Corporate Climate Change Adaptation, Vulnerability and Environmental Performance in the United States Ski Resort Industry

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A Dissertation submitted to

The Faculty of
The School of Business
of The George Washington University
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy

August 31, 2011

Dissertation directed by

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Acknowledgments

I am grateful and indebted to family members and colleagues who played essential roles in the development and completion of this dissertation. My mother Jackie's faith in me was a never-ending source of inspiration; my father Len's advice, support and wisdom about navigating life as a doctoral student guided me through countless times of difficulty and uncertainty; my step-mother Nancy, whose spirit of creativity helped inspire me to look for the same in work, and in life; my Italian family Antonio, Gaia and Stefania, who have so graciously and lovingly welcomed me into their family; and the love of my life, my fiancé Valentina, whose beauty, love, support and wisdom have been the pillars of my faith in this endeavor. I love you all, with all of my heart.

Several faculty in the Strategic Management and Public Policy Department have been invaluable colleagues. Mark Starik is a true champion of sustainability and has been a source of inspiration and critical intellectual support. His confidence in me and leadership in our department enabled me to stay focused on my research, and to pursue the ideas I care about, even if they are outside of the mainstream. Tim Fort was the first to provide me with opportunities to develop and present my research, and his support resulted in my first two publications. He has also been instrumental in connecting me with the Institute for Corporate Responsibility, which has provided generous support for my dissertation research over the years. Jenn Griffin helped me through the enormous challenge of "breaking the ice" with organizational theory, which was perhaps the greatest intellectual challenge I have faced in graduate school. Then, Ernie Englander helped me become truly engaged with organizational theory, and resource dependence

theory in particular, which is so prominent in this dissertation. Eun-Hee Kim and Jennifer Spencer challenged me to improve the rigor of my research, and my capabilities as a social scientist. Members of my doctoral cohort Chuck, Juan, Michelle, Patricia, Port, Smita and Tim deserve thanks for their friendship, support and wisdom over the years.

Finally, my advocate Jorge Rivera provided me with extraordinary guidance and generous attention for 5 years. He has shared with me his knowledge, experience, ideas and pragmatism, and forced me time and again to be better than I would have been if left to my own conceptions. I am truly indebted to his contributions, not only to this dissertation, but also to all of the positive developments in my academic career so far.

Abstract

Corporate Climate Change Adaptation, Vulnerability and Environmental Performance in the United States Ski Resort Industry

This dissertation examines the relationships between *Corporate Climate Change Vulnerability* and *Adaptive Capacity*, and *Corporate Environmental Performance*. It posits that these relationships merit attention because *Corporate Climate Change Vulnerability* can impact firms through their biophysical environments. To reduce this form of vulnerability, firms may deploy adaptations that affect their biophysical environments in ways that create harm in that domain. Similarly, firms' *Climate Change Adaptive Capacity* may also lead to negative impacts in that domain, because it reflects firms' capacity to reduce their vulnerability. Given that global climate change may, in the coming decades, significantly alter the environmental commons on which all life depends, it is important to understand whether firms' adaptations to the phenomenon can exacerbate global ecological change.

The study is part of the emerging research area of *Corporate Climate Change Adaptation*. Scholarship in this area is currently focused on discovering how firms reduce vulnerability via adaptations, and how adaptive capacity helps to facilitate the adaptation process. Scholars have also identified some of the types of adaptation strategies and described some of the internal organizational processes that underpin firms' vulnerability, adaptive capacity and choice of adaptation strategy. The current study aims to extend this work, first by theorizing how external biophysical and socioeconomic influences can induce firms to generate impacts in their biophysical and socioeconomic environments,

and then by developing empirical evidence regarding these linkages via quantitative analysis. The research questions guiding the study are:

1) Do *Corporate Climate Change Vulnerability* and *Adaptive capacity* significantly affect *Biophysical Environmental Performance*[1]?

2) And, do firms improve their *Socioeconomic Environmental Performance*[2] to compensate for declining levels of *Biophysical Environmental Performance* that result from corporate climate change adaptation?

This dissertation makes two additional contributions to the management literature. The first is to organizational theory. More specifically, it aims to extend resource dependence theory, by exploring the nature of firms' uncertainty in accessing critical ecological resources embedded in their biophysical environments. Currently, resource dependence theory focuses on explaining corporate attempts to manage resource dependence on resources that are traded or embedded in market and institutional environments. I argue that this theoretical extension is necessary to explain climate change adaptations, because the phenomenon involves corporate resource dependence created by ecological phenomena and resources. For this end, the dissertation describes some of the unique mechanisms associated with *natural* resource dependence, to complement the existing resource dependence theory framework and logic.

Second, it addresses calls from scholars of corporate environmental performance to conduct studies that assess multiple dimensions of the construct simultaneously. This is important for at least two reasons. First, there is anecdotal evidence that some firms

1 *Biophysical Environmental Performance* refers to the degree to which firms protect or conserve ecosystems that comprise their immediate biophysical environments.
2 *Socioeconomic Environmental Performance* refers to corporate protection of natural resources that are traded or exchange in firms' market or institutional environments.

protect the environment in some ways and simultaneously harm it in others. Thus, studies that assess impacts in only one dimension of environmental performance can potentially yield unreliable results about firms' overall performance. In addition, some scholars believe that different dimensions of environmental performance can be systematically related. Some firms may perform well in most dimensions because they pursue proactive environmental strategies. Others may perform well in some dimensions and poorly in others, because they lack capacity to be comprehensively good, or because they are trying to compensate for poor performance in one dimension by doing well in another. By assessing the impacts of an independent event on multiple dimensions of corporate environmental performance, I will uncover evidence both of firms' comprehensive environmental performance and of systematic relationships between its different dimensions.

The empirical study of the dissertation is set in the United States ski resort industry. This industry depends substantially upon climate, and many ski resorts have experienced *Corporate Climate Change Vulnerability* for many years. Thus, the industry could provide early evidence for the study of corporate climate change adaptation. Conducting the study within a single national industry can be advantageous, because it provides an element of statistical control with respect to the best available technology to firms for climate change adaptation, and to federal regulations governing environmental performance.

Results showed that *Corporate Climate Change Vulnerability* is both negatively related to *Biophysical Environmental Performance* and positively related to *Socioeconomic Environmental Performance*. Results linking *Corporate Climate Change*

Adaptive Capacity to *Biophysical Environmental Performance* were mixed. Specifically, *Public Ownership* is negatively and significantly related to this dependent variable; however, *State Environmentalism* and *Regulator Resource Dependence* are not. In addition, results linking *Corporate Climate Change Adaptive Capacity* to *Socioeconomic Environmental Performance* were also mixed. Specifically, *Regulator Resource Dependence* is positively related to *Socioeconomic Environmental Performance*; however, *State Environmentalism* and *Public Ownership* are not.

Table of Contents

Acknowledgements iii
Abstract v
List of Figures xiv
List of Tables xv
CHAPTER 1. INTRODUCTION 1
1.1 Overview 1
1.2 Description of the Phenomenon 3
1.3 Specific Research Questions and Overview of Conceptual Model 4
1.4 Theoretical Lens 8
1.5 Contributions to the Management Discipline 10
1.6 Policy and Strategy Implications 12
1.7 Research Context: The United States Ski Resort Industry 13
1.71 Rationale for Research Context 13
1.72 United States Ski Resort Industry Profile 14
1.8 Data 24
CHAPTER 2. LITERATURE REVIEW 26
2.1 The Impacts of Climate Change on Business 26
2.2 Corporate Responses to the Impacts of Changing Climate 28
2.21 Corporate Climate Change Mitigation in Practice and Theory 28
2.22 Corporate Political Strategies in Practice and Theory 30
2.23 Corporate Climate Change Adaptation in Practice 31
2.24 Corporate Climate Change Adaptation in Theory 35
2.3 Institutional Influence and Environmental Performance in the Ski Industry 49
2.4 Summary 51

CHAPTER 3. RESOURCE DEPENDENCE AND NATURAL RESOURCE DEPENDENCE 55
3.1 Introduction 55
3.2 Rationale for Using Resource Dependence Theory 55
3.3 Resource Dependence Theory Reviewed 56
3.4 Natural Resource Dependence 61
3.41 Organizational Dependence on Ecosystems 63
3.42 Ecological impacts on organizations 65
3.43 Organizational impacts on ecosystems 68
3.44 Organizational impacts on ecosystems feedback loop 70
3.45 The interaction of socioeconomic and natural resource dependence 72
3.46 An Illustrative Vignette 73
3.5 Summary 75
CHAPTER 4. MODEL AND HYPOTHESES 78
4.1 Conceptual Model 78
4.2 Hypotheses 79
Hypothesis 1: Corporate Climate Change Vulnerability is negatively related to Biophysical Environmental Performance. 79
Hypothesis 2: Corporate Climate Change Adaptive Capacity is negatively related to Biophysical Environmental Performance. 83
Hypothesis 3: Corporate Climate Change Vulnerability is positively associated with firms' Socioeconomic Environmental Performance. 87
Hypothesis 4: Corporate Climate Change Adaptive Capacity is positively associated with firms' Socioeconomic Environmental Performance. 91

CHAPTER 5. METHODS 93
5.1 Population, Sample, and Sources of Data 93
5.11 Population 93
5.12 Sample 94
5.13 Data Collection 95
5.2 Measures 100
5.21 Dependent Variables 100
5.22 Independent Variables 101
5.23 Control Variables 105
5.3 Methodology 108
5.31 Statistical Procedure – Panel Corrected Standard Errors (PCSE) 108
5.32 Model Specification for Biophysical Environmental Performance 111
5.33 Model Specifications for Socioeconomic Environmental Performance 112
5.34 Regression Procedures to Corroborate Results from PCSE Regression 114
CHAPTER 6. RESULTS 115
6.1 Descriptive Statistics 115
6.2 Correlations 117
6.3 Hypothesis 1 122
6.31 Alternative Regression Procedures to Corroborate PCSE Results 131
6.4 Hypothesis 2 133
6.41 Alternative Regression Procedures to Corroborate PCSE Results 136
6.5 Hypotheses 3 139
6.51 Alternative Regression Procedures to Corroborate PCSE Results 146
6.6 Hypothesis 4 148

