have a negative effect on the public perceptions of climate change (Hamilton and Keim 2009). Thus, I posit that individuals who attend religious services more often are less likely to believe global warming is a serious problem.

Predispositions. Party identification and ideology have been shown to be important indicators of perception of global warming. As for the analyses that use the CBS series data, I measure ideology on a three-point scale, ranging from 1 (liberal) to 3 (conservative). Party identification is also measured on a three-point scale, ranging from 0 (Democrat) to 2 (Republican). I hypothesize that people who are conservative and are Republicans are less likely to perceive that global warming is an urgent problem. As for the analyses that use Pew series data, Ideology is on a scale ranging from 0 (very liberal) to 4 (very conservative). I measure Party identification on a scale, ranging from 0 (Democrat) to 4 (Republican). I speculate that individuals who are more liberal and are Democrats are more likely to view global warming as a serious problem.

Contextual Variables. Local weather and climate. By using monthly temperature and precipitation data from USHCN, I create four seasonal temperature and four seasonal precipitation trends including Winter (December, January, February), Spring (March, April, May), Summer (June, July, August), and Fall (September, October, November) trends over the past 10 years prior to the survey dates. These variables are linear trends of temperature or precipitation over years. In addition, I include two weather measures to capture the short-term weather fluctuation. They are: average temperature departure from normal temperature (DNT) over the month prior to the survey date, average precipitation departure from normal precipitation (DNP) over the month prior to the survey date. To account for relative weather fluctuation in different regions, these departures are measured in standard deviations. I calculate these two measures:

DNT_i = ($temperature_i$-normal $temperature_i$)/standard deviation of temperature (1981-2010) ,

DNP_i = ($precipitation_i$-normal $precipitation_i$)/standard deviation of precipitation (1981-2010),

where DNT_i / DNP_i is the local temperature/precipitation experienced by respondent i, $temperature_i$ /$precipitation_i$ are the respondent i's local average temperature and monthly total precipitation over the month before his or her interview, normal $temperature_i$ / normal $precipitation_i$ is the normal average of monthly mean temperature and normal average of monthly total precipitation for that month, calculated over the period 1981-2010 (current normal period in climatology), and standard deviation of temperature/precipitation is the standard deviation of monthly mean temperature and monthly total precipitation calculated based on the monthly average over the period 1981-2010[9].

The county and state fips codes provided by the CBS/New York Times series and zip codes provided by the Pew series data allow me to identify geographically each respondent. In ArcGIS, I match the layer of respondents' locations with the layer of USHCN weather stations' locations. By using the feature – join data from another layer based on spatial location— provided in ArcGIS, I then identify the weather stations that are located closest to each respondent and use the monthly temperature and precipitation data from that station. I hypothesize that the effects of local weather should be positive on perception of global warming urgency, which means that people who experience more temperature variation are more likely to perceive global warming is urgent.

The other contextual variable is Unemployment rate. The data for unemployment rates are from the U.S. Labor of Bureau, and are measured at the county level. Here, unemployment rate at the county level is used as a proxy for the macro-economic condition.

Survey. There are seven surveys in the CBS series data. I create six dummy variables for six surveys, with the excluded survey representing the reference survey. There are six surveys in the Pew series data. I create five dummy variables for five surveys, with one being the reference. The purpose of doing so is to account for different mean values on the dependent variable across

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[9] The monthly data I select depends on the date when each survey was conducted. When the survey was mainly conducted early on a particular month (i.e., before 15th of that month), I extract the monthly average temperature and monthly total precipitation data on the month prior to the interview month. When the survey was conducted late on a particular month (i.e., after 20th of that month) or on the week between two months (i.e., from 28th of April to 10th of May), I extract the monthly average temperature and monthly total precipitation data on the former month.

surveys. The coefficients for these fixed effects variables are not reported in my statistical tables for the sake of brevity.

Interactions. I include two interaction variables in both analyses. First, I include an interaction for education and party identification to capture the variable effects of education on perception of global warming across the party line. As noted, I hypothesize that the effects of education on perception of global warming vary with party and political ideology. Specifically, the effects of education on the dependent variable should be positive among Democrats, and negative among Republican, so I expect the coefficient for these interactions to be negative. Second, I posit that the relationship between education and perception of global warming should be positive among individuals who are liberal, and negative among those who are conservative. Hence, I create an interaction variable for education and ideology; I expect that the coefficients for this variable will be negative. A summary of the variables used in these two analyses can be found in Tables 4.1 and 4.2.

Empirical Analysis and Results

Analysis I. Public Risk Perception of Global Warming Urgency

I first model public risk perception of global warming urgency as a function of a range of social variables, long-term weather trends, short-term weather variation, and unemployment rate. I estimate this model separately for each dataset of the CBS survey series. As Table 4.3 demonstrates, party identification and political ideology are the two most consistent independent variables that have significant negative effects on public perception of global warming urgency across the seven surveys. Simply, conservatives and Republicans are significantly less likely to perceive that global warming is an urgent problem than liberals and Democrats. The results lend

Table 4.1 Coding, Means, and Standard Deviations for Variables from the CBS Surveys[a]

Variable	coding	Mean	S.D
Global warming impact	0 (no serious impact); 1 (impact in the future); 2 (impact now)	1.34	.75
Party identification	0 (Democrat) to 2(Republican)	.94	.82
Ideology	1 (Liberal) to 3 (Conservative)	2.13	.73
Age	Number in actual years (18-99)	54.40	17.98
Gender	0 (male) to 1 (female)	.63	.48
Education	1 (not a high school grad) to 5 (post grad)	3.21	1.19
Annual income	1 (under 15K) to 5 (over 75K)	3.54	1.31
Black	0 (other) to 1 (black)	.07	.26
Hispanic	0 (other) to 1 (Hispanic)	.04	.21
Winter temperature trend	-9.14 to 9.25	-1.56	2.06
Spring temperature trend	-5.65 to 8.34	.31	2.01
Summer temperature trend	-6.38 to 6.42	.57	1.37
Fall temperature trend	-3.89 to 7.33	.23	1.34
Winter precipitation trend	-84.29 to 57.39	-1.04	13.06
Spring precipitation trend	-41.72 to 44.84	-1.98	11.07
Summer precipitation trend	-51.18 to 58.48	3.75	14.81
Fall precipitation trend	-56.90 to 49.28	2.64	15.60
Average temperature departure from normal temperature	-2.82 to 2.97	.37	1.02
Average precipitation departure from normal precipitation	-2.39 to 3.90	-.25	.89
Unemployment rate	1.6 to 23.9	6.35	3.12

[a] Note: The data used here are weighted.

strong support to the assertion that political predispositions play an essential role in determining public opinion towards global warming.

The coefficients for the various socio-demographic variables are less stable throughout the years. Among them, gender is the most consistent variable; the gender coefficient is statistically significant and positive in five of the seven surveys; it would appear that women are more likely to perceive that global warming is an urgent problem. Education is found to be positively associated with the dependent variable in the last four surveys, indicating that individuals with high levels of education are more likely to view global warming as a problem. Age has significant and negative effects on the dependent variable in three surveys, while

Table 4.2 . Coding, Means, and Standard Deviations for Variables from the Pew Center Surveys[a]

Variable	coding	Mean	S.D
Concern for Global warming	0 (not a problem) to 3 (very serious)	1.34	.75
Party identification	0 (Democrat) to 4(Republican)	1.84	1.66
Ideology	0 (very liberal) to 4 (very conservative)	2.20	.95
Age	Number in actual years (18-99)	52.14	18.30
Gender	0 (male) to 1 (female)	.51	.50
Education	1 (none, or grade 1-8) to 7 (post grad)	4.74	1.62
Annual income	1 (less than $10,000) to 9 (over $150,000)	5.19	2.36
Black	0 (other) to 1 (black)	.10	.31
Hispanic	0 (other) to 1 (Hispanic)	.06	.25
Church attendance	0 (never) to 5 (more than once a week)	2.73	1.61
Winter temperature trend	-10.34 to 5.94	-1.26	2.00
Spring temperature trend	-5.41 to 6.03	.31	2.01
Summer temperature trend	-6.34 to 7.11	.60	1.32
Fall temperature trend	-4.38 to 6.55	.43	1.39
Winter precipitation trend	-83.21 to 51.81	.89	12.29
Spring precipitation trend	-122.82 to 141.63	-.08	15.16
Summer precipitation trend	-61.96 to 67.90	2.66	14.79
Fall precipitation trend	-56.90 to 51.11	2.49	15.01
Average temperature departure from normal temperature	-2.69 to 2.94	.41	.80
Average precipitation departure from normal precipitation	-2.18 to 4.92	-.00	.95
Unemployment rate	1.4 to 31.8	7.04	2.98

[a] Note: The data used here are weighted.

income is only found to be negatively associated with public perception of global warming urgency in two surveys. Contrary to expectations, the effects of race are mostly absent, with Hispanics showing significant and negative results in the survey conducted in December 2007 and Black only showing significant and positive results in the survey conducted in April 2010.

Among the local weather and climate indicators, summer temperature trend is the most consistent variable that has significant effects on public perception of global warming urgency. However, the direction of this variable is not consistent. Summer temperature trend is positively associated with the dependent variable in the surveys conducted in December, 2007 and April, 2010, while it is negatively associated with the dependent variable in the survey conducted in

April, 2007. Other local weather and climate indicators that show significant effects on risk perceptions of global warming include the winter precipitation trend (December, 2007), fall precipitation trend (December, 2007 and February, 2009), and departure from normal temperature (in standard deviation units) over the month prior to the interview date (April, 2010). The unemployment rate at the county level over the month prior to the interview date is not found to have any significant effects on public risk perception of global warming urgency.

Fluctuations in the effects of some of these independent variables across surveys are not totally unexpected, particularly given the smaller sample sizes for some of the surveys. We can consider the overall effects of these variables by combining data from the surveys together to create a pooled data set. Using the pooled data[10], I model public risk perception of global warming urgency as a function of a range of social variables, long-term weather trends, short-term weather variation, interaction that capture the variable effects of ideology across different levels of education, and interaction that capture the variable effects of party across different levels of education. In Table 4.4, I present the empirical results of this model.

In Model (1) of Table 4.4, I report the coefficients for the independent variables, but without the interaction variables. As one can see, all of the social variables except Hispanics show significant effects on individuals' risk perceptions of global warming. As the results from Model (1) of Table 4.4 show, the observed effects of gender and race conform to the findings from most studies of environmental concern. Females and blacks tend to view global warming as

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[10] To account for different mean values on the dependent variables across different surveys, I also include the fixed effects – i.e., dichotomous variables for each of the surveys, except one.

Table 4.3 Ordered-Logit Estimates for Models of Public Risk Perceptions of Global Warming Urgency, 2001-2010 (CBS Survey Series)

	2001/06		2003/09		2007/04	
Social Variables						
	b	z	b	z	b	z
Party Identification [-]	-0.497	-3.15***	-0.436	-1.30	-0.718	-7.40***
Ideology [-]	-0.397	-2.26*	-0.622	-1.72*	-0.648	-6.12***
Race (Black) [+]	0.082	0.16	16.43	0.01	0.278	0.98
Race (Hispanic) [+]	0.385	0.55	-0.489	-0.53	-0.108	-0.35
Gender (female) [+]	0.404	1.65*	0.605	1.29	0.177	1.26
Age [-]	-0.004	-0.49	0.013	0.98	-0.005	-1.17
Education [+]	0.067	0.62	0.132	0.61	-0.017	-0.26
Income [-]	0.015	0.14	-0.428	-2.09*	-0.036	-0.60
Seasonal Temperature Trends						
Winter [+]	0.024	0.25	0.245	1.46	0.105	1.63
Spring [+/-]	-0.101	-1.45	0.016	0.42	-0.045	-0.59
Summer [+]	0.212	1.81	0.142	0.51	-0.170	-2.22*
Fall [+/-]	-0.047	-0.44	-0.324	-1.29	-0.109	-1.50
Seasonal Precipitation Trends						
Winter [+/-]	-0.009	-0.90	-0.007	-0.28	-0.001	-0.19
Spring [+/-]	-0.015	-1.11	-0.003	-0.12	-0.012	-1.44
Summer [+/-]	-0.007	-0.66	0.010	0.54	-0.003	-0.53
Fall [+/-]	-0.003	-0.20	0.000	0.02	-0.003	-0.45
Short-term Weather Fluctuation						
Temperature [+/-]	-0.149	-0.65	0.301	0.67	-0.270	-1.80
Precipitation [+/-]	-0.207	-1.13	-0.101	-0.33	-0.035	-0.42
Unemployment [-]	0.164	1.59	-0.100	-0.63	0.009	0.16
N	287		125		863	
Pseudo R^2	0.0861		0.171		0.1081	
Wald Chi^2	51.01		35.85		184.09	

Table 4.3 (Continued)

	2007/10		2007/12		2009/02	
Social Variables						
	b	z	b	z	b	z
Party Identification [-]	-0.591	-6.73***	-0.722	-7.33***	-0.717	-6.33***
Ideology [-]	-0.562	-5.63***	-0.483	-4.56***	-0.772	-6.03***
Race (Black) [+]	-0.240	-0.87	-0.075	-0.26	0.207	0.59
Race (Hispanic) [+]	0.123	0.38	-0.632	-1.83*	0.538	1.31
Gender (female) [+]	0.382	2.86**	0.333	2.17*	0.669	3.99***
Age [-]	-0.012	-3.04***	-0.011	-2.55**	-0.004	-0.86
Education [+]	0.131	2.20*	0.114	1.69*	0.167	2.14*
Income [-]	-0.099	-1.69*	-0.024	-0.39	-0.048	-0.66
Seasonal Temperature Trends						
Winter [+]	-0.067	-1.06	-0.047	-0.77	0.014	0.31
Spring [+/-]	0.028	0.58	0.103	1.58	0.050	0.48
Summer [+]	0.087	1.43	0.118	1.91*	0.101	1.06
Fall [+/-]	0.060	0.86	0.065	0.91	-0.123	-1.28
Seasonal Precipitation Trends						
Winter [+/-]	0.001	0.10	0.016	1.97*	0.004	0.43
Spring [+/-]	-0.003	-0.49	0.010	1.41	-0.017	-1.41
Summer [+/-]	0.000	0.00	0.001	0.20	0.004	0.63
Fall [+/-]	-0.001	-0.13	-0.012	-1.97*	0.002	0.23*
Short-term Weather Fluctuation						
Temperature [+/-]	-0.059	-0.43	-0.453	-2.54	0.278	2.32
Precipitation [+/-]	0.017	0.15	0.017	0.13	0.018	0.11
Unemployment [-]	-0.028	-0.54	0.007	0.12	-0.032	-0.91
N	1018		894		621	
Pseudo R^2	0.0892		0.0983		0.1384	
Wald Chi^2	177.57		166.38		185.29	

Table 4.3 (Continued)

	2010/04	
Social Variables		
	b	z
Party Identification [-]	-0.816	-8.58***
Ideology [-]	-0.980	-9.55***
Race (Black) [+]	0.814	2.43*
Race (Hispanic) [+]	0.476	1.33
Gender (Female) [+]	0.438	3.40***
Age [-]	-0.011	-2.69**
Education [+]	0.164	2.61**
Income [-]	-0.063	-1.10
Seasonal Temperature Trends		
Winter [+]	-0.016	0.33
Spring [+/-]	-0.058	-1.12
Summer [+]	0.124	1.79*
Fall [+/-]	-0.029	-0.40
Seasonal Precipitation Trends		
Winter [+/-]	0.002	0.42
Spring [+/-]	0.006	0.82
Summer [+/-]	0.009	1.55
Fall [+/-]	-0.003	-0.48
Short-term Weather Fluctuation		
Temperature [+/-]	0.196	2.01*
Precipitation [+/-]	0.010	0.14
Unemployment [-]	-0.007	-0.26
N	1104	
Pseudo R^2	0.1843	
Wald Chi^2	427.03	

***prob<0.001 (one-tail test); **prob<0.01 (one-tail test); *prob<0.05 (one-tail test)

Note: The constant terms and year fixed-effects variables are omitted from the table for the sake of brevity.

an urgent problem. However, Hispanics are not found to have significant effects on the risk perception of global warming urgency.