6.61 Alternative Regression Procedures to Corroborate PCSE Results 151
6.7 Explicit Tests for the Presence of Mediation for Hypotheses 3 and 4 153
6.8 Summary of Support for the Conceptual Model 153
6.81 Vulnerability, Adaptive Capacity and Biophysical Environmental Performance 153
6.82 Vulnerability, Adaptive Capacity and Socioeconomic Environmental Performance 155
CHAPTER 7. DISCUSSION AND CONCLUSIONS 158
7.1 Explaining Unexpected Results 160
7.2 Implications for Research 170
7.21 Implications for Organizational Theory 170
7.22 Implications for the Study of Corporate Climate Change Adaptation 173
7.23 Implications for Study of Corporate Sustainability 174
7.3 Implications for Policy and Practice 178
7.4 Limitations and Future Research 180
7.5 Next Steps 190
7.51 Beyond the Dissertation 174
REFERENCES 192
APPENDIX ONE. SACC RATINGS 192
APPENDIX TWO. SUPPLEMENTAL TABLES 228
APPENDIX THREE. MEDIATION ANALYSIS 238
A3.1 Mediational Model 238
Hypothesis 3a: Corporate Climate Change Vulnerability is positively associated with firms' Socioeconomic Environmental Performance; 238

Hypothesis 3b: Biophysical Environmental Performance mediates the relationship between the Corporate Climate Change Vulnerability and Socioeconomic Environmental Performance. 238

Hypothesis 4a: Corporate Climate Change Adaptive Capacity is positively associated with firms' Socioeconomic Environmental Performance 238

Hypothesis 4b: Biophysical Environmental Performance mediates the relationship between the Corporate Climate Change Adaptive Capacity and Socioeconomic Environmental Performance. 239

A.3.2 Results for Hypothesis 3b 242

A.3.3 Results for Hypothesis 4b 244

A.3.4 Discussion of Mediation Procedure Results 245

List of Figures

FIGURE 1. Resource Dependence, Power and Organizational Interdependence…..….59

FIGURE 2. The Components of Natural Resource Dependence……..63

FIGURE 3. Conceptual Model Framework……..78

FIGURE 4. Effect of Exposure on Biophysical Environmental Performance at Different Levels of Sensitivity……127

FIGURE 5. Effect of Sensitivity on Biophysical Environmental Performance at Different Levels of Exposure..……130

FIGURE 6. Effect of Exposure on Socioeconomic Environmental Performance at Different Levels of Sensitivity……..…143

FIGURE 7. Effect of Sensitivity on Socioeconomic Environmental Performance at Different Levels of Exposure……...……144

FIGURE 8. Conceptual Model Framework Including Mediation.……..……...……239

List of Tables

TABLE 1. Geographic Distribution of Ski Resorts across States …….…..…....95

TABLE 2. Descriptive Statistics……...……..118

TABLE 3. Correlation Matrix……..…..……..119

TABLE 4. Results of PCSE Regression of Biophysical Environmental Performance

…….…....123

TABLE 5. Results of PCSE Regression of Biophysical Environmental Performance Probing the Exposure x Sensitivity (Vulnerability) Interaction……..…128

TABLE 6. Summary of Regressions on Biophysical Environmental Performance…...132

TABLE 7. Results of PCSE Regression of Biophysical Environmental Performance, Using League of Conservation Voter (LCV) Records to Measure State Environmentalism……..……..135

TABLE 8. Results of PCSE Regression of Socioeconomic Environmental Performance

……..138

TABLE 9. Results of PCSE Regression of Socioeconomic Environmental Performance Probing the Exposure x Sensitivity (Vulnerability) Interaction.....142

TABLE 10. Summary of Regressions on Socioeconomic Environmental Performance

…….147

TABLE 11. Results of PCSE Regression of Socioeconomic Environmental Performance, Using League of Conservation Voter (LCV) Records to Measure State Environmentalism……..……..…149

TABLE 12. Summary of Support for Hypotheses……..……156

TABLE 13. Results of OLS Regression of Biophysical Environmental Performance...228

TABLE 14. Results of Random Effects Regression of Biophysical Environmental Performance…….229

TABLE 15. Correlations between Random Effect and Independent Variables in Random Effect Regressions of Biophysical Environmental Performance…….230

TABLE 16. Results of OLS Regression of Socioeconomic Environmental Performance ……..231

TABLE 17. Results of Random Effects Regression of Socioeconomic Environmental Performance…….232

TABLE 18. Correlations between Random Effect and Independent Variables in Random Effect Regressions of Socioeconomic Environmental Performance……...…233

TABLE 19. Influential Observations for Regression of Biophysical Environmental Performance……..……...…234

TABLE 20. Results of PCSE Regressions of Biophysical Environmental Performance with Outliers Excluded from the Sample ……...…235

TABLE 21. Influential Observations for Regression of Socioeconomic Environmental Performance……..……...…236

TABLE 22. Results of PCSE Regressions of Socioeconomic Environmental Performance with Outliers Excluded from the Sample ……...…237

TABLE 23. PCSE Regression of Socioeconomic Environmental Performance with Biophysical Environmental Performance Correlate……243

CHAPTER 1. INTRODUCTION

1.1 Overview

This dissertation studies the effects of *Corporate Climate Change Vulnerability* and *Adaptive Capacity* on *Corporate Environmental Performance* in the U.S. ski resort industry. It is in the research area of *Corporate Climate Change Adaptation,* which is concerned with issues related to how firms respond to the biophysical threats posed by climate change. Currently, most research in the management discipline about climate change is in the area of corporate climate change mitigation, rather than adaptation (e.g. Kolk & Pinkse, 2005; Levy & Egan, 2003; Levy & Rothenberg, 2002; Levy & Kolk, 2002; Pinkse & Kolk, 2009), where scholars have studied firm responses to risks and opportunities created by the *issue* of climate change. Indeed, the issue of climate change has led to social pressure to reduce greenhouse gas emissions (GHGs), industry voluntary self-regulation programs, new markets and market opportunities for carbon friendly business models and technologies, and political contests over GHG regulations (Lash & Wellington, 2007). Scholars have responded with a plethora of studies that have made sense of these phenomena and contributed to the evolution of organizational theories focused on the evolutions of institutions and technology.

However, research concerning firm adaptations to the biophysical effects of the phenomenon of climate change on firms is less cumulative. Still, the area could become highly salient for practitioners and scholars, as climate change's biophysical effects on all human systems becomes more pronounced (Hoffman et al., 2009; IPCC, 2001). To date, scholars have been able to observe types of adaptation employed and the organizational processes that underpin the development and implementation of adaptation (Berkhout,

Hertin & Gann, 2006; Hoffman et al., 2009; Scott & McBoyle, 2007; Smit & Skinner, 2002). In addition, they have identified the critical factors in firms' business environment that are associated with adaptation: specifically, vulnerability and adaptive capacity (Belliveau, Smit & Bradshaw, 2006; Bleda & Shackley, 2008; Hoffman et al., 2009). *Corporate Climate Change Vulnerability* depends on two factors: first, the degree to which climate change is actually present in firms' salient geographic environment, or *corporate climate change exposure*; and second, the degree to which firms' business models are susceptible to disruption if climate change is present, or *corporate climate change sensitivity* (Adger, 2006; Füssel, 2007; Hoffman et al., 2009). *Corporate Climate Change Adaptive Capacity* refers both to the forces in firms' market and institutional environments and firms' resources and capabilities that provide them with flexibility and capacity to adapt to climate change (Belliveau et al., 2006).

However, while these are fundamental findings, there are numerous topics that still need to be addressed, including the focal relationships examined in this study. I posit that these relationships merit attention because climate change can affect the ecological systems on which some business organizations depend (Smit & Pilifosova, 2001), as well as the availability of critical ecosystem services used by them. As a result, the phenomenon can induce affected firms to alter their use of the ecosystems that provide these resources. By implication, corporate climate change adaptation strategies could potentially improve the prospects for corporate sustainability or lead to more environmental harm (Costanza & Daly, 1992; Pogutz & Winn, 2009; Smit & Pilifosova, 2001; Spittlehouse &Stewart, 2003; Straussfogel, 2006). Since climate change is already altering the environmental commons on which all human systems depend, it is important

to understand whether business responses to the phenomenon are exacerbating the problems associated with global ecological change (Winn et al., 2010)

1.2 Description of the Phenomenon

Forms of climate change vulnerability and adaptive capacity that are associated with firms' relationships with their biophysical environments are most likely relevant to firms in renewable natural resource industries, such as agriculture, commercial fishing, forestry, hydro-electric power generation and tourism (IPCC, 2001; Straussfogel, 2006; WTO, 2003). Firms in these industries depend substantially on ecosystem services provisioned directly by the natural environment, because these resources are core components of their business models. Climate change becomes a threat to firms with ecosystem service resource dependence when it undermines the ecosystems that provide these services (Straussfogel, 2006). For example, it has already had the following impacts:

- In the forestry industry, it has enabled pine bark beetle pandemics, which are destroying commercial forests (Spittlehouse & Stewart, 2003);
- In the commercial fishing industry, warming ocean temperatures are dispersing fish stocks (Lash & Wellington, 2007);
- In agricultural, it is altering soil compositions of farm land (Schlenker, Hanneman & Fisher, 2005);
- Hydro-electric facilities are being affected by decreasing availabilities of water (IPCC, 2001);
- And, the tourism industry is being affected by unsuitable weather (WTO, 2003).

Thus, one form of physical risk to firms created by climate change involves firm dependence upon ecosystems that are themselves vulnerable to climate change. Climate change adaptations in these cases, therefore, should attempt to reduce the problems associated with resource dependence on salient ecosystems (Bleda & Shackley, 2008).

1.3 Specific Research Questions and Overview of Conceptual Model

My research questions are:

1) Do *Corporate Climate Change Vulnerability* and *Adaptive capacity* significantly affect *Biophysical Environmental Performance*?

2) And, do firms improve their *Socioeconomic Environmental Performance* to compensate for declining levels of *Biophysical Environmental Performance* that result from corporate climate change adaptations?

Biophysical Environmental Performance refers to the degree to which firms protect or conserve natural resources that are provisioned directly by their biophysical environments, without the mediating influence of markets and institutions. By implication, firms' ability to procure these resources is not constrained by their ability to pay for them or the application of strict coercive regulatory mechanisms. Firms' direct access to these resources can be enabled either by property rights granting legal ownership of them, or by government licenses to operate, which grant stewardship rights over the lands that provision them (Ostrom, 1999; Sethi & Somanathan, 1996). As a result, *Biophysical Environmental Performance* involves ecological resources that are non-excludable, meaning these resources most closely resemble "open-access common" goods, and firms have de facto power to use them as needed (Hardin, 1968; Ostrom,

1999). As an example, many forestry firms still rely on clear-cut logging practices on public lands. Typically governments charge stumpage fees based on volume and species of harvested timber, require tree replanting in harvested areas, and regulate the protection of wildlife habitats. However, these government interventions do not account for firms' consumption and depletion of two ungoverned and unpriced ecological resources, carbon sequestration and floral biodiversity (Costanza & Daly, 1992; Dewar & Cannell, 1992). Through the loss of these resources, clear-cut logging practices lower firms' Biophysical Environmental Performance.

Socioeconomic Environmental Performance refers to the degree to which firms protect or conserve natural resources that are exchanged in markets or allocated, and strictly regulated, by common property governance institutions (Hardin, 1968; Sethi & Somanathan, 1996). These natural resources are not directly provisioned by ecosystems from firms' salient biophysical environment; rather, they have been absorbed into markets or governance regimes. Therefore, they are subject either to pricing mechanisms (in the case of markets) or usage rules, oversight and sanctions for usage-rule non-compliance (in the case of governance regimes), making them excludable goods. Thus, *Socioeconomic Environmental Performance* reflects the degree to which firms protect or conserve "private" or "common pool" ecological resources (Prakesh & Potoski, 2007). As an example, many firms consume fossil fuels that create greenhouse gas emissions. Since firms must arrange for fossil fuels in the market place, greenhouse gas emissions associated with fossil fuel consumption reflect lower *Socioeconomic Environmental Performance*.

To address these research questions, I develop a conceptual model that links corporate climate vulnerability and adaptive capacity to these two different dimensions on environmental performance. An implicit assumption of the study is that corporate climate change vulnerability and adaptive capacity create effects on firms' environmental performance through corporate climate change adaptations. Thus, the study assesses the direct impacts of the independent variables on firms' biophysical and socioeconomic environmental performance, respectively, without modeling firms' adaptations to climate change as an intermediary variable. The tenability of this assumption is grounded in prior research that has shown that corporate climate change vulnerability and adaptive capacity tend to be associated with firms' propensity to adapt (e.g. Belliveau et al., 2006; Bleda & Shackley, 2008; Hoffman et al., 2009).

In addressing the first research question, the conceptual model predicts that corporate climate change vulnerability and adaptive capacity are associated with negative impacts in firms' biophysical environments. As mentioned above, vulnerability can occur when climate change undermines the functioning of ecosystems, thereby disrupting the provision of important ecosystem services from them. Vulnerability may be linked to negative impacts on firms' biophysical environment, because adaptations that reduce vulnerability can involve firms' increasing their consumption of ecosystem services that are directly embedded in their biophysical environments. Increasing consumption of ecosystem services can have deleterious impacts on the ecosystems that provide them because it can disrupt the organizing structure of these ecosystems (Costanza & Daly, 1992; Prugh et al., 1999; Wackernagel & Rees, 1997).

In addition, the conceptual model predicts that corporate climate change adaptive capacity is also associated with negative impacts in firms' biophysical environment. As mentioned above, adaptive capacity refers to the favorability of conditions in firms' internal and external environment for adjusting their business models in response to biophysical climate change effects. In particular, this study assesses whether firms' relationship with economic stakeholders who provide them with financial capacity to deploy adaptations, but also place them under financial pressure to do so, has these effects. In this case, the prediction is based in a logic that links firms' dependence on financial stakeholders to adaptations that harm their biophysical environment, because economic stakeholders may prioritize corporate financial performance over environmental performance. Second, it assess whether civil society normative pressure constrains firms' ability to adapt in ways that harm firms' biophysical environment. Third, the study assesses whether firms' relationship with local regulators administering federal environmental regulations might be associated with the flexibility to deploy adaptations that negatively impact their biophysical environments. In this case, firms in the study sample must comply with the same set of federal environmental rules, but contribute different amounts of user-fees to the local government agents overseeing them. Thus, local regulators depend on the sampled firms they oversee for budgetary funding to different degrees, meaning these regulators may have different amounts of power to influence the environmental performance of these firms (Pfeffer & Salancik, 1978).

In addressing the second research question, the study's conceptual model predicts that corporate climate change vulnerability and adaptive capacity induce firms to develop business practices that improve their socioeconomic environmental performance. These

predictions are based in a logic of inter-organizational resource dependence. If firms create negative biophysical environmental impacts as they adapt to climate change, they might also create environmental legitimacy problems for themselves (Bansal & Clelland, 2004). Since legitimacy is a critical resource for firms, and it is conferred to firms from stakeholders in firms' socioeconomic environments, new environmental legitimacy problems should induce firms to take steps to appease legitimacy-conferring stakeholders (Pfeffer & Salancik, 1978). To do so, firms can take steps to improve socioeconomic environmental performance. This outcome signals to such stakeholders that firms do, in fact, care about the environment (Bansal & Clelland, 2004), even though corporate climate change adaptation may lower their biophysical environmental performance.

1.4 Theoretical Lens

The current study diverges from existing research in the area and interprets the phenomena at hand through the lens of resource dependence theory. Existing research in the area has drawn upon the behavioral theory of the firm (Cyert & March, 1963) and theories of organizational learning (Nelson & Winter, 1982; Teece, Pisano & Shuen, 1997) to explain climate change adaptation (Berkhout et al., 2006; Hoffman et al., 2009). To date, scholars have suggested that managers of firms deploy climate change adaptations when they receive climate stimuli from outside their firm's organizational boundary, and then deploy "learning cycles" (Berkhout et al., 2006) to develop new routines that fit better with the dynamics of the external environment. Theories of organizational learning and routines tend to be focused on firms' internal processes of organizational change. However, the focal constructs of the current study, corporate

climate change vulnerability, adaptive capacity and environmental performance, involve either external pressures on the firms (vulnerability, and, at times, adaptive capacity) or external impacts created by the firms (environmental performance). Thus, to make sense of the phenomenon, which are largely outside of the organizational boundary of the firm, the study relies on an open-systems perspective of organizations, specifically resource dependence theory.

A key proposition of this theory is that firms depend upon resources that are controlled by actors, organizations, and forces in their external environments. As a result, they can face uncertainty associated with accessing these critical resources (Pfeffer & Salancik, 1978). In the dissertation, I rely on this theory because climate change can undermine firms' ability to access critical ecosystem services that are provisioned by the natural environment. As a result, climate change does appear to create uncertainty for firms associated with resource dependence. The nature of this uncertainty, however, represents a key departure from resource dependence theory. Pfeffer and Salancik (1978) explain that the external control of resources is held by market and institutional actors and organizations in firms' external socioeconomic environments. In the context of the dissertation, the natural environment also appears to regulate the provision of critical resources. Further, in the extant theory, corporate strategies to manage resource dependence are a function of the distribution of socially and market-constructed power in firms' socioeconomic environments (Pfeffer & Salancik, 1978). However, here strategies to manage resource dependence are also a function of the distribution of power between the focal firm and the natural environment. It follows, logically, that there is a role for

naturally-constructed power in a theory that explains what causes this type of resource dependence and how firms manage it.

1.5 Contributions to the Management Discipline

The dissertation aims to make three contributions to the management literature. The first is to organizational theory. As mentioned just above, it aims to extend resource dependence theory by exploring the nature of firms' uncertainty in accessing critical ecological resources embedded in their biophysical environments. To this end, the dissertation describes some of the unique mechanisms associated with *natural* resource dependence, to complement the existing resource-dependence theory framework and logic.

Second, it independently and objectively measure and model *Corporate Climate Change Vulnerability*. To date, scholars of the area of corporate climate change adaptation have assessed corporate climate change vulnerability either qualitatively, or via surveys of managers' perceptions of vulnerability (e.g. Belliveau et al, 2006; Bleda & Shackley, 2008; Hoffman et al., 2009). However, the construct does involve a natural event, climate change, which is exogenous of managers' perceptions and measurable using mechanical instrumentation. Thus, objective and independent measures are not only possible, but also arguably necessary to advance the area.

Third, it addresses calls from scholars of corporate environmental performance to conduct studies that assess multiple dimensions of the construct. This task is important for at least two reasons. First, there is anecdotal evidence that some firms simultaneously protect the environment in some ways and harm it in others. Thus, studies that assess

impacts in only one dimension of environmental performance can potentially yield unreliable results about firms' overall performance. Second, some scholars believe that different dimensions of environmental performance can be systematically related. Some firms may perform well in most dimensions of environmental performance, because they pursue proactive environmental strategies. Others may perform well in some dimensions and poorly in others, because they lack capacity to be comprehensively good, or because they are trying to compensate for poor performance in one dimension by doing well in another. By assessing the impacts of an independent event on multiple dimensions of corporate environmental performance in this study, I will uncover evidence both of firms' comprehensive environmental performance and whether different dimensions are related.