Meanwhile, older people are less likely to see global warming as urgent. The coefficient for education is positive, indicating that individuals with higher education tend to perceive that global warming is impacting now. On the other hand, the income variable has a negative effect on public risk perception of global warming urgency. People who have more income are less likely to see the urgency of global warming.

As for predisposition variables, the effects of party identification and ideology are significantly negative, indicating that Republicans (Democrats) and conservatives (liberals) are less (more) likely to see global warming as urgent. Using the results from Table 4, model 1 and holding the values of all other independent variables constant at their means, I estimate predicted probabilities across the scales of party identification and political ideology. To demonstrate the effects of party and ideology on public risk perception of global warming, in Figures 4.1 and 4.2 I present the predicted probabilities for the relationship between party and ideology, respectively, and three views of global warming. Moving from 0 (Democrat) to 2 (Republican), the probability that individuals believe that "global warming is causing a serious impact now" decreases from 61 percent to 29 percent. Meanwhile, the probability for one to believe "global warming won't have any serious impact at all" increases from 11 percent to 31 percent. Democrats tend to believe"global warming is having a serious impact now" by the margin of 61 percent to 28 percent, while Republicans tend to believe "the impact of global warming won't happen until sometime in the future" by the margin of 40 percent to 29 percent. Based on Figure 6, it appears that there is a consensus among Democrats that global warming is having an immediate impact, while Republicans are fairly equally divided among the three options.

Table 4.4 Ordered Logit Estimates for Models of Public Risk Perceptions of Global Warming Urgency, Pooled Data from CBS Survey Series (2001-2010)

Model	(1)		(2)	
	b	z	b	z
Social Variables				
Party Identification [-]	-0.670	-13.32***	-0.485	-3.62***
Ideology [-]	-0.624	-11.72***	0.161	1.05
Race (Black) [+]	0.321	2.18*	0.334	2.29*
Race(Hispanic) [+]	0.067	0.33	0.119	0.58
Gender (Female) [+]	0.354	5.04***	0.347	4.90***
Age [-]	-0.006	-2.89**	-0.007	-3.00**
Education [+]	0.087	2.61**	0.676	6.50***
Income [-]	-0.078	-2.51**	-0.079	-2.54**
Seasonal Temperature Trends				
Winter [+]	0.030	1.43	0.030	1.41
Spring [+/-]	-0.038	-1.79	-0.039	-1.81
Summer [+]	0.075	2.53*	0.075	2.51*
Fall [+/-]	-0.034	-1.19	-0.037	-1.28
Seasonal Precipitation Trends				
Winter [+/-]	-0.002	-0.75	-0.002	-0.77
Spring [+/-]	-0.006	-1.65	-0.006	-1.75
Summer [+/-]	0.001	0.46	0.001	0.55
Fall [+/-]	-0.002	-0.78	-0.002	-0.81
Short-term Weather Fluctuation				
Temperature [+/-]	0.094	2.18*	0.087	2.03*
Precipitation [+/-]	0.003	0.08	0.009	0.20
Unemployment Rate [-]	-0.007	-0.38	-0.005	-0.26
Interaction Terms				
Party*Education [-]	---	---	-0.038	-0.92
Ideology*Education [-]	---	---	-0.250	-5.23***
N	4912		4912	
Pseudo R^2	0.1349		0.1406	
Wald Chi^2	915.86		917.15	

***prob<0.001 (one-tail test); **prob<0.01 (one-tail test); *prob<0.05 (one-tail test)

Note: The constant terms are omitted from the table for the sake of brevity.

Likewise, based on the probabilities presented in Figure 4.2 it appears that liberals and conservatives differ considerably in their views toward global warming. As one moves from 1 (liberal) to 3 (conservative), the probability that individuals believe that "global warming is causing serious impact now" decreases from 64 percent to 32 percent, and probability of believing "global warming won't have any serious impact at all" increases from 10 percent to 29 percent. Liberals are more likely to believe that "global warming is causing a serious impact now" by a margin of 64 percent to 27 percent, while conservatives are more likely to believe "the impact of global warming won't happen until sometime in the future" by the margin of 40 percent to 32 percent. Here again, there is a relative consensus among liberals as to the urgency of concern over global warming, while conservatives are split among the three options.

Among the local weather and climate measures, I find that only two variables have significant effects on the dependent variable: (1) summer temperature trend over the past 10 years, and (2) the standard deviation departure from normal temperature over the month prior to the interview date. Specifically, rising temperatures during the summer months exert a positive effect on public perception of urgency of global warming impact, indicating that individuals who experience increasingly hot summers are more likely to believe global warming is having an immediate impact now.

Meanwhile, individuals who experienced a higher than normal temperatures in the month prior to the interview date are more likely to believe that global warming is an urgent problem. To illustrate the effects of local weather, in Figure 4.3, I present predicted probabilities for the relationship between the local temperature trend during the summer over the past 10 years and individuals' perceptions that "global warming is causing a serious impact now," "the impact of

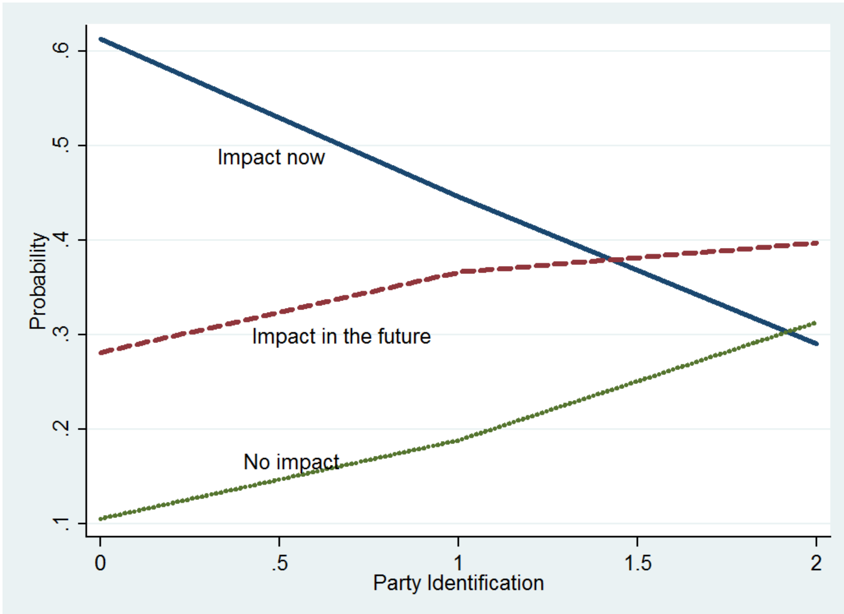

Figure 4.1 Predicted Probabilities that “Global warming is causing a serious impact now,” “the impact of global warming won’t happen until sometime in the future,” “global warming won’t have a serious impact at all,” as a Function of Party (0 =Democrat, 1=Independent, 2=Republican), based on Table 4.4, Model 1.

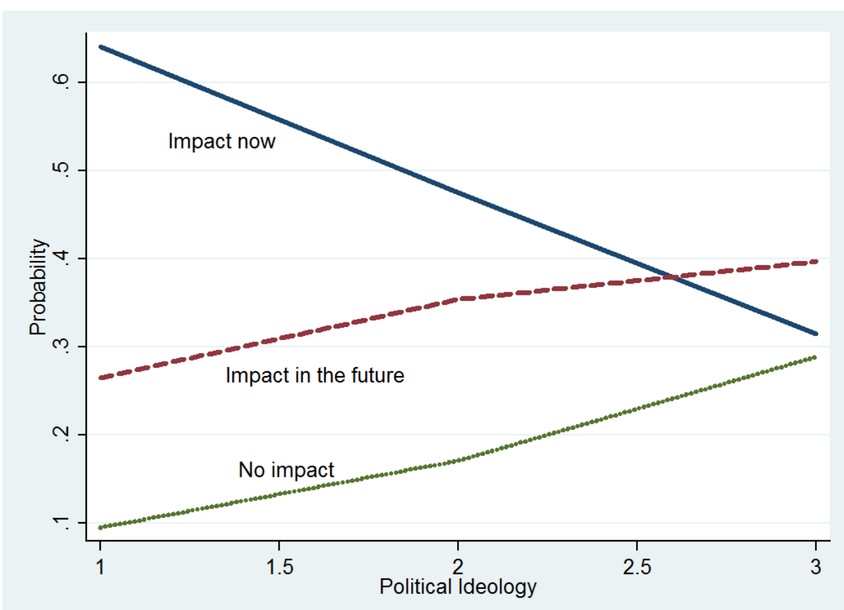

Figure 4.2 Predicted Probabilities that “global warming is causing a serious impact now,” “the impact of global warming won’t happen until sometime in the future,” and “global warming won’t have a serious impact at all,” as a Function of Political Ideology (1=Liberal, 2=Moderate, 3=Conservative), based on Table 4.4, Model 1.

global warming won't happen until sometime in the future," and "global warming won't have a serious impact at all," controlling for the effects of all the other independent variables. As individuals' experience of summers moves from -6 (roughly the lowest point) to 6 (roughly the highest point) on the range of summer temperature trend, the probability that individuals believe that "global warming is having a serious impact now" increases from 32 percent to 55 percent, while the probability that individuals believe that "global warming won't have a serious impact at all" decreases from 28 percent to 13 percent. In Figure 4.4, I present predicted probabilities for the relationship between the standard deviation departure from normal temperature over the month prior to the interview date and the three risk perceptions towards global warming. As Figure 4.4 demonstrates, residents who experience temperature at 2.8 standard deviation below normal are more likely to believe "the impact of global warming won't happen until sometime in the future" by the margin of 39 percent to 37 percent, while residents who experience temperature at 2.8 standard deviation above normal are more likely to believe "global warming is having a serious impact now" by the margin of 51 percent to 34 percent. This indicates that recent temperatures that are hotter than normal are more likely to trigger the public concern for global warming.

Surprisingly, the unemployment rate at the county level does not show any significant effect. This does not seem to conform to the pattern that the decrease of public concern for global warming follows the increase of public concern for the economy as manifested in the polls conducted by Pew Research Center for People and Press (2001-2010), which is mentioned in Chapter 1. This phenomenon might be due to the fact that the unemployment rate – a proxy for macroeconomic conditions – does not necessarily reflect personal economic conditions and

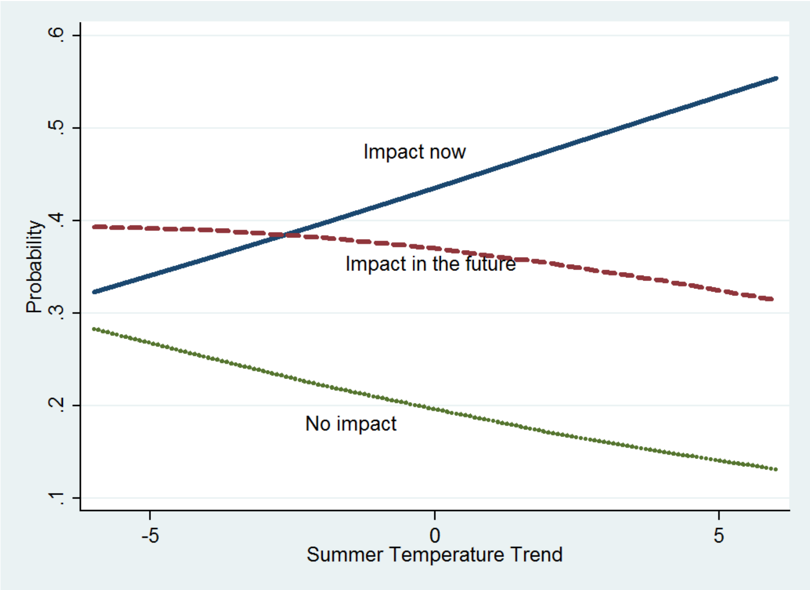

Figure 4.3 Predicted Probabilities that “global warming is causing a serious impact now,” “the impact of global warming won’t happen until sometime in the future,” and “global warming won’t have a serious impact at all,” as a Function of Summer Temperature Trend over the Past 10 years, based on Table 4.4, Model 1.