Finally, in measuring multiple dimensions of corporate environmental performance, I distinguish between *Biophysical Environmental Performance* and *Socioeconomic Environmental Performance*. The former construct refers to the degree to which firms protect or conserve ecosystems that comprise their immediate biophysical environments, while the latter refers to corporate protection of natural resources that are traded or exchange in firms' market or institutional environments. Such a distinction is relevant for analyses of corporate environmental performance because these two domains can be governed in exclusive ways. Ecosystems comprising firms' biophysical environments can be under direct or near-direct firm control, while the use of natural resources traded or embedded in firms' socioeconomic environments is governed by a complex set of institutional arrangements and market mechanisms.

1.6 Policy and Strategy Implications

Studying these research questions could have important implications for the fields of policy and strategy. Addressing the first research question (do *Corporate Climate Change Vulnerability* and *Adaptive Capacity* significantly affect *Biophysical* and *Socioeconomic Environmental Performance*?) might indicate that specific public policy mechanisms for promoting sustainable business responses to climate change are needed to discourage businesses from exacerbating the already-negative effects of global warming on the earth's ecosystems (Scheraga & Grambsch, 1998; Smit & Pilifosova, 2001; Spittlehouse & Stewart, 2003). Otherwise, policy regimes could overlook this potential "vicious circle." This appears especially relevant with respect to negative impacts by firms' on ecosystems in their biophysical environments, since the natural capital comprising them is often a public good that is not monetized to its full value to society by markets and institutions (Costanza et al., 1997; Costanza & Daly, 1992). These types of policies need not result in negative-sum economic welfare. Well-designed public policy mechanisms that induce businesses to develop ecologically sustainable climate change adaptations can lead to the creation of new markets (Porter & Van der Linde, 1995). In addition, flexible policies that allow firms to innovate organizational capabilities that optimize efficiency, quality, and sustainability have been shown to help firm competitiveness in increasingly dynamic ecological environments and stringent environmental regulatory environments (Aragon-Correa & Sharma, 2003; Hart, 1995; Sharma & Vredenberg, 1998; Smithers & Smit, 2009).

Answers to the second research question (do firms improve their *Socioeconomic Environmental Performance* to compensate for declining levels of *Biophysical Environmental Performance* that result from corporate climate change adaptations?)

could suggest that policy-makers and managers need to take more holistic approaches to sustainability. Policies that focus on one dimension of environmental performance to the exclusion of others may not actually improve sectors' or firms' sustainability in the aggregate.

British Petroleum's (BP) involvement in the Macondo Well oil spill in 2010 is a case in point. Global governance mechanisms designed to reduce industries' greenhouse gas emissions have helped induce BP to become an industry leader in carbon intensity (Levy & Kolk, 2002). However, they did not induce BP to protect the local aquatic ecosystems in the Gulf of Mexico enough to follow oil spill prevention regulations. For managers, addressing this research question could provide evidence that sustainability strategies are more effective at promoting ecological protection when they are embedded in the organization, rather than comprised of disconnected business practices that are on the periphery of firms' strategy.

1.7 Research Context: The United States Ski Resort Industry

1.71 Rationale for Research Context

The U.S. ski resort industry represents a workable setting to investigate the research questions proposed for this dissertation. First, many ski resorts appear to be vulnerable to climate change. Climate is a fundamental resource industry-wide, since snow is a necessary component of skiing operations competencies, and warmer winters with less accumulated snowfall are a clear threat to any ski resort (Scott & McBoyle, 2007; Scott, McBoyle & Mills, 2003). Second, ski resorts have been adapting to climate change for some time (Clifford, 2002; Scott et al., 2003). Third, because of the

availability of time series data for accumulated snow at U.S. ski resorts[3], it is possible to calculate objective measures of climate change vulnerability in the industry.

1.72 United States Ski Resort Industry Profile

The origins of the skiing in the U.S. date to the mid-19th century, when Scandinavian immigrants brought their pastime with them to the Midwest and to mining camps in the Rocky and Sierra Nevada mountain ranges (Clifford, 2002). Skiing was, of course, a much different activity at that time. First, it was neither commercial, nor a sport. Rather, skiing was a tradition that served as a means of transportation. Further, it was not really "downhill" as it is known today. There were no ski lifts, and ski technique was too archaic to facilitate controlled downhill turns (Hudson, 2000). Nonetheless, skiing diffused into new communities in the U.S. and soon became reinterpreted as a form of recreation by the new immigrants and their neighbors who took to the activity.

In the first part of the 20th century before the great depression, skiing technique improved, and the sport increased in popularity among certain demographics and evolved into both a competitive endeavor and a formal recreational activity. In Austria, the skier Hannes Schneider developed the "stem-turn" and "parallel-turn" techniques that facilitated controlled snow-descents never realized via the original "telemark" turn. Soon after, wealthy college students from Northeastern Universities began taking up the sport, while those with talent began to ski race and ski jump. Then, the 1932 Winter Olympics in Lake Placid, New York generated national recognition for the sport. W. Averell Harriman, owner of the Union Pacific Railroad, saw an opportunity in the groundswell of

[3] The National Oceanographic and Atmospheric Associated collects longitudinal climatic data measured through the National Weather Service (NWS) cooperative weather station network. This network contains 18,000 weather stations located within the United States.

enthusiasm and in 1936 he built Sun Valley in Ketchum, Idaho, the first U.S. ski resort with a base lodge, restaurant and chairlifts. Other resorts followed quickly, and by the end of the 1930s, skiing had become a $20 million industry in the United States (Clifford, 2002).

World War Two slowed the evolution of the industry; however, the market reestablished itself quickly in the post-war economy with the help of war veterans from the U.S. Army's Tenth Mountain Division, who became the principals of 62 new ski resorts during the 1950s. By 1960, there were approximately 1.6 million downhill skiers in the U.S. frequenting these resorts. This number would soon expand rapidly, following the 1960 Winter Olympics at Squaw Valley in California. By 1964, there were 2.4 million skiers in the U.S. (Clifford, 2002) and by the late 1960s there were ski resorts in every region of North America with mountains and snow (Hudson, 2000). By 1970, the U.S. ski resort industry was generating over $1 billion annually, and by 1975 there were 745 ski resorts in the U.S. (Clifford, 2002).

During the 1960s and early 1970s, important new trends took root in the industry. First, revolutionary improvements in ski equipment technology made the sport accessible to many more people. Plastic ski boots replaced leather ones and fiberglass skis with metal edges replaced wooden ones, giving the average skier much more control over the main instruments of skiing. This not only allowed the mass-market to more easily learn to ski, but also enabled talented skiers to perform in ways that were difficult to previously conceptualize (Hudson, 2000).

Second, the expanding market increasingly included overnight skiers who did not live close enough the mountains to drive there for the day. Serving this new market

segment required adding lodging to ski resorts' business model, as well as ensuring multiple food and beverage options so that overnighters had choice. In addition, catering to overnight skiers also facilitated diversification into retail operations involving primarily ski equipment and clothing. Ski resorts were adding these components to their business models either by developing the new capabilities themselves, or through strategic alliances with local entrepreneurs who could provide these services. Third, large corporations, sensing the opportunities from the growing market to generate complementary revenues from lodging, retail and food and beverage businesses, began to buy ski resorts from the local entrepreneurs, and invested the capital necessary to turn ski areas into full-service winter resorts. Fourth, some ski resorts were experimenting with leveraging full service skiing operations into real estate developments, betting that destination resort skiers may want to own part of their mountain experiences (Clifford, 2002). Finally, many new ski resorts were setting up their operations on publicly-owned land administered by the U.S. Forest Service. Ski resorts required large tracts of terrain on mountain-sides with very specific geographic characteristics and climate. Privately-owned land suitable for ski resorts was rare, while the Forest Service controlled a significant amount of the skiable terrain in the U.S. As a result, more and more new ski resorts leased land from the Forest Service (Briggs, 2000).

The 1980s was a different decade for the industry. First, downhill skiing matured quickly, like many industries that were fueled by the baby-boomer generation. In 1979, the U.S. ski industry had grown significantly, recording approximately 50,200,000 skier-days[4]. However, this number stagnated through the decade. In 1990 the industry recorded approximately 46,700,000 skier-days, while its range fluctuated between 39,700,000

[4] A skier-day is defined as one person's paid visit to a ski resort for one day.

skier-days in 1981 to 53,900,000 skier-days in 1988 (NSAA, 2010). Second, like many industries in the 1980s, the U.S. ski resort industry underwent a substantial wave of consolidation (Hudson, 2000). In 1982, there were still 735 ski resorts operating in the U.S. However, in 1990 there were only 569 ski resorts. This trend persisted through the following decade. In 2000 there were only 490 ski resorts in the U.S. However, the 21st century has seen some stabilization in the number of industry participants; in 2010, 471 ski resorts operated in the U.S.[5]

Third, the nature of ski resort ownership was changing. Large corporations that owned ski resorts as subsidiaries were getting out of the business, while horizontally-integrated ski resort companies that specialized in skiing operations and related businesses had begun their ascent to their current industry dominance. Some of these companies, like Booth Creek Holdings and Boyne Mountain resorts, remained privately-owned; however, others, like American Ski Company, Vail Corporation and Intrawest became public companies and raised large sums of capital to buy ski resorts and develop their real estate potential (Clifford, 2002).

Finally, Congress enacted the National Forest Ski Area Permit Act of 1986 (16USC§497c). The goals of this legislation were to modernize the regulation of ski resorts on public land. Specifically, it was designed to enact consistent policies towards ski resort licensees' management of public lands, streamline overlapping regulatory requirements of licensees including environmental regulations, give the Forest Service the authority to administer those regulations, provide licensees with regulatory certainty commensurate with their need to make long-term capital investments, and collect fees

[5] Source: http://www.nsaa.org/nsaa/press/operating-ski-areas.asp. Access date: March 22, 2011.

from licensees that reflect fair-value returns to the public for ski resorts' use of the permitted land (Briggs, 2000).