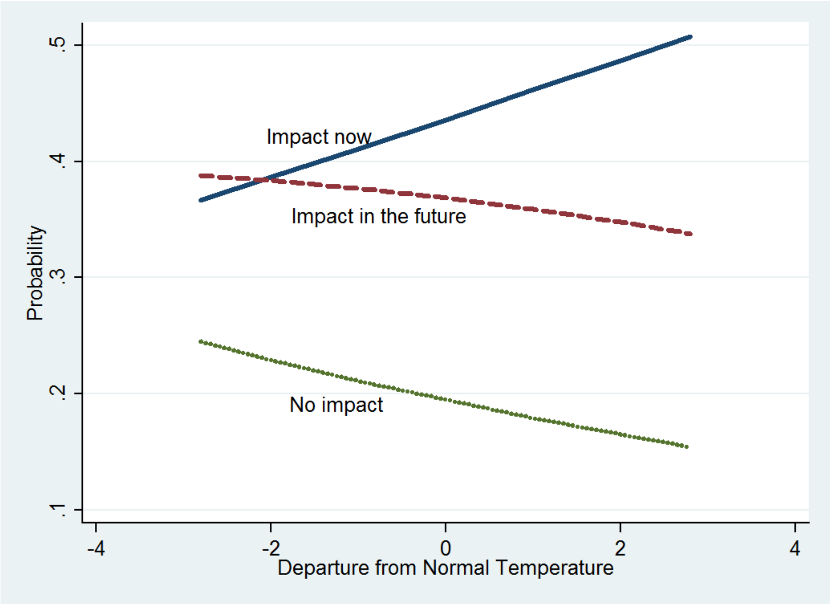

Figure 4.4 Predicted Probabilities that Respondents Believe “global warming is causing a serious impact now,” “the impact of global warming won’t happen until sometime in the future,” or “global warming won’t have a serious impact at all,” as a Function of the Standard Deviation Departure from Normal Temperature over the Month prior to the Interview Date, based on Table 4.4, Model 1

individuals' subjective judgments of the economy. The local county-level economy does not appear to have a direct effect on how a person thinks about global warming. Instead, personal economic conditions involving how an individual is doing economically (e.g. is he/she unemployed? did the person's income increase or decrease in the past year?) might be the real competitor with environmental quality in the realm of human motivations. In addition, the objective macro-economic condition does not necessarily translate into subjective assessment of the economic condition. Presumably, there is a certain distance between the reality of the economy and individuals' judgments on the economy. Regrettably, a variable representing either personal economic conditions or individuals' subjective assessments of economic conditions is not included in this data set.

Now, I turn to Table 4.4, model 2, which includes all of the independent variables from model 1 but also adds two interactions. The coefficient for the interaction for education and ideology is significant, while that for the interaction for education and party identification does not show significance. The coefficient for education is 0.676, which represents the effect of education on public risk perceptions of global warming urgency among Democrats and liberals (party identification and political ideology equal to 0). The coefficient for the interaction for political ideology and education is -0.025, indicating that the effects of education on the dependent variable decreases 0.025 as political ideology increases by one unit (moving from liberal toward conservative). In other words, as education level increases, liberals are more likely to view global warming as urgent while conservatives are less likely to do so. To illustrate the interaction effects for ideology and education in Figure 4.5, I present predicted probabilities for the relationship between education level and individuals' perceptions that "global warming is causing a serious impact now," broken down by liberals, moderates and conservatives, controlling for other independent variables constant at their means. For liberals with low education level (not a high school grad), the probability that they perceive "global warming is causing a serious impact now" is 39 percent; this rises to a probability of 80 percent for liberals with high education level (post graduate work or degree). On the other hand, the relationship between education level and perceptions of global warming impact is negative for conservatives; the probability of perceiving that "global warming is causing serious impact now" decreases from 33 percent to 29 percent as the education level moves from its lowest to highest value.

Analysis II. Public Risk Perception of Global Warming Severity

In this section I discuss the determinants of public risk perceptions about the severity of global warming, but in this case I use data from several Pew Center surveys conducted from June 2006 to October 2010.

I begin by modeling public risk perception of global warming severity as a function of a range of social variables, long-term climate trends, short-term weather variation, and unemployment rate for each dataset of the Pew survey series. The empirical results for each Pew survey are presented in Table 4.5. As these results demonstrate, party identification, political ideology, and gender, among all independent variables, stand out as the most consistent significant predictors for public risk perception of global warming severity. Results suggest that Republicans, conservatives and males tend to express lower level of concern for global warming. Another variable that has a consistent effect on the dependent variable is church attendance, the coefficients for which are statistically significant throughout the years except in 2008. This indicates that religiosity has negative effects on public risk perception of global warming.

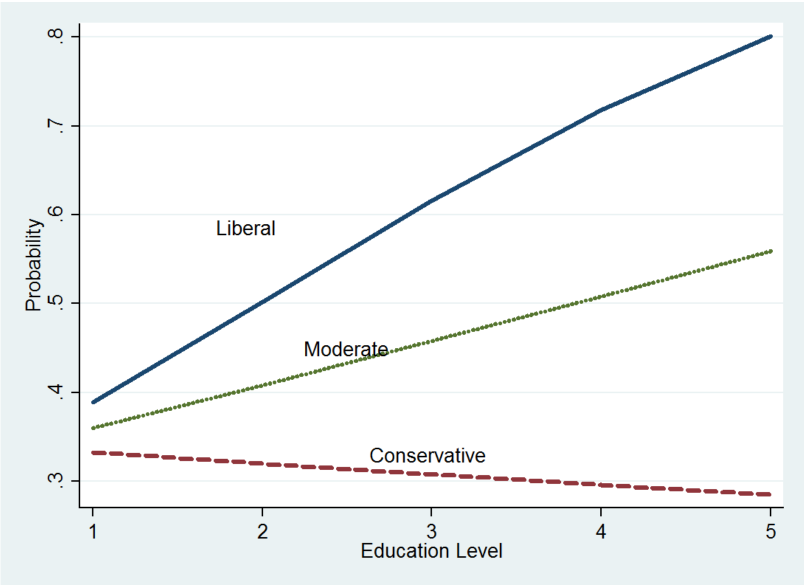

Figure 4.5 Predicted Probability that Respondents Believe "global warming is causing a serious impact now," as a Function of Education Level (1=not a high school grad, 2=high school grad, 3=some college (trade or business), 4=college grad, 5=post grad work or degree (Masters, MBA, JD, MD, PhD));, by Political Ideology, based on Table 4.4, Model 2

The black race variable does not show a significant effect in any of these surveys. In only two surveys (October, 2009 and October, 2010) does age have the expected significant and negative effect on public risk perception of severity. Education is found to be positively associated with the dependent variable in four of these surveys (June, 2006; April, 2008; May, 2009 and October, 2010), indicating that individuals with high education are more likely to perceive a risk associated with global warming. Moreover, income is found to be negatively associated with the dependent variable in four of these surveys (June, 2006; April, 2008; May, 2009 and October, 2009). The local weather and climate, represented by different combinations of indicators, show significant effects throughout these years except in May, 2009 and October, 2010. Finally, the unemployment rate at the county level only shows significant in the survey conducted in June 2006. The Pseudo R^2 is mainly above 0.10, with 0.135 (October, 2010) being the highest.

I then model the public risk perception of global warming severity, using the pooled data. In Model (1) of Table 4.6, I report the coefficients for the independent variables without the interaction variables. As one can see, all the socio-demographic variables are shown to have significant effects on public risk perception of global warming severity (see Model (1) of Table 4.6). Specifically, women, blacks, and Hispanics are more likely to view global warming as a very serious problem than their counterparts. This is particularly the case for women and Hispanics, though even for blacks there is a significantly greater propensity to perceive global warming as serious problem. Based on the coefficient for the age variable, I can say that younger people are more likely than older ones to see that global warming is a serious problem. Education and income also affect threat perceptions of global warming, though in opposite directions. Individuals with higher level of education and lower level of income, compared to those with lower level of education and higher level of income, tend to accept the severity of global warming as a problem.

Religiosity— represented by a variable that measures religious services attendance— has a significant and negative effect on public risk perception of global warming. This suggests that individuals who are more religious are more likely to doubt the severity of global warming. Based on the predicted probabilities from Figure 4.6, I conclude that people who attend religious services more than once a week are more likely to believe that "global warming is a somewhat serious problem" by the margin of 40 percent over 32 percent, while people who never attend

Table 4.5 Ordered Logit Estimates for Models of Public Risk Perceptions of Global Warming Severity, 2006-2010 (Pew Survey Series)

	2006/06		2007/01		2008/04	
Social Variables						
	b	z	b	z	b	z
Party Identification [-]	-0.32	-8.38***	-0.297	-8.02***	-0.397	-9.77***
Ideology [-]	-0.301	-4.35***	-0.530	-7.36***	-0.449	-6.34***
Church Attendance [-]	-0.095	-2.49**	-0.137	-3.71***	-0.044	-1.18
Race (Black) [+]	-0.202	-0.98	0.166	0.80	0.339	1.53
Race (Hispanic) [+]	0.600	2.36**	0.372	1.37	0.705	2.34*
Gender (Female) [+]	0.614	5.36***	0.396	3.59***	0.252	2.17*
Age [-]	-0.004	-1.11	-0.001	-0.17	0.001	0.34
Education [+]	0.070	1.74*	0.027	0.71	0.103	2.38*
Income [-]	-0.074	-2.65***	-0.025	-0.92	-0.058	-1.95*
Seasonal Temperature Trends						
Winter [+]	0.029	0.71	0.064	1.40	0.056	1.23
Spring [+/-]	0.014	0.24	-0.022	-0.46	0.058	1.03
Summer [+]	0.027	0.52	0.030	0.57	-0.071	-1.35
Fall [+/-]	-0.024	-0.46	-0.107	-1.94*	0.052	0.71
Seasonal Precipitation Trends						
Winter [+/-]	-0.005	-0.74	0.001	0.17	0.006	1.04
Spring [+/-]	-0.005	-0.74	0.010	1.66	-0.003	-1.41
Summer [+/-]	0.000	0.08	-0.005	-1.40	-0.006	-1.39
Fall [+/-]	0.011	2.30*	0.008	2.02*	-0.001	-0.29
Short-term Weather Fluctuation						
Temperature [+/-]	-0.045	-0.35	0.087	0.70	-0.077	-0.77
Precipitation [+/-]	0.122	1.56	-0.138	-2.00*	-0.163	-2.48*
Unemployment [-]	-0.083	-1.65*	-0.043	-1.05	-0.053	-1.40
N	1166		1343		1191	
Pseudo R^2	0.081		0.103		0.110	
Wald Chi^2	191.17		297.44		326.23	

Table 4.5 (Continued)

	2009/05		2009/10		2010/10	
Socio-demographic Variables	b	z	b	z	b	z
Party Identification [-]	-0.459	-12.85***	-0.407	-10.13***	-0.413	-11.75***
Ideology [-]	-0.451	-7.02***	-0.644	-8.94***	-0.494	-8.45***
Church Attendance [-]	-0.063	-1.83*	-0.077	-2.12*	-0.084	-2.68**
Race (Black) [+]	0.182	1.03	0.078	0.39	0.253	1.51
Race (Hispanic) [+]	0.883	3.99***	0.389	1.59	0.103	0.42
Gender (Female) [+]	0.227	2.20*	0.534	4.71***	0.514	5.30***
Age [-]	-0.004	-1.25	-0.007	-2.25*	-0.007	-2.31**
Education [+]	0.060	1.70*	0.056	1.41	0.058	1.65*
Income [-]	-0.042	-1.69*	-0.085	-3.14***	-0.029	-1.28
Seasonal Temperature Trends						
Winter [+]	-0.024	-0.82	-0.036	-0.90	-0.019	-0.51
Spring [+/-]	-0.029	-0.44	-0.041	-0.57	0.013	0.46
Summer [+]	0.003	0.05	0.166	2.57**	0.011	0.24
Fall [+/-]	0.029	0.52	0.024	0.36	-0.041	-0.76
Seasonal Precipitation Trends						
Winter [+/-]	0.005	0.89	-0.010	-1.58	0.000	0.09
Spring [+/-]	-0.006	-1.12	-0.005	-0.87	0.007	1.42
Summer [+/-]	0.000	0.07	0.011	2.24*	-0.000	-0.13
Fall [+/-]	-0.007	-1.29	0.004	0.61	0.003	0.57
Short-term Weather Fluctuation						
Temperature [+/-]	0.071	0.59	-0.079	-0.97	0.108	1.32
Precipitation [+/-]	0.016	0.26	0.100	1.32	0.031	0.49
Unemployment [-]	-0.014	-0.59	0.008	0.32	0.005	0.23
N	1531		1178		1604	
Pseudo R^2	0.124		0.1348		0.1228	
Wald Chi^2	475.83		426.14		532.79	

***prob<0.001 (one-tail test); **prob<0.01 (one-tail test); *prob<0.05 (one-tail test)

Note: The constant terms are omitted from the table for the sake of brevity.

any religious services are more likely to believe that "global warming is a very serious problem" by the margin of 41 percent over 38 percent.

Party identification and political ideology both have significant and negative effects on public risk perception of global warming severity, indicating that Republicans and conservatives are less likely than Democrats and liberals to think that global warming is a very serious problem. Using results from Model (1) of Table 4.6, in Figure 4.7, I present the predicted probabilities for the relationships between party identification and individuals' risk perception of global warming severity by holding all other independent variables at their means. Democrats are more likely to believe that "global warming is a very serious problem" by margin of 53 percent to 33 percent, while Republicans are more likely to believe "global warming is somewhat serious" by the margin of 37 percent to 20 percent. The probability of believing that "global warming is not a problem" increases from 5 percent to 21 percent, as one moves from "Democrat" to "Republican". Likewise, political ideology has similar effects on public risk perception of global warming severity. As Figure 4.8 demonstrates, moving from "liberal" to "conservative", the probability for one to believe that "global warming is a very serious problem" decreases by 42 percent, while the probability for one to believe that "global warming is not a problem" increases by 17 percent.

Similar to the finding in Analysis I, unemployment at the county level does not show any significant effects on public risk perception of global warming severity. This again reflects the limited power of objective macroeconomic measures to explain public risk perceptions of global warming.

Table 4.6 Model II-Ordered Logit Estimates for Models of Public Risk Perceptions of Global Warming Severity, Pooled Data from Pew Survey Series 2006-2010.

Model	(1)		(2)	
	b	z	b	z
Socio-demographic Variables				
Party Identification [-]	-0.376	-24.20***	-0.165	-3.54***
Ideology [-]	-0.475	-16.33***	0.010	1.17
Church Attendance [-]	-0.082	-5.47***	-0.073	-4.91***
Race (Black) [+]	0.145	1.74*	0.180	2.23*
Race(Hispanic) [+]	0.591	5.53***	0.630	5.95***
Gender (Female) [+]	0.414	9.38***	0.404	9.09***
Age [-]	-0.003	-2.57**	-0.003	-2.55**
Education [+]	0.062	3.88***	0.411	10.19***
Income [-]	-0.049	-4.53***	-0.052	-4.84***
Seasonal Temperature Trends				
Winter [+]	0.013	1.01	0.017	1.02
Spring [+/-]	0.001	0.05	0.003	0.19
Summer [+]	0.038	2.04*	0.035	2.04*
Fall [+/-]	-0.017	-0.86	-0.016	-0.90
Seasonal Precipitation Trends				
Winter [+/-]	-0.002	-0.83	-0.001	-1.21
Spring [+/-]	-0.001	-0.74	-0.002	-0.74
Summer [+/-]	-0.000	-0.12	0.001	0.01
Fall [+/-]	0.003	1.97*	0.003	1.90
Short-term Weather Fluctuation				
Temperature [+/-]	0.001	0.04	0.001	0.17
Precipitation [+/-]	-0.029	-1.21	-0.029	-1.20
Unemployment Rate [-]	-0.015	-1.29	-0.016	-1.42
Interaction Terms				
Party*Education [-]	---	---	-0.041	-4.42***
Ideology*Education [-]	---	---	-0.120	-6.81***
N	8012		8012	
Pseudo R^2	0.1127		0.1184	
Wald Chi^2	1943.61		2085.97	

***prob<0.001 (one-tail test); **prob<0.01 (one-tail test); *prob<0.05 (one-tail test)

Note: The constant terms are omitted from the table for the sake of brevity.

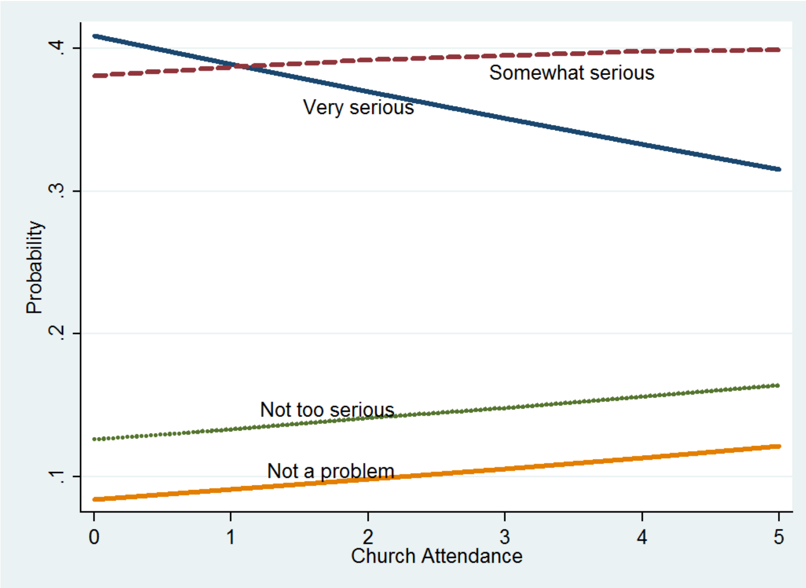

Figure 4.6 Predicted Probabilities that Respondents Believe that "global warming is a very serious problem," "global warming is somewhat serious," "global warming is not too serious," or "global warming is not a problem," as Church Attendance (0=never, 1=seldom,3=a few times a year, 4=once or twice a month, 5=once a week, 6=more than once a week), based on Table 4.6, Model 1

Summer temperature trend and fall precipitation trend over the past 10 years, among all local weather measures, stand out as significant predictors on public risk perception of global warming severity. Specifically, individuals who have experienced increasingly hot summers over the past 10 years are more likely to accept that "global warming is a very serious problem." To illustrate the effects of this local climate indicator in Figure 4.9, I present the predicted probabilities for the relationship between summer temperature trend and four risk perceptions of global warming severity controlling for the effects of all other independent variables. The probability for one to think "global warming is a very serious problem" increases from 30 percent to 40 percent, while the probability for one to believe that "global warming is not a problem" decreases from 13 percent to 9 percent, as the indicator for one's experience with temperature during the summer seasons moves from -6 to 6. Furthermore, individuals who have experienced increasing precipitation during the fall season over the past 10 years tend to believe that “global warming is a very serious problem.” In Figure 4.15, I present predicted probabilities for the relationship between this local weather measure and the four risk perceptions of global warming severity. The probability for one to think “global warming is a very serious problem” increases from 32 percent to 40 percent, while the probability for one to believe that “global warming is not a problem” decreases from 12 percent to 9 percent, as the indicator for one’s experience with precipitation during the falls moves from minimum (-56) to maximum (56).

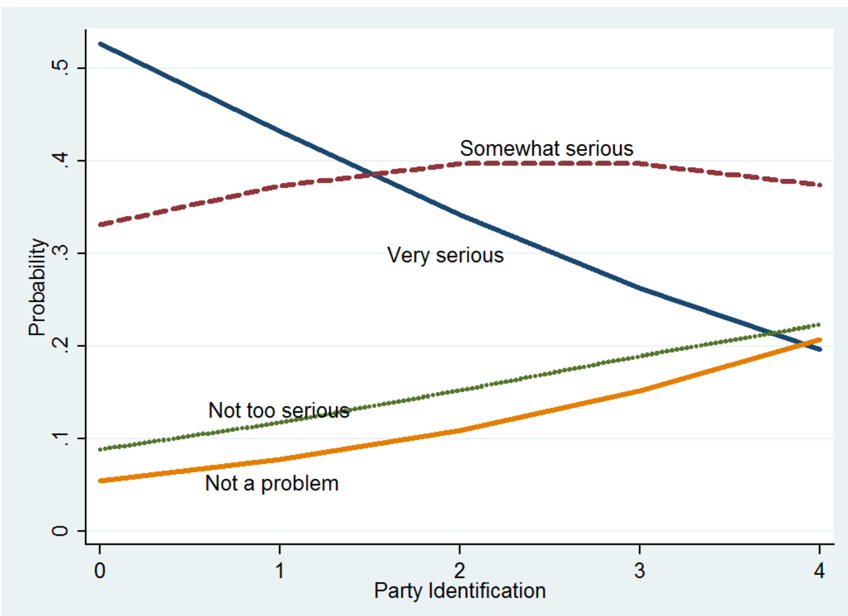

Figure 4.7 Predicted Probabilities that Respondents Believe that “global warming is a very serious problem,” “global warming is somewhat serious,” “global warming is not too serious,” or “global warming is not a problem,” as Party Identification (0=Democrat, 1=Independent leaning towards Democrat, 2=Independent, 3=Independent leaning towards Republican, 4=Republican , based on Table 4.6, Model 1

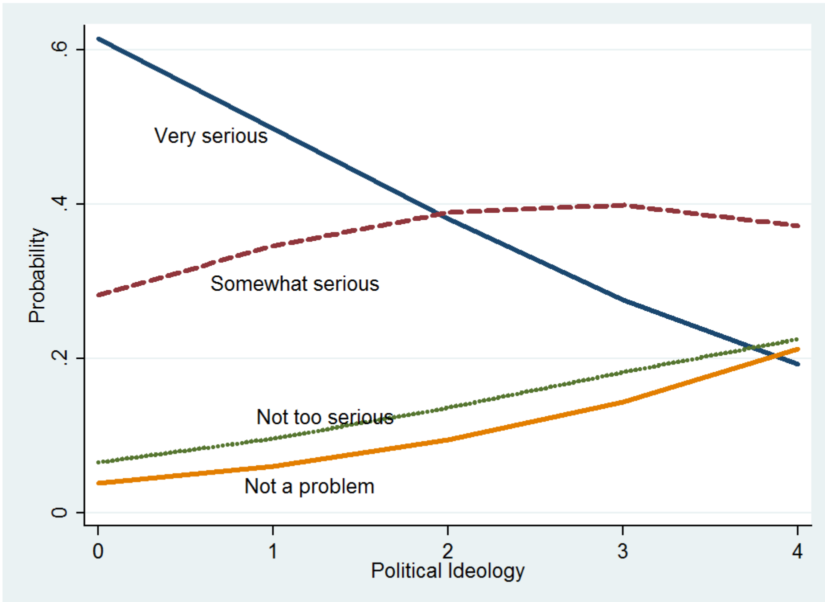

Figure 4.8 Predicted Probabilities that Respondents Believe that “global warming is a very serious problem,” “global warming is somewhat serious,” “global warming is not too serious,” or “global warming is not a problem,” as Political Ideology (0=very liberal, 1=liberal, 2=moderate, 3=conservative, 4= very conservative, based on Table 4.6, Model 1

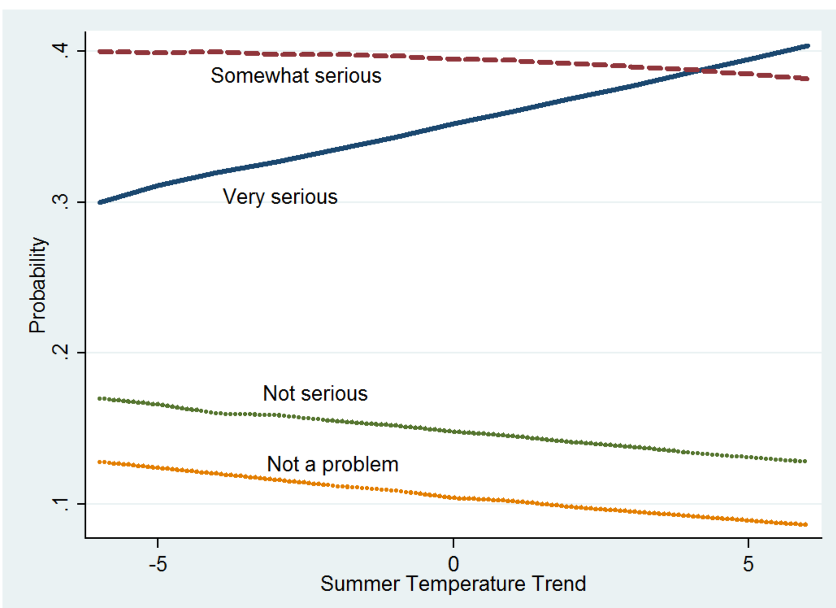

Figure 4.9 Predicted Probabilities that Respondents Believe that “global warming is a very serious problem,” “global warming is somewhat serious,” “global warming is not too serious,” or “global warming is not a problem,” as Summer Temperature Trend, based on Table 4.6, Model 1

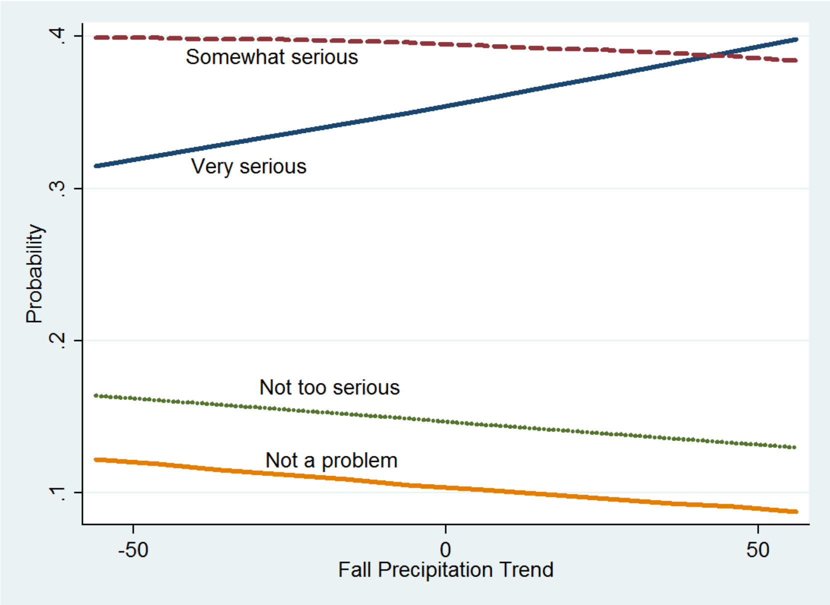

Figure 4.10 Predicted Probabilities that Respondents Believe that "global warming is a very serious problem," "global warming is somewhat serious," "global warming is not too serious," or "global warming is not a problem," as Fall Precipitation Trend, based on Table 4.6, Model 1

In Model (2) of Table 4.6, I include two interaction terms, one for education and party, and the other for political ideology and education. The coefficient for education is 0.411 which represents the effects of education on public risk perceptions of global warming severity among Democrats and liberals (party identification and political ideology equal 0). Both interaction terms show significant and negative, indicating that education have different effects on public risk perception of global warming severity among Republicans and Democrats on the one hand, and conservatives and liberals on the other hand. Specifically, the coefficient for the interaction for party identification and education is -0.041, indicating that the effects of education on the dependent variable decreases by 0.041 as party identification increases by one unit (moving from Democrats toward Republicans). The coefficient for the interaction for political ideology is -0.119, which suggests that the effects of education on the dependent variable decreases by 0.119 as political ideology increases by one unit (moving from liberals toward conservatives). This finding conforms to the results in the first study of this chapter. To illustrate, in Figure 4.11, I present predicted probabilities for the relationship between education level and individuals' perceptions that "global warming is a very serious problem," broken down by strong Democrats, Independents, and strong Republicans, holding all other independent variables constant at their

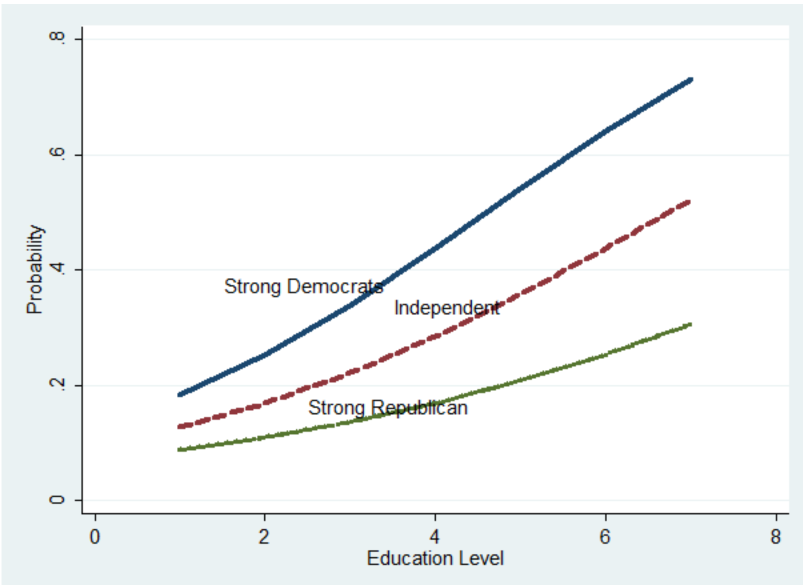

Figure 4.11 Predicted Probability that Respondents Believe "global warming is a very serious problem," as a Function of Education Level (1=none, or grad 1-8; 2=high school incomplete; 3=high school graduate; 4=technical, trade, or vocational school after high school; 5=some college, associate degree, no 4-year degree; 6=college graduate; 7= post-graduate training or professional schooling after college), by Party Identification, based on Table 4.6, Model 2

means. For strong Democrats with low education level (none, or grade 1-8), the probability that they perceive "global warming is a very serious problem" is 18 percent; this rises to a probability of 73 percent for strong Democrats with high education level (post grad work or degree). On the other hand, the effects of education on perceptions of global warming severity among strong Republicans are moderate; the probability of perceiving that "global warming is a very serious problem” increases from 9 percent to 31 percent as the education level moves from its lowest to highest value. Similarly, as Figure 4.12 demonstrates, the effects of education on public perception of global warming severity vary over the spectrum of political ideology. For strong liberals, the probability that they perceive “global warming is a very serious problem” increases from 24 percent to 80 percent, as one moves from low education level (none, or grade 1-8). On the other hand, education has negative effects on public perception of global warming among strong conservatives. The probability for one to perceive that “global warming is a very serious problem” decreases from 24 percent to 17 percent moving from the lowest to highest value on the range of education level.