The 1990s also ushered in new industry trends. First, as the baby-boomer population became increasingly middle-aged, the number of skiers retiring from the sport began to rise dramatically (Snowsports Industry Intelligence Report, 2000). At the same time, fewer people were taking up the sport on a long-term basis, because of shifting demographics (Clifford, 2002). However, fortunately for the industry, snowboarding became completely mainstream, and the growth of snowboarding was more or less equivalent to the decline of skiing during the 1990s. Thus, the industry was able to avoid a period of decline (Snowsports Industry Intelligence Report, 2000). In 1999, the industry record approximately 52,200,000 skier-days, while the figure ranged from 46,700,000 in 1991 to 54,650,000 in 1994 (NSAA, 2010).

Second, industry consolidation continued its progression and more and more horizontally-integrated ski resort companies became established in the market. At the same time, ski resorts' development of real estate near their base areas became an increasingly common strategy. Given that skiing operations occurred exclusively in the winter, ski resort executives began seeing the utility in developing summertime activities to make the resorts attractive to a broader range of tourists in more seasons. The mountain environments of ski resorts lent themselves to this strategy, since they often offer exceptionally scenery, and some of them were suitable for mass-market forms of recreational tourism like golf and tennis. In addition, with suitable terrain and uphill lift capacity, ski resorts could also be ideal locations for hiking and mountain biking. Each of these activities had the potential to improve the demand for a resorts' real estate offering,

making summertime operations a true complementary capability (Clifford, 2002). To generate further synergies between skiing and non-skiing competencies, many of these resorts also invested in on-mountain improvements. Snow-making capabilities helped to ensure that skiing operations were robust to poor weather, and new chairlifts had more seats and went at "high speeds". In addition, many ski resorts attempted to expand their operating areas so they could boast more terrain to their customers. As a result, the capacity of the ski industry expanded significantly during this decade even though the demand for skiing did not (Clifford, 2002).

A key reason that many resorts were able to obtain permission for these expansions even though industry growth did not justify them was the Service's new and serious budgetary problems for the Forest Service. Since its founding in 1891, the Forest Service's goal was to act as steward of the nations' forest resources and to facilitate and oversee the responsible extraction of timber resources. In exchange, the agency collected stumpage fees from commercial harvesting businesses who leased the land. However, commercial harvesting on Forest Service land peaked in the late 1980s. Due to executive orders from the Clinton Administration and intense environmental concern for the impacts of harvesting on forest health in the U.S., both harvesting and stumpage fees paid by licensees declined by 75 percent during 1990s (Clifford, 2002).

At the same time, the U.S. tourism industry was growing significantly, and more and more Americans were vacationing in their National Forests. The Forest Service recognized the shift of the value proposition of the National Forests, and decided to reinvent itself as a "recreation provider" (Clifford, 2002: 139). This shift in policy was fortuitous for ski resorts that were pursuing business models that involved real estate and

summer activities. These resorts could benefit from strong relationships with the Forest Service, given that the agency was responsible for granting and renewing their special use permits, and for overseeing compliance with environmental regulations, the two biggest obstacles to receiving permission for pursuing these strategies. Now, the ski resort industry was the most significant recreational licensee on Forest Service land, and the agency was willing to establish numerous partnerships with the industry to promote skiing. In addition, individual Forest Service districts began working with ski resorts to expedite ski resort developments. In return, individual Forest Service districts earned revenue and received good publicity for being active stewards of the National Forests after the decline of forestry (Clifford, 2002).

These partnerships and some ski resorts' expansion plans were controversial. Members of ski resorts' local communities and environmental activists claimed that Forest Service districts had a conflict of interest, because they simultaneously generated revenue and publicity from ski resorts and provided regulatory oversight of them (Rivera et al., 2006). Others have accused Forest Service district offices of providing ski resorts special exceptions to federal regulations to facilitate developments that have harmed or destroyed habitats and communal ecosystems. Even the National Environmental Protection Agency has expressed public concern of some district office's application of federal regulations (Clifford, 2002). In response, the Forest Service and the ski resort industry association, the National Ski Area Association (NSAA), developed a voluntary environmental program, the Sustainable Slopes Program. The stated goals of the program are to demonstrate the industry's "commitment to good environmental stewardship" and "provide a framework for resorts across the country to implement best practices, assess

environmental performance, and set goals for improvement in the future" (NSAA, 2000: 2; in Rivera et al., 2006).

Finally, the decade of 2000 through 2010 has also seen some new trends for the industry. First, the issue of global climate change and warming became front and center for the industry. For decades the industry had grappled with the physical effects of climate variability. On-the-ground snow quality and length of snow season are fundamental resources for ski resorts, irrespective of the complexity of their business models. Climate variability directly impacts the stability of these resources over time and therefore is a significant cause of uncertainty for ski resorts. In response, ski resorts had deployed numerous adaptations, such as expanding into new terrain, deploying snow-making, and, arguably, developing new sources of revenue that did not depend so much on climate (like real estate) (Hoffman et al., 2009).

However, in the 2000s, climate change also became a social issue that induced significant climate change mitigation efforts from the industry, and served as a tool to generate good publicity (NSAA, 2008). First, given the linkages between environmental performance and climate change mitigation and the industry's problematic reputation for environmental stewardship, the issue became a central focus of industry efforts to reduce its GHG emissions. The Sustainable Slope Program incorporated several categories to address emissions reductions, and the NSAA develop an alliance with several prominent environmental NGOs called "Keep Winter Cool" to raise awareness about global warming. In addition, they became vocal supporters of any proposed GHG emissions regulations on public agendas at state, regional and federal levels. Finally, the NSAA began working with its members to design and implement effective promotional

capabilities at the resorts for their efforts to reduce emissions. These promotions help to educate skiers about these efforts (NSAA, 2008).

A second important trend in the industry was a new set of revolutionary innovations to ski equipment. Ski boot manufacturers developed important updates to plastic ski boots, which could be very uncomfortable and even painful. New plastics and liner materials helped to alleviate these issues. In addition, ski manufacturers began making wider skis and skis with "sidecut" or curved outside edges. Wider skis are more stable, so that average skiers had improved control over the skis, and sidecut makes it easier to turn the ski. As a result, it became much easier for novices to learn how to ski, and for experienced skiers to improve quickly. Thus, the sport became less painful, more fun and more accessible to a broader range of athletic abilities (Clifford, 2002).

While ski equipment technology underwent radical improvements, the comprehensive ski resort business model had become fully diffused through North America. By 2008, horizontally integrated ski resort companies accounted for more than half of skier-days in the industry, meaning most skiers were frequenting resorts with high-speed chairlifts, significant snow-making capabilities, and ski resort villages with lodges, condominiums, shops, restaurants, and parking garages (SACC, 2008). Such a transformation reflects the efforts of the industry leaders to promote overnight ski visitations and/or real estate development as the core features the industry's value-proposition.

However, threats to the industry have constrained the success of this business model. Leisure time, a necessity for a robust overnight skier clientele, was in decline, and the number of outdoor recreation activities competing against skiing was growing

rapidly. In addition, internet commerce allowed destination skiers to make “last minute” decisions about vacations, thereby giving them the opportunity to shop around for the best deals and not commit to vacation packages before they know how good the weather will be (Clifford, 2002). As a result, overnight skier-visits declined by 5.25% between 2003 and 2008 in spite of the industry’s investments (NSAA, 2008). Further, the number of people retiring from skiing still outpaced the number of new entrants to the market. Finally, the recession, slumping housing market, and prolonged economic recovery at the end of the decade impacted every revenue-generating component available to ski resort. The industry appears to be withstanding these threats, as the average annual number of skier-days over this decade was approximately 57,000,000 skier-days, up from approximately 52,400,000 skier-days in the previous decade (NSAA, 2010).

1.8 Data

To conduct the study, I collected longitudinal data from a diverse range of sources. The sampling history extends from 2001 to 2009, and the number of ski resorts sampled in each year varies from 57 in 2001 to 76 in 2009. In total, there are 612 firm-year observations in the sample. I develop measures of *Corporate Climate Change Vulnerability* using climatic data collected from National Climatic Data Center (the data archiving department of the National Oceanographic and Atmospheric Association), which maintains the database of climatic observations from the National Weather Service's weather station network. I developed measures of *Corporate Climate Change Adaptive Capacity* by measuring whether ski resorts were publicly-owned and traded companies, the level of environmental activism in ski resorts' states, and by measuring the percentage of local regulatory agents' budgets that were funded by ski resort user-fees. The first measure assesses the degree to which ski resorts depend on investors for capital. The second measure captures the institutional flexibility a firm may have to deploy climate change adaptation. The third measure captures ski resorts' economic influence over environmental regulators. I develop measures of B*iophysical* and *Socioeconomic Environmental Performance* using a database of ski resort environmental performance ratings from the Ski Area Citizens Coalition. This non-governmental organization rates U.S. ski resorts on 14 different dimensions of environmental performance, including 6 dimensions that are associated with *Biophysical Environmental Performance* and 5 dimensions that are associated with *Socioeconomic Environmental Performance*. I measure control variables using a number of data sources, including documentation from the National Ski Area Association (the U.S. ski resort industry

association), ski resort websites, the Compustat database, and geospatial analysis of U.S. census data.

CHAPTER 2. LITERATURE REVIEW

2.1 The Impacts of Climate Change on Business

Increasingly, climate change is affecting the institution of business on multiple fronts. It is the source of a social movement that is mobilizing consumers and civil activists to demand GHG emission reductions from businesses (Margolis & Walsh, 2003). It is reflected in emerging regulatory threats from local, regional, national and international governance regimes (Levy & Kolk, 2002). It is also the source of costs passed on from suppliers and coercive pressures from buyers who demand more carbon friendly processes and products (Lash & Wellington, 2007) and competitive pressures from industry rivals who have derived economic advantages from carbon emission mitigation strategies (Hoffman, 2006). Finally, it can threaten business models by undermining firms' biophysical foundations (Pogutz & Winn, 2009). Some of these pressures are creating business opportunities. They have, in fact, catalyzed a myriad of innovations that have led to new ventures, product/market combinations and/or improved efficiency among existing business operations by reducing their energy demands (Hoffman, 2006; Lash & Wellington, 2007). In addition, a loosely coupled system of GHG emissions credits exchanges has emerged to further incentivize win-win business innovations associated with GHG emissions reductions. Increasingly entrepreneurs with innovative technologies that can sequester carbon have joined these exchanges, where they receive credits that they can sell to exchange members who require GHG offsets (Pinkse & Kolk, 2009).