Conclusion

In this chapter, I investigate how socio-demographic characteristics, political predispositions, local weather and climate, and unemployment affect public risk perceptions of global warming. I do so by utilizing survey data from two pooled cross section datasets. A few conclusions can be made from this study. First, socio-demographic variables have steadily shown to have significant effects on public risk perception of global warming over the past 10 years. Specifically, young people, females, and racial minorities including African Americans and Hispanics are more likely to show higher level of concern for global warming than their counterparts. Meanwhile, individuals with lower levels of income and higher levels of education tend to be more concerned with global warming, compared to those with more income and lower levels of education.

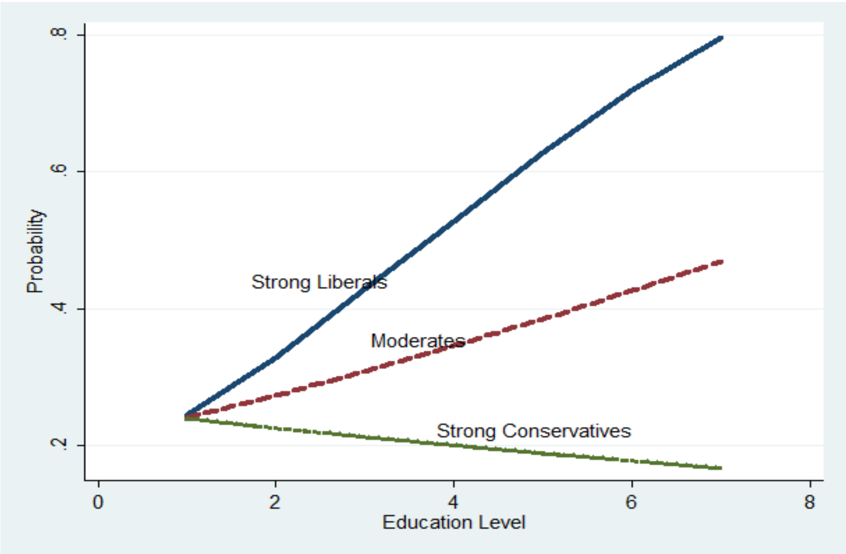

Figure 4.12 Predicted Probability that Respondents Believe "global warming is a very serious problem," as a Function of Education Level(1=none, or grad 1-8; 2=high school incomplete; 3=high school graduate; 4=technical, trade, or vocational school after high school; 5=some college, associate degree, no 4-year degree; 6=college graduate; 7= post-graduate training or professional schooling after college), by Political Ideology, based on Table 4.6, Model 2

Second, political predispositions have consistently shown strong effects on how the public views the impacts and severity of global warming. Democrats and liberals are more likely than Republicans and conservatives to express concerns for global warming. Furthermore, consistent with some previous studies, the effect of education on public risk perception of global warming varies over the spectrum of party identification and political ideology. With the increase of education, Democrats and liberals tend to show more concern with global warming. However, the opposite holds true with Republicans and conservatives. These results contribute more evidence to the accumulating literature on the polarizing effects of education along party and ideology lines.

Third, one of the local weather measures, the summer temperature trend over the past 10 years, has consistently shown positive effects on public risk perceptions of global warming. This finding suggests that people are most sensitive to summer temperature among other weather indicators, and they are most likely to translate the increasingly hot summers into a sense of urgency and the severity of global warming. In a broader picture, this result indicates that personal observations of the weather and climate play an important role in shaping public risk perceptions of global warming.

Finally, the unemployment rate in respondents' home counties is not found to have any significant effects on public risk perceptions of global warming. This result suggests that future studies to examine the effects of the economy on public risk perception of global warming should adopt measures to characterize personal economic conditions or capture subjective assessments of economic conditions. Objective economic condition does not necessarily translate into subjective judgments on the economy, for individuals, they might be lack of adequate willingness and capacity to detect the change in the economy.

CHAPTER 5 DETERMINANTS OF ENVIRONMENTALLY SIGNIFICANT BEHAVIORS RELEVANT TO GLOBAL WARMING

Introduction

The issue of global warming joins a long list of different types of environmental degradation by manifesting itself as another issue reflecting the tragedy of the commons (Hardin 1968). The pursuit of individual interests is usually trapped in the conflict with collective interests, which therefore constrains individual contributions to the collective good (Karp 1996). However, unlike other types of environmental pollution, the impact of global warming transcends regional boundaries and extends to the global level. The unprecedented scale of the impact makes it even harder to externalize the true cost of global warming, since it calls for international agreements by countries from a wide variety of cultural and political backgrounds. For countries, the implication of anthropogenic global warming is multifaceted, and the solution to this problem requires the decrease of dependence on traditional energy sources in the form of fossil fuels, and exploration for alternative energies such as solar and wind. For individuals, to reduce the adverse effects of global warming means major changes of lifestyle—i.e., from being motivated by convenience to being motivated by environmental considerations. The United States, as one of the largest contributors of carbon dioxide in the world, has not passed comprehensive climate legislation to curb the emission of carbon dioxide, which is believed by many scientists to be the main factor of global warming. Given the prevailing view about the role of carbon dioxide emissions in mitigating the effects of global warming, in the minds of many observers the American public would need to show its willingness and take personal actions to reduce emissions.

In this chapter, I explore the determinants of private-sector environmentally significant behaviors by individuals, as well as of individuals' willingness to pay more to address global warming. These expressions of support for individual-level action relating to global warming may be indicative of the willingness of the mass public to support government action to address carbon emissions. As a modern tragedy of the commons at an unprecedented scale, by no means can global warming be solved without collective willingness and efforts.

The social dilemma–conflicts between individual interests and collective interests (Dawes 1980)—embedded in global warming has inhibited individuals from taking adequate actions to address this issue. For instance, personal automobiles for transportation might serve well for the convenience of each individual. However, solely relying on personal automobiles by each individual will collectively cause massive traffic jams and air pollution. Considering that the benefit, which is exclusive to the individual exceeds the cost that is shared by the public, any economically rational being would favor personal automobile over public transportation. Meanwhile, in addition to the ultimate pursuit of self-interests, human demonstrate altruism and conscience as well (Dawes 1980). For instance, many people donate blood to strangers, even though they do not gain visible benefits from doing it. Many couples adopt orphans, even though raising children requires immense efforts. Some individuals make financial donations to public radio, even though the service is for the entire public. Promoting cooperation in social dilemma situations requires three ancient, but important, virtues: knowledge, morality, and trust (Dawes 1980).

More recently, there is a growing body of literature focused on determinants of environmentally significant behaviors. Stern (2000) attributes environmentally significant behaviors to four types of causal variables: attitudinal factors, contextual forces, personal capabilities, and habit or routine. In this chapter, due to the constraints of the survey, I only include the former three types of independent variables.

Attitudinal variables include “norms, beliefs, and values” (Stern 2000, 416). Empirical studies provide evidence to support the view that attitudinal variables play an important role in affecting environmentally significant behaviors. Specifically, general environmental beliefs and risk perception of climate change are found to be strong predictors of environmental behavior intentions (O'Connor et al. 1999). Belief in the national seriousness of global warming also leads to support for policies to reduce global warming (Krosnick et al. 2006). Personal values have noticeable effects on environmental behaviors. For instance, values such as self-transcendent and openness to change have a positive impact on pro-environmental behaviors, while values such as self-enhancement and conservation have a negative influence on pro-environmental behaviors (Karp 1996). Egalitarianism is associated with support for national policies, while individualism and hierarchism are associated with opposition of the policies (Leiserowitz 2006). Furthermore, trust in environmentalists, distrust in industry, and recognition of consequences of global warming lead to the support of climate change relevant policies (Dietz et al. 2007). In addition, the level of concern with global warming has been found to be an efficient indicator of climate relevant behavior change (Semenza et al. 2008).

Contextual forces include “interpersonal influences…government regulations; other legal and institutional factors… and various features of the broad social, economic, and political context” (Stern 2000, 417). Economic condition is positively associated with public support for environmental spending (Elliott et al. 1995, Elliott et al. 1997). County unemployment rate is negatively associated with individual support for environmental regulation (Hamilton et al. 2010). Cultural rules and social network have positive effects on climate relevant environmental action (Jaeger et al. 1993). In addition to social, economic, and political context, physical contextual variables are examined in some studies. For instance, Zahran *et.al* (2006) find that physical contextual forces such as natural hazard casualties, sea-level rise risk, carbon dioxide emissions, and temperature trend have strong effects on climate change policy support. Likewise, physical vulnerabilities to climate change significantly increase the likelihood that a locality commits to climate change policy (Zahran et al. 2008).

Personal capabilities refer to "literacy, social status, financial resources, and behavior-specific knowledge and skills" (Stern 2000, 421). Socio-demographic variables are usually used as proxies. Women are found to be more likely to get involved in daily activities to reduce the effects of global warming (O'Connor *et al.* 1999). However, for the support of public policies to address global warming, the literature provides mixed results. Some studies find that women are more likely than men to support national policies on global warming (Leiserowitz 2006; Zahran et al. 2006), however one study finds the opposite (O'Connor et al. 1999). The literature also provides an unclear picture of the effects of age on environmentally significant behaviors. Older people are more likely to vote for governmental interventions to address global warming (O'Connor et al. 1999); however, they are less likely than young people to take voluntary mitigation actions (Semenza et al. 2008). Meanwhile, Jaeger et al. (1993) find that older cohorts, compared to younger ones, tend to take action to combat climate change. Previous studies show that education has a consistent positive effect on environmental behaviors. Individuals with higher level of education are more likely to favor public policies that require public sacrifice to reduce the effects of global warming (O'Connor et al. 1999; Zahran et al. 2006), to support more public environmental spending (Elliott et al. 1996), to back tax policies (Leiserowitz 2006), and to take voluntary action to address the issue of global warming (Jaeger et al. 1993; Semenza et al. 2008). Racial minorities are often found to be in support of environmental policies, since they are more exposed to degraded environments. For instance, non-whites tend to support more environmental spending (Elliott et al. 1996), to favor higher taxes to mitigate global warming (Leiserowitz 2006), and to endorse climate change policies (Dietz et al. 2007). Income is also found in some studies to be a significant predictor of public support for expanding environmental spending in general (Elliott et al. 1996), and for climate change policy in particular (Dietz et al. 2007). As one's income increases, one is more likely to support climate change policy and environmental spending. Few studies include party identification and political philosophy in their models to predict environmental significant behaviors. But those studies that have these two variables find that being Democrat and liberal increases the likelihood that one supports environmental policies (Dietz et al. 2007; Elliott et al. 1996; Leiserowitz 2006).

These three types of independent variables have different effects on environmental significant behaviors. Jaeger et al. (1993) suggest that cultural rules and social network, compared to knowledge and concern about climate change, and socio-demographic variables such as gender, age, and education, are stronger predictors of climate relevant environmental actions. Zaharan et al. (2006) conclude that risk perception outperforms physical vulnerability in explaining climate policy support.

In this chapter, I examine the effects of various factors on two types of environmentally significant behaviors out of three identified by Stern (2000): nonactivist behavior in the public sphere, and private-sphere environmentalism. Due to the constraint of the survey used in this study, the effects of environmental activism and other environmentally significant behaviors cannot be examined. Stern (2000) points out that causes of different kinds of pro-environmental behavior vary greatly. I cautiously include three clusters of variables including attitudinal factors, personal capabilities, and contextual forces to separately examine their effects on specific behaviors.

Modeling Environmentally Significant Behaviors

Dependent Variables

The primary research interest in this chapter is environmentally significant behavior to address global warming. The CBS News/New York Times Poll (April 20-24, 2007) provides a series of questions that fit the research topic. Two out of the four major types of environmentally significant behaviors suggested by Stern (2000) are the dependent variables in this study. I construct the two dependent variables based on nine questions. Tables 5.1 and 5.2 provide the exact wording of the questions. The first dependent variable is private-sphere environmental behavior or voluntary actions. For question 1 of Table 5.1, I code "yes" 1, and "no" 0. For questions 2-5 of Table 5.1, there are three responses provided by the survey: "regularly", "occasionally", and "don't do", I code these variables on a scale from 0 (don't do) to 2 (regularly). There are two voluntary responses to question 4 in Table 5.1:"don't drive to work" and "don't work." Likewise, there is one voluntary response to question 5 in Table 5.1: "no mass transit available." Considering the irrelevance of these responses to the measurement of individuals' environmentally oriented behaviors, I code them as missing data. For question 6 of Table 5.1, there are two responses provided by the survey: "yes, seriously consider" and "no, not."

There are also two voluntary responses: “already have a hybrid” and “don’t drive.” The response “yes, seriously consider” captures the intention to behave, while the response “already have a hybrid” captures the behavior. Despite the conceptual difference, I code this response 1 as “yes, seriously consider” since there are only two percent of respondents that gave the response “already have a hybrid.” The response “don’t drive” is irrelevant to the measurement of environmentally significant behavior. I therefore code it as missing data.

Table 5.1 Private-Sector Environmentally Significant Behaviors, the CBS News/New York Times Poll (April 20-24, 2007)

1.Do you separate out newspapers, cans or glass bottles in your household for recycling, or don’t you?	Yes (80%)		No (20 %)
2.Do you buy products made from recycled materials regularly, or is that something you do occasionally, or is buying products made from recycled material something you do not do?	Regularly (42%)	Occasionally (50%)	Don’t do (8%)
3.Do you buy compact fluorescent light bulbs that cost more but use less energy regularly, or is that something you do occasionally, or is buying compact fluorescent light bulbs something you do not do?	Regularly (50 %)	Occasionally (29%)	Don’t do (21%)
4.Do you car pool to work regularly, or is that something you do occasionally, or is car pooling something you do not do?	Regularly (11 %)	Occasionally (11%)	Don’t do (78%)
5.Do you take mass transit regularly, or is that something you do occasionally, or is taking mass transit something you do not do?	Regularly (7%)	Occasionally (18%)	Don’t do (75%)
6.From what you’ve seen or heard about the hybrid cars now on the market that use a combination of gas and electric power, would you seriously consider buying or leasing a hybrid car when replacing a vehicle you now drive, or not?	Yes (70%)	Already have a hybrid (2%)	No (28%)

To create a single scale that includes all of these variables, I execute a factor analysis for the private-sphere behavior variables. As Table 5.3 shows, the factor analysis shows that these items form a single factor with an eigenvalue of 1.77. I also execute a reliability analysis, which produces a Cronbach's alpha of 0.53. I then create a scale based on the factor scores. This scale, that captures private-sphere behaviors, ranges from -2.63 to 2.49 with mean being 0 and standard deviation being 1.

The second dependent variable is willingness to pay more to address global warming. For questions 1 and 3, I code the answer "favor" 1 and "oppose" 0. For question 2, I code the response "willing" 1 and "not willing" 0. I execute a factor analysis (results, see Table 5.4 and a reliability analysis. Both indicators show that these three items can form a reliable scale (eigenvalue of 1.91; Cronbach's alpha of 0.71). I then create a scale based on the factor scores. This scale, that captures individuals' willingness to pay more to address global warming, ranges from -1.72 to 1.01 with mean being 0 and standard deviation being 1.

Table 5.2 Willingness to Pay More to Address Global Warming, the CBS News/New York Times Poll (April 20-24, 2007)

1.Would you be willing or not willing to pay higher taxes on gasoline and other fuels if the money was used for research into renewable sources like solar and wind energy?	Favor (66%)	Oppose (34%)
2.In order to help reduce global warming, would you be willing or not willing to pay more for electricity if it were generated by renewable sources like solar or wind energy?	Willing (78%)	Not willing (22%)
3.In order to cut down on energy consumption and reduce global warming, would you favor or oppose an increased federal tax on gasoline?	Favor (40%)	Oppose (60%)

Table 5.3 Eigenvalues for Each Factor and Loadings on Factor 1, Personal Voluntary Actions to Reduce Global Warming

Factor	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Eigenvalue	1.77	1.04	.88	.85	.75	.70
Variable	Recycle	Recycled Products	Fluorescent Bulbs	Car Pool	Mass Transit	Hybrid
Loadings on Factor1	.59	.61	.58	.44	.51	.50

Table 5.4 Eigenvalues for Each Factor and Loadings on Factor 1, Public Willingness to Reduce Global Warming

Factor	Factor1	Factor2	Factor3
Eigenvalue	1.91	.61	.48
Variable	Tax for Research into Renewable Resources	Pay more for Renewable Resources	Tax to Reduce Global Warming
Loadings on Factor1	.83	.78	.78

Independent Variables

Demographic characteristics. The demographic measures are straightforward. I measure respondents' age in years, ranging from 18 to 98 years. I measure Education on a scale from 1 (respondent has not completed high school) to 5 (respondent has earned a post-graduate degree). Income is on a scale ranging from 1 ("less than $15,000") to 5 ("more than $75,000"). I create two binary variables to represent race: black ("black"=1; "other"=0) and Hispanic ("Hispanic"=1; "other"=0). The code for sex is 1 (female) and 0 (male).

Political predispositions. I measure ideology on a three-point scale from 1 (liberal) to 3 (conservative). Party identification is on a three-point scale from 0 (Democrat) to 2 (Republican).

General environmental views. I include three variables that capture individuals' views towards the environment. These three variables are based on three items in the survey. The first variable protecting environment regardless of cost is derived from the item: "Do you agree or disagree with the following statement: Protecting the environment is so important that requirements and standards cannot be too high and continuing environmental improvements must be made regardless of cost." I create a two-point scale from 0 (disagree) to 1 (agree). The second variable economy vs. environment is based on the item: "Often there are trade-offs or sacrifices people must make in deciding what is important to them. Generally speaking, when a trade-off has to be made, which is more important to you – stimulating the economy or protecting the environment?" I create a three-point scale from 0 (stimulating the economy), 1 (both), to 2 (protecting the environment). The third variable environment vs. new energy is based on the item: "Right now, which do you think should be a higher priority for the government – protecting the environment, or developing new sources of energy?" I create a three-point scale from 0 (developing new sources of energy), 1 (both), to 2 (protecting the environment).

Perception of global warming. I include five variables to capture the public perception of global warming. The first variable awareness of global warming is based on the item: "Global warming is a term used to describe changes in the temperature of the earth's atmosphere, which could result in changes in the environment. How much have you heard or read about global warming?" The answer ranges from 0 (nothing at all) to 3 (a lot). The second variable priority of global warming is based on responses to the item: "Which comes closer to your view: 1. Global warming is a very serious problem and should be one of the highest priorities for government leaders or 2. Global warming is serious but does not need to be a high priority or 3. Global warming is not serious and can be addressed years from now or 4. Global warming is not serious and never needs to be addressed (voluntary).” I code this variable on a 4-point scale from 0 (not serious/never needs to be addressed) to 3(very serious/high priority). The third variable impact of global warming is based on the item: “Do you think global warming is an environmental problem that is causing a serious impact now, or do you think the impact of global warming won’t happen until sometime in the future, or do you think global warming won’t have a serious impact at all?” There are four responses to this question: “impact now,” “in the future,” “no serious impact,” and “global warming doesn’t exist.” Due to the low percentages of respondents giving the answer “global warming doesn’t exist” (1.1%) and its actual implication of “no impact”, I combine this response with “no serious impact.” Therefore, this variable is based on a three-point scale ranging from 0 (no serious impact) to 2 (impact now). The fourth variable factors in global warming is derived from the item: “Greenhouse gases are released when coal, oil and gasoline are burned by cars, utilities and factories. Which comes closest to your opinion: 1. The release of greenhouse gases is the most important factor causing global warming, or is one factor among many causes of global warming, or is not a factor causing global warming at all.” I code this variable on a three-point scale from 0 (not a factor) to 2 (most important). Furthermore, the survey provides one item that captures the subjective judgment of weather. The item asks: “In the past few years, would you say the weather generally has followed its normal patterns, or has the weather been stranger than usual?” The responses are: 0 (normal patterns) and 1 (stranger than usual).

Subjective assessment of family financial situation. This variable is based on the item: (1) “How would you rate the financial situation in your household these days?” The answer to this question ranges from 0 (very bad) to 3(very good).

Contextual forces. I include three types of variables in this group. The first type is local weather. By using monthly data from United States Historical Climatology Network (USHCN), I create eight long-term climate indicators and two short-term weather measures. Specifically, I create four seasonal temperature and four seasonal precipitation trends including Winter (December, January, February), Spring (March, April, May), Summer (June, July, August), and Fall (September, October, November) trends over the past 10 years prior to the survey date. I regress the average of a particular season of each year on year, and use the bivariate regression coefficient to represent seasonal trends. In addition, I include two weather measures to capture the short-term weather fluctuation. They are: average temperature departure from normal temperature over the month prior to the survey date (DNT), and average precipitation departure from normal precipitation over the month prior to the survey date (DNP). To account for relative weather fluctuation in different regions, these departures are measured in standard deviation units. I calculate these two measures:

DNT_i = ($temperature_i$-normal $temperature_i$)/standard deviation of temperature (1981-2010) ,

DNP_i = ($precipitation_i$-normal $precipitation_i$)/standard deviation of precipitation (1981-2010), where DNT_i / DNP_i is the local temperature/precipitation experienced by respondent i, $temperature_i$ /$precipitation_i$ are the respondent i’s monthly mean temperature and monthly total precipitation over the month (April) before his or her interview, normal $temperature_i$ / normal $precipitation_i$ is the normal average of mean temperature and normal average of total precipitation for the month April, calculated over the period 1981-2010, and standard deviation of temperature/precipitation are the standard deviation of monthly mean temperature and monthly total precipitation calculated based on the monthly average (April) over the period 1981-2010[11]. To merge the survey data with local weather and climate data, I first use GIS to map each weather station and survey respondent. I then use GIS to identify the weather station that is located the closest to each corresponding survey respondent.

The second contextual variable is unemployment rate at the county level over the month prior to the interview date. These data are from U.S. Bureau of Labor. The third contextual variable is carbon dioxide emission by state in 2007 (the survey year). These data are from U.S. Environmental Protection Agency.

I use ordinary least squares (OLS) regression to estimate the effect of each independent variable on the dependent variables. Because the three contextual forces are at three different geographic levels: unemployment—county, local weather—weather station, and carbon dioxide emission—state, I estimate three multiple regression models with attitudinal and personal capability variables, on the one hand, and each of these three contextual forces, on the other hand. I use a clustering technique to address the issue that integrating aggregate (state, county, and weather station) data into an individual-level model violates one important regression

[11] The survey was conducted on April 20-24, 2007. I extract the monthly temperature and precipitation data on April, 2007. I calculate the average of monthly mean temperature and monthly total precipitation on Aprils over the period 1981 to 2010.

assumption—the error terms should be independent for each observation (Primo, Jacobsmeier, and Milyo 2007).

Empirical Results

As Table 5.1 demonstrates, the private-sector environmentally significant behaviors are inconsistent. The majority of respondents indicate that they recycle and express their serious consideration of buying a hybrid car (80% and 70%, respectively). When it comes to consumers' choices, 42% of respondents buy products made from recycled materials regularly while 50% of respondents buy compact fluorescent light bulbs. Two behaviors that are resisted by a majority of respondents are car pooling and taking mass transit. Only 11% of respondents say they car pool to work regularly and 7% of respondents say they take mass transit regularly. Clearly, there are some behaviors that are common to many respondents and some that are only for the hardiest of respondents.

Seemingly, there is an irony among the public willingness to pay more to reduce global warming. As Table 5.2 shows, the majority (66%) are willing to pay higher taxes on "gasoline and other fuels" when the money was used for research into renewable sources and a larger majority (78%) are willing to pay more for electricity if it were generated by renewable sources. On the other hand, the majority (60%) oppose an increased federal tax on gasoline to reduce global warming. My speculation is that the public feels uncomfortable with the notion of "cutting down on energy consumption." The majority do not anticipate a future with less energy consumption. However, given the prospect that renewable sources will be alternatives to fossil fuels, the public is willing to make financial sacrifices to exploit renewable resources as new major energy source. Moreover, the questions do not measure how much individuals are willing to pay in increased taxes, if at all.

Private-sector Environmentally Significant Behaviors

In Table 5.5, I present the regression models for private-sector environmentally significant behaviors. All three of the models in Table 5.5 are estimated without contextual forces. Variables representing environmental views and perceptions of global warming explain 12% of the variance, while the demographic characteristics explain only 7% of variance. The variance explained jumps to 16% with all sets of variables combined in a single model.

Three variables show significance in Model 1, including views towards the environment and economics, and awareness of global warming and priority of global warming. Individuals who think protecting the environment is more important than stimulating the economy tend to engage in environmentally friendly behaviors to reduce global warming. People who are more aware of global warming are more likely to engage in these environmentally significant activities than those who are less aware of global warming. Those who see that global warming "is causing serious impacts now" tend to be more active in their daily lives to reduce global warming. In Model 2, party identification, political ideology, age and education are found to be significant predictors of private-sector environmentally significant behaviors. Specifically, Democrats are more likely than Republicans to be environmentally responsible. Likewise, liberals, compared to conservatives, tend to be conscious of the environmental consequences of their behaviors, and act more responsibly. Younger citizens are more likely than older ones to have environmentally significant behaviors. More educated people have the tendency to engage in the environmentally significant activities.

In Model 3, most significant variables verified by Models 1 and 2 retain their predictive powers while two variables lose their significance. Specifically, the coefficients for opinion of environment vs. economics and awareness of global warming retain significance while the impact of global warming becomes insignificant in Model 3. The coefficients for party identification, political ideology and age retain significance in model 3, whereas the coefficient for education becomes insignificant.

In Table 5.6, I present the empirical results for three models with contextual forces. The first model has county unemployment rate as contextual force, the second model includes long-term indicators of local weather[12], while the third one has emission of CO^2 by states as contextual force. The three contextual forces are at three different levels. For instance, the unemployment rate is at the county level, local weather indicators are at the weather station level, and the emission of CO^2 is at the state level. Furthermore, merging aggregate data (county, weather station, and state, in this study) and individual-level data (survey data) violate one important statistical assumption that error terms are independent for each observation. To correct this, I employ clustered standard errors to estimate the three models with unemployment rate, local weather, and CO^2 emission, respectively (Primo, Jacobsmeier, and Milyo, 2007). [13] Three models have the same groups of independent variables including environmental views,

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[12] I do not include the two short-term weather indicators—departures from normal temperature/precipitation— in the model predicting private-sector environmentally significant behaviors, because these behaviors tend to be long-term routines or habits.

[13] The results of the models with clustered standard errors do not differ much from those of the normal OLS models – with no clustered standard errors.

perceptions of global warming, and demographic characteristics. The direction and magnitude of the coefficients for non-contextual variables barely change from Model 1 to Model 3.

Table 5.5 OLS estimates for models of individuals' voluntary actions to address global warming, without contextual forces

Model	1		2		3	
Variables	b	t	b	t	b	t
Environmental Views						
Environment regardless of cost [+]	0.14	1.37	---	---	0.04	0.40
Environment vs. Economy [+]	0.17	3.45***	---	---	0.20	3.80***
Environment vs. New Energy [+]	-0.03	-0.45	---	---	-0.07	-1.19
Perceptions of Global Warming						
Awareness of global warming [+]	0.18	2.74**	---	---	0.17	2.43*
Priority of global warming [+]	0.09	1.13	---	---	0.10	1.11
Urgency of global warming [+]	0.18	2.02*	---	---	0.15	1.55
Factor of global warming [+]	-0.00	-0.01	---	---	0.00	0.04
Perception of strange weather [+]	0.12	1.08	---	---	0.06	0.48
Demographic Characteristics						
Party identification [-]	---	---	-0.16	-2.65**	-0.12	-1.85*
Political ideology [-]	---	---	-0.20	-3.18***	-0.13	-1.82*
Age [-]	---	---	-0.01	-2.92**	-0.01	-2.57**
Gender (Female) [+]	---	---	-0.02	-0.18	-0.02	-0.19
Education [+]	---	---	0.08	2.06*	0.05	1.06
Income [+]	---	---	0.02	0.52	0.01	0.23
Race (Black) [+]	---	---	-0.10	-0.65	-0.09	-0.54
Race (Hispanic) [+]	---	---	0.21	1.22	0.17	0.94
Church attendance [-]	---	---	-0.02	-0.66	0.01	0.39
Subjective assessment of financial situation [-]	---	---	0.05	0.62	-0.02	-0.22
F	9.39		4.96		5.39	
Adjusted R^2	0.12		0.07		0.16	
N	492		496		426	

***prob<0.001 (one-tail test); **prob<0.01 (one-tail test); *prob<0.05 (one-tail test)

Note: The constant terms are omitted from the table for the sake of brevity.