However, climate change is still, by and large, perceived as a threat by businesses because of its implications for new regulations, energy costs, scrutiny from civil society, and potential to alter the environmental commons on which all social and natural actors

depend (Nitkin, Foster & Medalye, 2009a). The consensus of the Intergovernmental Panel on Climate Change (IPCC) is that the warming planet will, over the several generations, cause more extreme weather, droughts, and rising seas in most parts of the world (IPCC, 2001; 2007). Because of their direct dependence on affected ecosystems, natural resource-based industries, perhaps, have the highest exposure and risk to these impacts. Winter tourism is losing snow and subjected to too much warmth (Scott et al., 2003) and agriculture is seeing its soil composition and access to water change (Schlenker, Haneman & Fischer, 2005). In addition, commercial fisheries are threatened from changes in ocean temperatures (Lash & Wellington, 2007), and forestry industries are losing commercial forests (while the planet is losing valuable carbon sinks) because higher mean temperatures have facilitated the bark beetles pandemics (Spittlehouse & Stewart, 2003). Even extractive industries located in the arctic are at risk as transportation routes using ice roads are melting (Hoffman, 2006). In addition, climate change is associated with the direct physical threat from extreme weather events to all kinds of businesses and communities ranging from small businesses located in coastal areas (Adger, 1999) to oil rigs located offshore (Hoffman, 2006). Finally, it poses indirect risks to businesses that have economic interdependencies with organizations that are directly affected by the phenomenon. The insurance industry is perhaps the most exposed to indirect risk through organizational interdependence, as evidenced by claims of nearly $83 billion made on the industry in 2005 as a result of natural disasters caused by extreme weather, such as Hurricane Katrina and the Indian Ocean Tsunami (Hoffman, 2006). Climate change can also indirectly affect businesses through their social environments, since communities can also be vulnerable to the effects that climate

change can have on their environmental commons. Social vulnerability to climate change can destabilize markets and social institutions (Adger, 1999). Further, it can create competition for scarce resources among businesses and community actors and lead to political contests over how the environmental commons should be governed and distributed (Levy & Kolk, 2002; Shiva, 2002).

Increasingly businesses are developing strategies for managing a variety of issues associated with climate change. Generally, these strategies fall into three analytical categories: mitigation, political contestation, and the focal organizational response of this study, adaptation (Hoffman, 2006; Pinkse & Kolk, 2009). The next section will review the literature describing each of these types of strategies, with richer detail given to describing corporate climate change adaptation since it is the research area of interest in this dissertation.

2.2 Corporate Responses to the Impacts of Changing Climate

2.21 Corporate Climate Change Mitigation in Practice and Theory

The first of these strategies, mitigation through reduction of GHG emissions, is typically made operational either via innovative methods, involving the development and deployment of new technologies that reduce firms' own emissions, or compensatory methods, which rely on the GHG emissions reductions of other stakeholders (Kolk & Pinkse, 2005). Innovative strategies include improving processes to reduce energy requirements and emissions of GHGs other than carbon, developing market offerings that are more emission friendly, and engaging in inter-industry cooperation to develop competency-enhancing technologies that reduce emissions (such as the development of

flex-fuel cars from the automobile industry and the development of bio-fuels from various other industries). Compensatory approaches include transferring carbon emissions internally, using more emission friendly supply chain partners, or purchasing carbon off-sets and/or emission credits (Kolk & Pinkse, 2005; Pinkse & Kolk, 2009)

Management scholars have generally explained the presence of mitigation strategies through resource-based view logics (Ambec & Lanoie, 2008; Hoffman, 2006; Pinkse & Kolk, 2009) or new institutional theory (Hoffman, 1999; King & Lenox, 2000; Levy & Kolk, 2002; Rivera et al., 2006). The former theory has been used to suggest that climate change mitigation can help firms differentiate their products from industry competitors, or develop unique technologies that can support low-cost strategies or that can be licensed to competitors. The latter theory has been used in a variety of ways to interpret how firms can bolster their legitimacy with an array of market and non-market stakeholders and regulators through conformity. Sometimes conformity is seen as more symbolic than substantive (Meyer & Rowan, 1977). Pinkse and Kolk (2009) explain how this is the case for many European multinational firms and their practice of exporting pollution control technologies to developing nations via the clean development mechanism (CDM). The CDM, as allowed by the first iteration of the European Trading Scheme (ETS), grants firms carbon credits when they export pollution-control technologies to foreign firms that do not already possess them, even though these technologies are seen by some as reinforcing "business-as-usual" practices and are considered the most reactive form of environmental impact mitigation strategy (Hart, 1995). In any event, legitimacy-seeking strategies can improve stakeholder relations,

thereby positively affecting firm reputation, access to capital, and consumer demand (Ambec & Lanoie, 2008).

2.22 Corporate Political Strategies in Practice and Theory

The second stream of research in the management discipline has examined the corporate political strategies and political contests that are shaping the governance of GHG emissions. In the United States, firms and industries have generally contested proposed federal regulations because of the increased costs in energy and the potential comparative disadvantages they would create (Rivera, 2010). Some of these corporate interests have core competencies centered around carbon intensive processes and products and are attempting to at least "buy time" to amortize the technological costs of switching to more GHG emission-friendly competencies (Levy & Rothenberg, 2002). At the multi-lateral level, national governments have contested or attempted to alter global governance regimes, such as the Kyoto Protocol, or frameworks being proposed at the various Conference of Parties meetings sponsored by the United Nations Framework Convention on Climate Change. Countries typically employ these strategies in international negotiations when their economies depend on carbon-intensive industries, they are experiencing rapid economic development and increases in demand for energy, and/or have differing views of how the economic burdens of GHG emissions reductions should be distributed across countries at different stages of economic development (Levy & Egan, 2003; Levy & Rothenberg, 2002; Pinkse & Kolk, 2009).

To make sense of this topic, scholars have also drawn predominantly upon the resource-based view and new institutional theory. Pinkse and Kolk (2009), Levy and

Kolk (2002), Levy and Rothenberg (2002) each cite the relevance of organizational history and path-dependent resource commitments in carbon intensive technologies as influencing the political stance that the U.S. automobile and energy industries have taken when confronted by potential climate change legislation. GHG emissions reduction regulations would immediately devalue these investments. Thus, challenging the legislation was (and continues to be) the most effective means of maintaining the value in their emissions intensive competencies or at least preventing near-term devaluations from occurring because of regulation (Rivera, 2010). As a result, the organizational field constituted around climate change legislation, and its relevant stakeholders[6] and their diverging interests, reflect an ongoing "institutional war," as described by Hoffman (1999: 352).

2.23 Corporate Climate Change Adaptation in Practice

The third of these strategic types, adaptation, is still an embryonic research field, consisting of only a handful of journal articles and reports (e.g. Belliveau, Smit, & Bradshaw, 2006; Berkhout et al. 2006; Bleda & Shackley, 2008; Hoffman et al. 2009; Scott & McBoyle, 2007; Scott et al., 2003) and reports (e.g. Nitkin, Foster & Medalye, 2009a; 2009b; 2009c; Sussman & Freed, 2008; World Business Council on Sustainable Development (WCBSD), 2008). It is noteworthy that, as of January, 2011, only one article addressing the area has appeared in a "management" journal (Winn et al., 2010: *Business Strategy and the Environment*), a conceptual paper that draws on other social science disciplines to develop some conceptual foundations for describing corporate

[6] These actors include carbon-intensive industries, renewable energy industries, voluntary carbon trading markets at the national and regional level, environmental groups, civil society and federal and state governments.

adaptation to climate change. In practice, however, the topic is emerging in mainstream business discourse (Nitken et al., 2009a; WBCSD, 2008). The impetus for its growing practical relevance comes originally from the policy realm, led by the IPCC's various assessments, which have become the authoritative sources for scientific information concerning global warming and climate change (Adger, 2006). In its *Third Assessment Report* (2001: 982), the IPCC defines climate change adaptation for broader societal systems as any "Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, public and private adaptation, and autonomous and planned adaptation." The types of adaptations are defined as follows:

"**Anticipatory Adaptation**—Adaptation that takes place before impacts of climate change are observed. Also referred to as proactive adaptation.

Autonomous Adaptation—Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. Also referred to as spontaneous adaptation.

Planned Adaptation—Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

Private Adaptation—Adaptation that is initiated and implemented by individuals, households or private companies. Private adaptation is usually in the actor's rational self-interest.

Public Adaptation—Adaptation that is initiated and implemented by governments at any level. Public adaptation is usually directed at collective needs.

Reactive Adaptation—Adaptation that takes place after impacts of climate change have been observed. (IPCC, 2001: 982)"

The private sector has, to some extent, also followed the lead of the IPCC in conceptualizing climate change adaptation specific to firms (corporate climate change adaptations). For example, the International Chamber of Commerce's World Business Council on Sustainable Development adopts the IPCC definition (WBCSD, 2008). However, most often private sector organizations take a risk-management and costs-benefits approach to defining the problem (Nitken et al., 2009a). For example, the Chartered Accountants of Canada (CAC) (2008:6) characterize corporate climate change adaptations as "…taking action to minimize and respond to the effects of climate change…for companies, adapting to these phenomena will involve identifying their current and potential impacts on business, reducing vulnerability to them and taking advantage of any potential opportunities they present. Some geographical areas and some industries may be impacted more than others by adaptation issues. Companies will increasingly address adaptation as aspects of their business strategy and risk management. Actions taken to minimize and respond to the effects of climate change will ultimately be reflected in financial statements." Bleda and Shackley (2008: 517) offer a more concise and less specific definition: "Corporate climate change adaptations are the changes in the behavior of a business or organization aimed at coping with (or taking advantage of) the effects of any climate change related event occurring in the physical or

institutional environment of the organization." Given that this is the only firm-specific definition of corporate climate change adaptation, the current study adopts it.