In the three models with contextual forces, five non-contextual variables obtain their explanatory power. The view towards environment and economics, among other environmental views, stands out as a significant predictor for the private-sector environmentally significant behaviors. Awareness of global warming is a significant predictor on environmentally significant behaviors to reduce global warming in the group of independent variables for perceptions of global warming. Party identification, political philosophy, and age, among other demographic characteristics, are found to be important indicators of the environmentally significant behaviors to address global warming.

There is one point that is noteworthy. Neither the subjective assessment of one's financial situation nor the objective indicator of economic condition—county-level unemployment rate—is found to have any statistically significant impact on individuals' behaviors to reduce global warming. This suggests that individuals do not particularly take into considerations the economic conditions when they take voluntary actions to address global warming.

As Table 5.6 Model 2 displays, the variance explained improves moderately with the local weather indicators as contextual forces. Two of the four seasonal temperature trends—winter temperature trend and spring temperature trend—are found to be significant predictors on individuals' behaviors to reduce global warming. Specifically, individuals who have been exposed to warming winters tend to make environmentally sound choices in their daily lives. On the other hand, people who have experienced increasingly cold springs are more likely than their counterparts to engage in environmentally significant behaviors. It appears that individuals in which the temperature trends are heading in the extreme direction are more likely to participate in these behaviors. Table 5.6 model 3 demonstrates that CO_2 emission by state does not significantly help explain the variance in personal voluntary actions to address global warming.

To compare the different effects of the contextual forces, I estimate a normal OLS model including each of three sets of contextual variables[14]. In Table 5.7, I present the empirical results of the model with all contextual variables. The significance and direction of most variables remain the same as found in the models presented in Table 5.6. The effect of political ideology becomes insignificant in the model including all contextual variables. The effect of county unemployment rate on the dependent variable becomes significant. Individuals who reside in counties with higher unemployment rate are less likely to take part in the environmentally significant behaviors to reduce global warming. This result resonates with the theoretical argument that humans tend to prioritize the immediate basic physiological needs (food and shelter) over future aesthetic needs (environmental quality) when the economy is on the downturn. The two significant variables of local weather and climate verified in Model 2 of Table 5.6 – winter and spring seasonal temperature trends – remain significant in the Model including all contextual forces, and the directions of these two coefficients are the same as those in the Model with only local weather as contextual force. Furthermore, another local weather and climate indicator—fall temperature trend—is found to be significantly associated with the personal voluntary actions in this model. The coefficient of this variable is negative, indicating that people who have experienced increasingly cold falls over the past 10 years are more likely to take voluntary actions to reduce global warming.

In summary, attitudinal variables including general environmental views and specific perceptions towards global warming account for more variance explained than demographic

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[14] Due to the difference of the geographic levels on which each contextual variable is on, it is not possible to estimate the clustered standard errors within one model.

Table 5.6 OLS estimates for models (clustered standard errors) of individuals' voluntary actions to address global warming, with contextual forces

Model	1		2		3	
Variables	b	t	b	t	b	t
Environmental Views						
Environment regardless of cost [+]	0.05	0.44	0.04	0.43	0.04	0.57
Environment vs. Economy [+]	0.20	4.02***	0.20	4.23***	0.20	3.91***
Environment vs. New Energy [+]	-0.08	-1.17	-0.06	-0.87	-0.07	-1.30
Perceptions of Global Warming						
Awareness of global warming [+]	0.17	2.46*	0.18	2.85**	0.17	1.97*
Priority of global warming [+]	0.10	1.19	0.13	1.53	0.10	1.07
Urgency of global warming [+]	0.15	1.61	0.10	1.09	0.15	1.88*
Factor of global warming [+]	-0.00	-0.01	0.01	0.10	0.01	0.05
Perception of strange weather [+]	0.06	0.49	0.06	0.52	0.06	0.46
Demographic Characteristics						
Party identification [-]	-0.12	-1.89*	-0.11	-1.68*	-0.12	-2.43**
Political ideology [-]	-0.13	-1.76*	-0.12	-1.66*	-0.13	-1.80*
Age [-]	-0.01	-2.63**	-0.01	-2.91**	-0.01	-3.11**
Gender [+]	-0.02	-0.25	0.01	0.14	-0.02	-0.23
Education [+]	0.04	0.98	0.04	0.94	0.05	0.83
Income [+]	0.01	0.19	0.02	0.41	0.01	0.26
Race (Black) [+]	-0.09	-0.49	-0.13	-0.74	-0.09	-0.63
Race (Hispanic) [+]	0.17	0.97	0.17	0.97	0.17	0.95
Church attendance [-]	0.01	0.33	0.03	1.13	0.01	0.36
Subjective assessment of financial situation [+]	-0.02	-0.23	-0.03	1.13	-0.02	-0.23
Contextual Forces						
Unemployment rate (County) [-]	-0.03	-0.89	---	---	---	---
Local Weather						
Temperature trends						
Winter [+]	---	---	0.09	2.38*	---	---
Spring [+/-]	---	---	-0.11	-3.12**	---	---
Summer [+]	---	---	0.04	0.90	---	---
Fall [+/-]	---	---	-0.08	-1.60	---	---
Precipitation trends						
Winter [+/-]	---	---	0.00	0.84	---	---
Spring [+/-]	---	---	-0.00	-0.48	---	---
Summer [+/-]	---	---	-0.00	-0.07	---	---
Fall [+/-]	---	---	-0.00	-0.19	---	---
CO^2 Emission (State) [+]	---	---	---	---	-0.00	-0.14
F	5.35***		4.69***		15.60***	
Adjusted R^2	0.19		0.22		0.19	
N	426		423		426	

***prob<0.001 (one-tail test); **prob<0.01 (one-tail test); *prob<0.05 (one-tail test)

Note: The constant terms are omitted from the table for the sake of brevity.

variables in the models for private-sector environmentally significant actions to address global warming. The objective macroeconomic conditions, represented by the county-level unemployment rate, are found to be insignificantly associated with these private-sector environmentally significant behaviors in the model including only unemployment rate as its contextual force. However, the effect of this variable turns significant in the model with all contextual forces. The coefficient being negative suggests that the economic downturn can inhibit people from taking an active part in environmentally significant behaviors to reduce global warming. Meanwhile, the other contextual force, climate and weather, is found to be an important effect on individuals' daily voluntary actions to address global warming. Especially, increasingly warm winters, cold springs, and cold falls are associated with higher likelihood for individuals to participate in environmentally significant behaviors.

Willingness to Pay More to Address Global Warming

In Table 5.8, I present regression estimates for models in which the dependent variable is the willingness to pay more to reduce global warming without contextual forces. These models include a wide range of independent variables, but not contextual variables. Demographic characteristics only explain 11% of the variance, while environmental views and perception of global warming alone explain 26% of the variance explained. With three groups of variables combined, the adjusted R^2 rises to 30%.

In Model 1, the coefficients for two variables representing environmental views and three variables relating to perceptions of global warming obtain statistical significance, indicating that these variables influence individuals' willingness to pay more to address global warming.

Specifically, individuals who believe that protecting and improving the environment should be made regardless of cost are more willing to pay more to reduce global warming. Likewise,

Table 5.7 OLS estimates for model of individuals' voluntary actions to address global warming, with contextual forces

Variables	b	t
Environmental Views		
Environment regardless of cost [+]	0.04	0.35
Environment vs. Economy [+]	0.20	3.69***
Environment vs. New Energy [+]	-0.06	-1.01
Perceptions of Global Warming		
Awareness of global warming [+]	0.18	2.58**
Priority of global warming [+]	0.13	1.43
Urgency of global warming [+]	0.09	0.96
Factor of global warming [+]	0.00	0.05
Perception of strange weather [+]	0.08	0.64
Demographic Characteristics		
Party identification [-]	-0.11	-1.72*
Political philosophy [-]	-0.11	-1.56
Age [-]	-0.01	-2.65**
Gender [+]	0.01	0.11
Education [+]	0.03	0.77
Income [+]	0.02	0.39
Race (Black) [+]	-0.11	-0.69
Race (Hispanic) [+]	0.17	0.98
Church attendance [-]	0.03	0.94
Subjective assessment of financial situation [+]	-0.03	-0.29
Contextual Forces		
Unemployment rate (County) [-]	-0.07	-1.92*
Local Weather		
Temperature trends		
Winter [+]	0.09	2.36**
Spring [+/-]	-0.13	-3.55***
Summer [+]	0.07	1.40
Fall [+/-]	-0.10	-2.11*
Precipitation trends		
Winter [+/-]	0.00	0.90
Spring [+/-]	-0.00	-0.81
Summer [+/-]	-0.00	-0.47
Fall [+/-]	0.00	0.01
CO^2 Emission (State) [+]	0.00	1.09
F		4.08***
Adjusted R^2		.17
N		423

***prob<0.001 (one-tail test); **prob<0.01 (one-tail test); *prob<0.05 (one-tail test)

Note: The constant terms are omitted from the table for the sake of brevity.

people who think that protecting the environment is more important than stimulating the economy are more willing to make financial sacrifices to address the issue of global warming. The explanatory power of these two variables continues to hold up strongly in model 3. Individuals who believe “global warming is a very serious problem”, see “global warming is causing a serious impact now”, and think “the release of greenhouse gases is the most important factor causing global warming” are willing to pay more to address the issue of global warming. The variable – the impact of global warming— loses its explanatory power when one includes demographic variables, as is the case in Model 3.

In Model 2 of Table 5.8, coefficients for five variables show significance even though this model only accounts for 11% of the variance in the dependent variable explained. Party identification, liberal-conservative ideology, and age are found to have negative effects on the public willingness to address the issue of global warming, while education and individuals’ subjective assessments of their financial situations are found to be positively associated with the dependent variable. Specifically, Democrats, liberals, and young people are more willing than their counterparts to pay more to reduce global warming. People with higher levels of education and those who judge their family financial situations as good tend to show higher level of willingness to make financial sacrifices to reduce global warming. After adding the attitudinal variables as shown in Table 5.8 model 3, party identification, political philosophy, and age lose their statistical significance, while income gains statistical significance. Income is found to have positive effects on individuals’ willingness to address global warming, meaning that people with more income are more willing to make financial contribution to the battle against global warming. In addition, one's subjective assessment of his/her family financial situation is found to be positively associated with the willingness to pay more to reduce global warming.

In Table 5.9 I present the empirical results for models of public willingness to pay more to reduce global warming, but in this case I include variables representing contextual forces in the models. These three models have county-level unemployment rate, local weather, and CO2 emission as contextual forces, respectively. To estimate each model, I adopt clustered standard errors to correct for the violation that standard errors are not independent when merging individual-level data with aggregate data (Primo, Jacobsmeier, and Milyo, 2007). Three models slightly improve the variance explained by 2 %, 4%, and 2%, respectively. All the significant attitudinal variables and most significant demographic variables verified by model 3 in Table 5.8 retain their explanatory powers in the models with the addition of contextual variables. Specifically, the views that protecting the environment should be made regardless of cost and environmental protection should be more important than economic stimulation remain to be positively associated with the public willingness to pay more to reduce global warming in the models with contextual forces. Meanwhile, individuals who prioritize global warming and attribute global warming mainly to the release of greenhouse gases are found to be more willing to make financial efforts to address global warming. Education and subjective assessment of one's family financial situation both remain as significant predictors on the dependent variable. Surprisingly, none of these three contextual forces – county-level unemployment rate, local weather indicators, and state-level CO2 emission—are found to be significantly associated with the public willingness to pay more to address global warming.

Attitudinal variables including general environmental views and specific perceptions of global warming by and large have more explanatory powers than demographic characteristics in the models for willingness to pay more to reduce global warming. Subjective assessment of one's family financial situation is a more consistent predictor than the objective indicator of one's family financial situation—income. The contextual forces represented in this study by county-level unemployment, local weather and climate measures, and state-level CO2 emission are found not to exert any significant influence on individuals' willingness to pay more to reduce global warming.

To compare the effects of each of these three contextual forces, I include all the three contextual variables in one model. Because the three contextual forces are at three different geographic levels, it is not possible to estimate clustered standard errors within one model. Therefore, I estimate a normal OLS model. As Table 5.10 shows, all the significant independent variables verified by the models in Table 5.9 retain their predictive power. None of the contextual measures shows significance. This reinforces the results of the models in Table 5.9 that none of the contextual forces exert significant influence on public willingness to pay more to address global warming.

Conclusion

A few conclusions can be drawn from the statistical analyses of individuals' private-sector environmentally significant behaviors and their willingness to pay more to reduce global warming. First, based on the descriptive statistics, two major points can be raised. On the one hand, there is some discrepancy on individuals' voluntary actions to address global warming. The majority recycles, purchases energy efficient light bulbs regularly, buys products made from

Table 5.8 OLS estimates for models of individuals' willingness to pay more to address global warming, without contextual forces

Model	1		2		3	
Variables	b	t	b	t	b	t
Environmental Views						
Environment regardless of cost [+]	0.40	5.47***	---	---	0.47	6.27***
Environment vs. Economy [+]	0.16	4.40***	---	---	0.13	3.46***
Environment vs. New Energy [+]	0.02	0.61	---	---	0.04	0.95
Perceptions of Global Warming						
Awareness of global warming [+]	0.03	0.70	---	---	-0.06	-1.17
Priority of global warming [+]	0.28	4.53***	---	---	0.29	4.39***
Urgency of global warming [+]	0.11	1.84*	---	---	0.07	1.12
Factor of global warming [+]	0.17	2.69**	---	---	0.17	2.53*
Perception of strange weather [+]	-0.12	-1.47	---	---	-0.16	-1.90
Demographic Characteristics						
Party identification [-]	---	---	-0.19	-4.10***	-0.04	-0.98
Political philosophy [-]	---	---	-0.24	-4.82***	-0.07	-1.38
Age [-]	---	---	-0.00	-1.87**	-0.00	-0.94
Gender [+]	---	---	0.12	1.75	0.10	1.54
Education [+]	---	---	0.06	1.93*	0.10	3.13**
Income [+]	---	---	0.04	1.17	0.05	1.67*
Race (Black) [+]	---	---	-0.16	-1.26	-0.09	-0.70
Race (Hispanic) [+]	---	---	-0.03	-0.22	-0.14	-1.08
Church attendance [-]	---	---	-0.03	-1.33	0.00	0.06
Subjective assessment of financial situation [+]	---	---	0.16	2.85**	0.13	2.42**
F	35.13		11.19		17.43	
Adjusted R^2	.26		.11		.30	
N	786		813		691	

***prob<0.001 (one-tail test); **prob<0.01 (one-tail test); *prob<0.05 (one-tail test)

Note: The constant terms are omitted from the table for the sake of brevity.