While the definitions recognizes the potential for new business opportunities, they reflect the predominant view in the business discourse that climate change adaptations are generally a response to risk (Nitken et al., 2009a). Further, they reflect the focus of concern of most business organizations on mitigating private risks. This corroborates the view of Nitken and colleagues (2009a, 2009b, 2009c), who found, in a review of corporate climate change adaptation case studies, that corporate statements typically focused on private adaptation. Otherwise, firms could engage in both anticipatory and reactive adaptation, to preempt or mitigate climate change effects, respectively. In addition, firms might pursue planned adaptations any time they wish to preempt or react to climate change effects (Nitken et al., 2009a).

Put into practice, many firms have started to engage in scenario planning in order to incorporate the potential and real impacts of climate change on their business models (Hoffman, 2006; Spittlehouse & Stewart, 2003). For example, insurance companies are beginning to develop sophisticated means of modeling, monetizing and underwriting the climate change risk of their clients (Hoffman, 2006). Other firms with direct physical exposure to rising temperatures or natural disasters resulting from extreme weather events are physically protecting human and manufactured capital (Lash & Wellington, 2007). For example, agriculture firms are developing new methods for protecting cattle and produce from rising temperatures (Sussman & Freed, 2008), while offshore oil rig operators are reinforcing equipment and property that is exposed to extreme weather and storm surges (Hoffman, 2006). Businesses that depend on climate-affected renewable

natural resources are developing new land and water management techniques (Spittlehouse & Stewart, 2003). For example, agriculture industries are using low water-intensity irrigation techniques and drought-resistant seed stocks to address water shortages (Sussman & Freed, 2008). Some firms have exited or decoupled themselves from activities that have been impacted by climate change. For example, some forestry firms in British Columbia, whose licensed commercial forests have been overrun by bark-beetles, have engaged in salvage harvesting on timber with remaining value, subsequently shutting down harvesting operations in those areas (Straussfogel, 2006). Others have begun to develop new competencies that are less vulnerable to climate change. For example, many ski resorts have developed real estate, retail, food and beverage, lodging and summer outdoor recreation operations (Scott et al., 2003). Finally, firms that are not able to develop and/or implement adaptation strategies sometimes exit the affected businesses. Many ski resorts in the United States that have too little natural snow and insufficient institutional capacity to develop snowmaking and/or other non-vulnerable revenue-generating competencies have shut-down their operations (Clifford, 2002).

2.24 Corporate Climate Change Adaptation in Theory

As mentioned earlier, the scientific study of corporate climate change adaptation is still at a very early stage (Hoffman et al., 2009; Nitken et al., 2009a) and includes articles published in "non-management" journals, such as *Climate Research, Ecological Economics, Global Environmental Change,* and *Mitigation and Adaptation to Global Change* (e.g. Belliveau, Smit, & Bradshaw, 2006; Berkhout et al. 2006; Bleda &

Shackley, 2008; Hoffman et al. 2009; Scott & McBoyle, 2007; Scott et al., 2003). Winn and colleagues (2010) wrote the lone management journal article, appearing in *Business Strategy and Environment*. Nonetheless, the emerging literature has begun to take shape, focusing on three areas. Scholars have studied the drivers of corporate climate change adaptation, through the constructs of corporate climate change vulnerability and adaptive capacity, the types of adaptation, and the theoretical mechanisms underpinning adaptation, including dynamic capabilities, organizational learning processes, and evolutionary routines. The research in each of these areas is reviewed below.

Vulnerability as a driver of climate change adaptations. The IPCC (2001: 995) defines *climate change vulnerability* at the systems level of analysis as "The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity." Climate change adaptation studies of organizations have generally co-opted this definition, with one notable modification: climate change vulnerability at this level is considered to be the joint pressures of *exposure* and *sensitivity*, while *adaptive capacity* is considered a separate construct (e.g. Belliveau et al., 2006; Berkhout et al., 2006; Bleda & Shackley, 2008; Hoffman et al., 2009). This interpretation distinguishes organizations' vulnerability to climate change from its abilities to mitigate the impacts associated with the phenomenon (Adger, 2006; Smit & Wandel, 2006). The distinction is important because it recognizes that vulnerability and adaptive capacity involve different organizational processes. Vulnerability, in particular, reflects the degree to which climate change can damage components of a firm's business

model. Adaptive capacity, on the other hand, reflects the degree to which firms' have the capacity to repair that damage if it occurs, which is conceptually separable from the process of vulnerability that creates the damage at the outset. For this reason, the current study will follow other researchers of corporate climate change adaption, who characterize corporate climate change vulnerability as the joint pressures of exposure and sensitivity, and adaptive capacity as a separate driver of corporate adaptations to the phenomenon.

Climate change exposure of human systems, including business organizations, refers to the degree that the system is exposed to significant climatic variations. Climatic variations include changes in any element of the climate, called *climate-related stimuli*, including mean climate characteristics, patterns of variability of climate characteristics, and the frequency or magnitude of extremes (IPCC, 2001). Adger (2006) notes that exposure involves the biophysical stress created by climate change, while Belliveau and colleagues (2006: 366) describe it as "a condition of being subject to detrimental effect" from changing local climatic patterns. The sensitivity of a human system to climate change is the degree to which it is adversely affected by climate change exposure (IPCC, 2001; Adger, 2006). For firms, it refers to the degree to which firms' resources, relationships and the strength of its institutional environment can be threatened by the phenomenon (Belliveau et al., 2006). In other words, any component of firms' business models can be sensitive to climate change. Belliveau and colleagues (2006) and Adger (2006) argue that climate change vulnerability implies that firms and human systems, respectively, must experience minimum thresholds of both exposure and sensitivity. In particular, Belliveau and colleagues (2006: 366) argue that "If a system is not sensitive to

a stimulus to which it is exposed then there would be no effect, and it would not be relevant to the system. Thus the two terms are discussed jointly." Following this assessment, corporate climate change vulnerability involves climate change in firms' salient biophysical environments or stakeholder network, and important resources, capabilities or relationships that climate change exposure can somehow damage.

To illustrate the argument, consider two hypothetical ski resorts (A and B) in the same part of a mountain range, with identical average annual declines in snowfall of an average of five inches each year, over a 10-year period. One could surmise that each would be subject to the same degree of exposure, since they experience identical variations in a key climate indicator. Then consider that ski resort A is located at much higher average elevations than ski resort B, and as a result receives significantly more snowfall (ski resort A received on average 200 inches of snow each year over the 10-year period, while ski resort B received 20 inches of snow each year on the average over the same time frame). The difference in average snowfall amounts reflects the different climate change sensitivities of each resort, where ski resort A appears to be insensitive in the near-term, while ski resort B is very sensitive. Given these levels of exposure and sensitivity, it would appear that ski resort A is not (yet) vulnerable, while ski resort B is very vulnerable and might completely run out of natural snow in four years at this rate.

Climate change vulnerability drives adaptation because it creates risk and uncertainty and conditions which drive organizational change (Cyert & March, 1963; Levinthal, 1991; Pfeffer & Salancik, 1978). In particular, climate change has the capacity to undermine firms' biophysical foundations (Pogutz & Winn, 2009) and their access to critical ecological resources provisioned by ecosystems that comprise their biophysical

environments. However, it also can affect firms' stakeholders who are themselves biophysically sensitive to climate change (Adger, 2006), creating indirect risk for firms involving the stability of critical socioeconomic relationships. Thus, firms can experience both biophysical and socioeconomic vulnerability (Straussfogel, 2006); socioeconomic vulnerability, however, is ultimately a function of biophysical vulnerability of stakeholders in firms' institutional networks (Füssel, 2007).

Füssel (2007) argues that operationalizing climate change vulnerability requires focusing on specific geographic regions that exhibit common forms of biophysical vulnerability. For example, coastal regions are vulnerable to rising seas levels and flooding, whereas inland regions may be vulnerable to water scarcity. Similarly, Belliveau and colleagues (2006) point out that different industry sectors may be vulnerable to climate change for incomparable reasons, implying that intra-industry quantitative studies may be necessary until meta-theory can be developed.

Empirical studies that have measured and modeled corporate climate change vulnerability (e.g. Belliveau et al., 2006; Bleda & Shackley, 2008; Hoffman et al., 2009) have done so qualitatively, by interviewing managers and coding their assessments of *perceptions* of vulnerability (Belliveau et al., 2008; Bleda & Shackley, 2006), or quantitatively via survey of managers' perceptions (Hoffman et al., 2009). As of March, 2011, there have yet to be studies that develop objective physical measures of corporate climate change vulnerability based on independent observations of firms' climate change exposures and sensitivities.

Adaptive Capacity as a driver of climate change adaptations. The IPCC (2001: 982) defines climate change adaptive capacity at the systems level as "The ability of a

system to adjust to *climate change* (including *climate variability* and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences." Another definition is offered by Adger (2006: 270): "the ability of a system to evolve in order to accommodate environmental hazards or policy change and to expand the range of variability with which it can cope." Although similar, the IPCC definition recognizes that there may be opportunities associated with climate change adaptation, while Adger's recognizes that societal factors, such as public policy, can help to determine systems' adaptive capacity. Smit and Wandel (2006) similarly describe adaptive capacity as a function of socioeconomic and policy characteristics of the system, such "as managerial ability, access to financial, technological and information resource, infrastructure, the institutional environment with which adaptations occur, political influence, kinships networks, etc." (p. 287). It is notable that this definition involves factors at different levels of analysis that can influence systems' adaptive capacity. In an analysis of social networks and communities, Adger (2003) emphasizes the importance of social capital in creating adaptive capacity within groups of actors. In doing so, he theorizes that *bonding social capital*, rooted in community loyalty, and *networking social capital*, which is made up of economic and political ties, are both critical drivers of climate change adaptations.