Table 5.9 OLS estimates for models (clustered standard errors) of individuals' willingness to pay more to address global warming, with contextual forces

Model	1		2		3	
Variables	b	t	b	t	b	t
Environmental Views						
Environment regardless of cost [+]	0.48	6.04***	0.48	6.05***	0.47	6.56***
Environment vs. Economy [+]	0.13	3.55***	0.13	3.69***	0.13	4.07***
Environment vs. New Energy [+]	0.04	0.97	0.05	1.20	0.04	1.35
Perceptions of Global Warming						
Awareness of global warming [+]	-0.06	-1.07	-0.06	-1.09	-0.06	-1.00
Priority of global warming [+]	0.29	3.97***	0.29	3.98***	0.29	3.27***
Urgency of global warming [+]	0.07	1.05	0.07	0.96	0.07	0.88
Factor of global warming [+]	0.16	2.37**	0.17	2.39**	0.17	2.57**
Perception of strange weather [+]	-0.16	-1.91	-0.13	-1.42	-0.16	-1.86
Demographic Characteristics						
Party identification [-]	-0.04	-0.91	-0.04	-0.75	-0.04	-0.77
Political ideology [-]	-0.07	-1.32	-0.08	-1.48	-0.07	-1.63
Age [-]	-0.00	-0.98	-0.00	-0.66	-0.00	-1.42
Gender (Female) [+]	0.10	1.56	0.09	1.37	0.10	1.38
Education [+]	0.09	3.14***	0.09	3.14***	0.10	3.12**
Income [+]	0.05	1.49	0.05	1.58	0.05	2.39*
Race (Black) [+]	-0.08	-0.63	-0.13	-0.74	-0.09	-0.68
Race (Hispanic) [+]	-0.15	-1.21	-0.19	-1.50	-0.14	-1.28
Church attendance [-]	0.00	-0.06	-0.00	-0.12	0.00	0.06
Subjective assessment of financial situation [+]	0.13	2.30*	0.13	2.35*	0.13	3.19***
Contextual Forces						
Unemployment rate	-0.03	-1.30	---	---	---	---
Local Weather						
Temperature trends						
Winter [+]	---	---	-0.04	-1.22	---	---
Spring [+/-]	---	---	0.04	1.16	---	---
Summer [+]	---	---	0.03	0.96	---	---
Fall [+/-]	---	---	-0.01	-0.39	---	---
Precipitation trends						
Winter [+/-]	---	---	-0.01	-1.83	---	---
Spring [+/-]	---	---	0.00	0.68	---	---
Summer [+/-]	---	---	0.00	0.15	---	---
Fall [+/-]	---	---	-0.00	-0.69	---	---
Departure from Normal Temperature [+/-]	---	---	0.02	0.25	---	---
Departure from Normal Precipitation [+/-]	---	---	0.05	1.17	---	---
CO2 emission (state) [+]	---	---	---	---	-0.00	-0.21
F	19.42***		16.27***		28.67***	
Adjusted R^2	0.32		0.34		0.32	
N	691		685		691	

***prob<0.001 (one-tail test); **prob<0.01 (one-tail test); *prob<0.05 (one-tail test)

Note: The constant terms are omitted from the table for the sake of brevity.

Table 5.10 OLS estimates for model of individuals' willingness to pay more to address global warming, with contextual forces

Variables	b	t
Environmental Views		
Environment regardless of cost [+]	0.48	6.33***
Environment vs. Economy [+]	0.13	3.46***
Environment vs. New Energy [+]	0.04	1.04
Perceptions of Global Warming		
Awareness of global warming [+]	-0.06	-1.13
Priority of global warming [+]	0.29	4.36***
Urgency of global warming [+]	0.07	1.01
Factor of global warming [+]	0.17	2.53**
Perception of strange weather [+]	-0.13	-1.55
Demographic Characteristics		
Party identification [-]	-0.04	-0.80
Political philosophy [-]	-0.08	-1.51
Age [-]	-0.00	-0.59
Gender (Female) [+]	0.09	1.37
Education [+]	0.09	2.95**
Income [+]	0.05	1.67*
Race (Black) [+]	-0.02	-0.17
Race (Hispanic) [+]	-0.19	-1.37
Church attendance [-]	-0.00	-0.19
Subjective assessment of financial situation [+]	0.13	2.34*
Contextual Forces		
Unemployment rate (County) [-]	-0.03	-0.98
Local Weather and Climate		
Temperature trends		
Winter [+]	-0.03	-0.89
Spring [+/-]	0.03	0.79
Summer [+]	0.04	1.04
Fall [+/-]	-0.02	-0.46
Precipitation trends		
Winter [+/-]	-0.01	-1.69
Spring [+/-]	0.00	0.99
Summer [+/-]	0.00	0.16
Fall [+/-]	-0.00	-0.86
Departure from Normal Temperature [+/-]	0.04	0.56
Departure from Normal Precipitation [+/-]	0.05	1.38
CO^2 Emission (State) [+]	-0.00	-0.56
F	11.05***	
Adjusted R^2	0.30	
N	685	

***prob<0.001 (one-tail test); **prob<0.01 (one-tail test); *prob<0.05 (one-tail test)

Note: The constant terms are omitted from the table for the sake of brevity.

recycled materials at least occasionally, and seriously considers buying hybrid cars. However, few would like to car pool or take mass transit to work regularly, when it comes to personal transportation choices. This highlights the public reluctance to change their lifestyle reliant on private vehicles. This finding is consistent with results of O'Connor *et al.* (1999). On the other hand, the public is willing to make financial sacrifices to reduce global warming when the money is used for research on renewable sources, and the energy is generated by renewable sources. However, the majority of Americans refuses to pay more federal tax on gasoline for the purpose of energy consumption reduction to help address global warming. This implies the public's aversion to attempts to reduce energy consumption.

Second, multi-regression models help to identify key determinants of the private-sector environmentally significant behaviors and the public willingness to pay more to reduce global warming. Attitudinal variables including general environmental views and specific perceptions of global warming outperform either socio-demographic characteristics variables or contextual forces in explaining the two dependent variables. Furthermore, there is variance in how the attitudinal variables influence the voluntary actions and willingness to reduce global warming. For instance, the opinion that environmental protection is more important than economic stimulation is positively associated with both voluntary actions and the intention to reduce global warming, while the view that the environment should be protected regardless of cost is found to be only positively associated with the intention to make financial contributions to the reduction of global warming. Being aware of global warming encourages people to take voluntary actions to address this issue, whereas prioritizing global warming and attributing global warming mainly to the release of greenhouse gases determine individuals' willingness to pay more to reduce global warming. There is also variation among demographic variables in their effects on the two dependent variables. For instance, party identification and political philosophy only have significant effects on the voluntary actions, where Democrats and liberals are more likely than Republicans and conservatives to take voluntary actions to address global warming. Age is also found to be negatively associated with the voluntary actions, where older people are more reluctant than younger ones to get involved in the personal voluntary behaviors. Meanwhile, education and individuals' subjective assessments of the family financial situation play an important role in explaining individuals' intention to make financial contributions to combating global warming. Specifically, people who have higher levels of education and think more positive about their own financial situation show a greater willingness to pay more to reduce global warming. One key finding is that the subjective assessment of the family financial situation outperforms the objective family financial situation—income. This finding highlights one point that objective economic condition does not necessarily translate into subjective assessment of the financial situation. This finding is consistent with Durr (1993), who finds that economic expectations move policy sentiment along a liberal-conservative continuum.

Finally, the three contextual forces are found to have different effects on the voluntary actions and intentions to pay more to address global warming. The macroeconomic condition represented by county-level unemployment rate in this study is found to have a negative effect on individuals' voluntary actions in the model including all three contextual variables, indicating that individuals are less likely to participate in behaviors to address global warming during an economic downturn. This variable is found not have any significant effect on the public willingness to pay more to reduce global warming. The local weather represented by the winter, spring, and fall seasonal temperature trends over the past 10 years, on the other hand, is found to be significantly associated with individuals' voluntary actions to reduce global warming. For instance, individuals who are exposed to increasingly warm winters, increasingly cold springs, and increasingly cold falls are more likely to take voluntary actions to combat global warming. However, the local weather does not show significance in the model explaining the public willingness to address global warming. In general, contextual forces have some effects on individuals' environmentally significant behaviors. However, these contextual forces as identified in this study, do not exert significant influence on public willingness to pay more to address global warming.

CHAPTER 6 CONCLUDING REMARKS

This dissertation investigated factors that affect American public opinion towards global warming and individuals' environmentally significant behaviors. These studies which make up the three major analyses— Chapters 3, 4, and 5— are the first to systematically investigate the impacts of long-term climate trends and short-term weather fluctuations, along with attitudinal variables and socio-demographic characteristics, on public perceptions of global warming and voluntary actions and intentions to reduce global warming. Results of these studies provide insights to how individuals translate local weather and climate into their perceptions of global warming and personal environmentally significant behaviors. These analyses reveal several important findings.

First, among all the local weather climate indicators identified in this dissertation, long-term (10 years) seasonal temperature trends outperform long-term seasonal precipitation trends and short-term (over the last month prior to the survey interview date) weather fluctuations in predicting public opinion towards global warming and individuals' voluntary actions to reduce global warming. Especially, the summer temperature trend over the past 10 years has consistently shown positive effects on public perceptions of global warming. Individuals who have experienced increasingly hot summers over the past 10 years tend to believe that global warming is occurring and attribute it to human causes, and are more likely to see the urgency of the impact and severity of the problem. In other words, people's perceptions are most sensitive to increasing temperature in summer. They are more likely to link increasingly hot summers to evidence of anthropogenic global warming, and of the urgency and severity of global warming. In addition, the spring temperature trend over the past 10 years is found to have negative effects on public opinion towards global warming and personal voluntary actions to reduce global warming. Increasingly cold springs, along with increasingly hot summers over the past 10 years, are significantly associated with higher likelihood that individuals believe in human made global warming. Meanwhile, increasingly cold springs, along with increasingly warm winters, are significantly associated with individuals' participation in private-sector environmentally significant behaviors. Colder spring must serve as a reminder that one form of climate change is an increase in climate variability, which could include colder springs. It appears that individuals in which the temperature trends are heading toward increasing extremes are more sensitive and responsive to global warming.

Second, global warming has become a politically polarized issue. Survey data of the last decade suggests that global warming has divided the public by political party and ideology. Democrats and political liberals tend to accept anthropogenic global warming, be more concerned with the impact of global warming, and take voluntary actions to reduce the effects of global warming. On the other hand, Republicans and political conservatives are more likely to be skeptical of anthropogenic global warming, express lower level of concern for the urgency and severity of global warming, and resist taking an active part in environmentally significant behaviors to address global warming. In addition, another finding is that the effects of education on public opinion toward global warming are different among Democrats and liberals, on the one hand, and Republicans and conservatives, on the other hand. Specifically, with the increase of education level, the likelihood increases that Democrats and liberals accept anthropogenic global warming and are more concerned with the effects of global warming. Whereas, the effects of education on public perceptions of global warming among Republicans and conservatives are either nearly unnoticeable or negative.

Third, attitudinal variables play an important role in affecting public perceptions of global warming and individuals' environmentally significant behaviors. For instance, personal attitudes toward scientists are found to be a strong group of predictors on public opinion toward global warming. When people have more confidence in scientists, believe scientists are conservative, and think there is a scientific consensus on global warming, they are more likely to accept anthropogenic global warming. In addition, attitudinal variables including individuals' environmental views and perceptions of global warming outperform socio-demographic characteristics and contextual forces in explaining the variance of personal voluntary actions and public willingness to pay more to reduce global warming.

Finally, objective macro-economic condition represented by county-level unemployment rate in this dissertation is not found to have any consistently significant effects on either public perceptions of global warming or individuals' environmentally significant behaviors. This finding is contrary to the theoretical argument that human motivation is a limited pool and requires basic physiological needs before aesthetic needs are to be met. However, subjective assessment of the family financial situation outperforms the objective economic condition measure—income—in predicting public willingness to pay more to address global warming. This finding suggests that objective economic condition does not necessarily translate into subjective assessments of the economy and the latter plays a more important role in affecting individuals' environmentally significant behaviors as found in this dissertation.

There are a few limitations of this dissertation. First, all the survey data used in this dissertation come from sources that are accessible to the public. Even though these survey data provide rich sets of variables that fit into the research interest of this dissertation, there are some variables that I wanted to include in this dissertation but did not because of the lack of relevant survey items provided by these available data. For instance, the New Environmental Paradigm (NEP) developed by Dunlap (1978) is a valid measure widely used to conceptualize individual environmental values. However, no relevant survey questions regarding NEP are provided in the survey used in Chapter 5. I only adopt an incomplete list of variables to conceptualize environmental beliefs. In future studies, scholars should consider designing their own surveys to include items that can construct NEP. In addition, the county unemployment rate is adopted in this dissertation to represent objective macroeconomic conditions. Due to the limit of the survey data, I did not include any independent variable relating to subjective assessment of macroeconomic conditions. Future studies should be directed to include variables that measure the subjective judgment of economy. Second, no systematic spatial non-stationarity is found to exist in the GWR model in the exploration of spatial variation. Further tests are needed to examine the existence of a mixed GWR model in which some parameters are spatially uniform, but others are geographically non-stationary. Third, the effect of media on public perceptions of global warming is not examined in this dissertation. Future research may include variables that measure the volume and content of media reports on global warming.

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APPENDIX

The following questions are from Pew Research Center for the People and the Press April 2009 General Public Science Survey:

Question 45, Form 1

Which of these three statements about the earth's temperature comes closest to your view?

	Frequency	Percent
A. The earth is getting warmer mostly because of natural changes in the atmosphere	329	32.74
B. The earth is getting warmer mostly because of human activity such as burning fossil fuels	491	48.86
C. The earth is not getting warmer	151	15.02
D. Don't know/refused (vol.)	34	3.38
Total	1,005	100

Question 45, Form 2

Which of these three statements about the earth's temperature comes closest to your view?

	Frequency	Percent
A. The earth is not getting warmer	88	8.84
B. The earth is getting warmer mostly because of natural changes in the atmosphere	384	38.55
C. The earth is getting warmer mostly because of human activity such as burning fossil fuels	474	47.59
D. Don't know/refused (vol.)	50	5.02
Total	996	100

VITA

Wanyun Shao was born in southwestern China, in a city called Dazhou in October 1983. Her parents are Yongjin Shao and Houyu Huang. After high school, she went to Jilin University in northeastern China. She studied urban and regional planning in college and acquired her Bachelor of Sciences in geography. She came to the United States for graduate degrees in 2006. She obtained her Master degree of Planning at University of Wyoming in 2009. She is a doctoral candidate at Louisiana State University and will be awarded her doctorate in the summer of 2012.