Corporate climate change adaptation research, likewise, has generally applied each of the aspects of these definitions to characterize corporate climate change adaptive capacity. Bleda and Shackley (2008) define adaptive capacity of firms as "the ability of business organizations to adjust, moderate potential damages, take advantage of opportunities, or to cope with the consequence of climate related events (both physical

and institutional)." (p. 519) Belliveau and colleagues (2006) suggest that the adaptive capacity of firms is a function of "the availability of financial, technological, and information resources, infrastructure, institutions, human capital, social networks, and risk perception; these factors are a reflection of both local characteristics of the system and broader external influences." (p. 367) Finally, Hoffman and colleagues (2009) add that corporate climate change adaptive capacity involves firms' ability to implement "internal changes that provide a better fit to the new environment, such as introducing new technologies and processes. As such, it represents the resources available to the firm that can be employed in the course of adaptation." (p. 258)

Firms' climate change adaptive capacity should induce climate change adaptation, since it represents both firms' capabilities in adapting to biophysical environmental dynamics, and how supportive firms' institutional and market environments are of these capabilities (Belliveau et al., 2006). As such, the concept is congruent with popular organizational theories[7] that describe how and whether firms can learn to create technical and social fit with their ever-changing external environments (Cyert & March, 1963; Levinthal, 1991; March 1991; Nelson & Winter, 1982; Pfeffer & Salancik, 1978; Scott, 2008; Zollo & Winter, 2002). The next sub-section will describe how several of these theories have been applied in explanations of firms' climate change adaptations. Nonetheless, it is important to note here that these theories, in their current conceptualizations, focus solely on fit with socioeconomic environments, and not biophysical environments. Still, climate change is an ecological phenomenon that can undermine firms and stakeholders' access to critical ecosystem services provisioned

[7] These theories include, but are not limited to, the Behavioral Theory of Firm, Evolutionary Economics, New Institutional Theory, and Resource Dependence Theory.

directly by ecological systems. Thus, *Corporate Climate Change Adaptive Capacity* can refer to firms' ability to create better fit with the dynamics in their biophysical environments. Therefore, it is likely that current organizational theory applications to the problem need to be extended, so that they can account for firms' fit with their biophysical environments (Pogutz & Winn, 2009).

Empirical studies have operationalized corporate climate change adaptive capacity in several ways. Hoffman and colleagues (2009) used annual firm revenues as a proxy measure for firms' institutional capacity to affect organizational change. Belliveau and colleagues (2006) found in their inductive study that adaptive capacity depended on availability of financial resources, technology, and supportive government policies. Bleda and Shackley (2009) measured adaptive capacity as a weighted composite of firms' range of available adaptation options, financial resources, organizational culture, managerial ability, stocks of human capital, stocks of social capital, and favorability of institutional framework for adaptations.

Theory underpinning corporate climate change adaptations. Berkhout and colleagues (2006) have developed the most systematic theory of corporate climate change adaptations, rooted in the behavioral theory of the firm (Cyert & March, 1963), evolutionary economics (Nelson & Winter, 1982) and the dynamic capabilities view (Eisenhardt & Martin, 2000; Teece, Pisano & Shuen, 1997). Using these theories, they develop a logic that posits that corporate climate change adaptation involves the strategic management and development of organizational learning capabilities. More specifically, they propose that organizations will use dynamic capabilities to attempt to modify their routines, if signals from their biophysical, market, and institutional environments indicate

that existing routines will cease to be effective. If firms perceive that they have climate vulnerability, they use dynamic capabilities to initiate "learning cycles" (p. 138) that involve receiving and interpreting these signals, searching for and experimenting with new routines embedded with more effective capabilities, selecting new routines, articulating and codifying the knowledge embedded within them, and then finally refining them iteratively using feedback (March, 1991; Zollo & Winter, 2002). The goal of these learning cycles is to reduce vulnerability and/or develop and implement adaptive capacity (Berkhout et al., 2006).

It should be noted that in these theories the perception and subsequent interpretation of corporate climate change vulnerability and baseline adaptive capacity are assumed to take place under conditions of bounded-rationality and are subject to various types of managerial cognitive limitations (Amit & Schoemaker, 1993; Nelson & Winter, 1982; Peteraf & Bergen, 2003). Managers have limited time and attention to devote to these tasks, have access to imperfect information, and are in many cases limited in their ability to engage in rational behaviors in situations that are uncertain and probabilistic (Kahneman & Tversky, 1979). Further, they often rely on heuristics when confronted with decision-making uncertainty that can bias thinking (Kahneman & Tversky, 1979; Peteraf & Bergen, 2003). Thus, while the behavioral theory of the firm, evolutionary economics and dynamic capabilities view assume that managers are intentionally rational, they recognize that imperfect information and managerial cognitive limitations constrain rationality.

Berkhout and colleagues (2006) also develop a typology of adaptation strategies. There are four general areas: commercial strategy adaptation, process technology

adaptations, financial strategy adaptation, and climate change stimuli monitoring adaptations. The choice of strategy type depends on the outcome of organizational learning responses to climate stimuli. Generally, firms will tend to favor those that optimize congruency with their existing resource bases, capabilities, competencies and organizational cultures, and legitimacy and competitiveness in institutional and market environments, respectively. Finally, with regard to feedback and refinement, they believe that the newness of these practices and the uncertainty that organizations face with regard to future climate change stimuli constrain empirically valid theorizing about feedback and refinement processes (Berkhout et al., 2006).

In the end, they believe that corporate climate change adaptations will consist of mixes of the four general areas of strategy options described above, clustering into four strategic types:

"1. *'Wait and see'*: A strategy of deferral, based on skepticism or uncertainty about the possible impacts of climate change and about the benefits of adaptation.

2. *Risk assessment and options appraisal*: A strategy of appraising options in preparation for adaptation of organizational routines.

3. *Bearing and managing risks and opportunities*: A strategy of handling risks and opportunities arising from climate impacts employing organizational resources and capabilities.

4. *Sharing and shifting risks*: A strategy of seeking to 'externalize' risks associated with climate impacts through processes of syndication and collaboration." (p. 150)

The third of these strategies, which involves transforming or reconfiguring firms' resource bases, could include shedding resources and exiting businesses (Eisenhardt &

Martin, 2000). If climate change vulnerability involves excessive risk in accessing critical non-replaceable resources, firms might perceive that the only viable option is divestment and exit (Berkhout et al., 2006).

Finally, Hoffman and colleagues (2009) have conducted the only published quantitative empirical study in the area, as of March, 2011. In their study of the determinants of corporate climate change adaptations of 124 ski resorts in the Swiss Ski Lift Operator's Industry, they conduct a test of theory largely as articulated by Berkhout and colleagues (2006). Given their phenomenon of interest and the research context, their study is the most similar and relevant research to the current dissertation. In it, they identify five potential antecedents to adaptation. *Awareness of Climate Change Effects* refers to how cognizant managers are to their climate change vulnerability. They define *Climate Change Vulnerability* as the joint effects of *Exposure* and *Sensitivity*. *Dependency on Affected Business* refers to the importance of the vulnerable component of firms' business model (ski operations) to their revenue. They define *Adaptive Capacity* as the ability of firms to make internal changes that improve their fit with their business environments. Finally, *Perceived Uncertainty* refers to managers' perceptions of firms' future vulnerability to climate change. The dependent variables in their study consist of three different types of planned and private adaptation measures. *Protecting the Affected Business* refers to steps by the firm to mitigate their climate change vulnerability, including snowmaking, moving to higher elevations, opening ski runs with less snow than usual and using glacier blankets when possible. *Expanding beyond the Existing Business* refers to attempting to develop new competencies and revenue streams that are not as vulnerable to climate change. New alternatives included developing summer

hiking, mountain biking, promoting festivals and concerts, and developing winter activities such as snowshoeing and tobogganing. Finally, S*haring Risks of Financial Impacts* refers to organizing ski insurance, mergers and acquisitions, and strategic alliances with other ski resorts to share resources and capabilities and reduce commonalities.

Their main hypotheses were:

- Firms with higher levels of *Awareness* and *Vulnerability* to climate change will be more likely to adapt in general;
- *Dependency on Affected Businesses* should lead to more measures to *Protect that Business*, fewer measures to *Expand beyond the Existing Business*, and more measures to *Share Risks of Financial Impacts*.
- *Adaptation Capacity* should lead to more measures to *Protect that Business*, more measures to *Expand beyond the Existing Business*, and fewer measures to *Share Risks of Financial Impacts*; and,
- *Perceived Uncertainty* about the future impacts of climate change should lead to more measures to *Protect that Business*, fewer measures to *Expand beyond the Existing Business*, and fewer measures to *Share Risks of Financial Impacts*.

Their results were mixed. They could only weakly confirm that *Awareness of Climate Effects* was associated with adaptations in general, and found no evidence that *Vulnerability* and propensity to adapt were related. They did find that dependency on skiing operations was significantly related to the measures to protect them, such as snowmaking or moving to higher elevation areas, but could not confirm that this independent variable was associated with the other adaptation measures. In addition, they

found that *Adaptation Capacity* was positively associated with efforts to *Protect Affected Business* and *Expand into New Businesses*, but not to efforts to *Share Risks of Financial Impacts*. Finally, *Perceived Uncertainty* was not significantly related to any adaptation measure. In sum, ski resorts' *Adaptive Capacity*, *Dependency on Affected Businesses* and *Awareness of Climate Effects* seemed to be associated with their propensity to protect skiing operations, and in the case of *Adaptation Capacity*, *Develop New Businesses* that are less vulnerable to climate change. Most importantly for the current study, Hoffman and colleagues (2009) found that *Adaptive Capacity* did induce adaptation, while *Vulnerability* did not.

The first finding contributes to evidence of a relationship between firms' capacity and flexibility to adapt to climate change and its propensity to do so. While this is an important finding, Hoffman and colleagues (2009) only capture firms' internal capacity to adapt to climate via annual sales, and do not assess whether conditions in firms' business environment can enable or constrain their ability to adapt. Given that favorability of market and institutional conditions in firms' business environments are also components of *Corporate Climate Change Adaptation Capacity* (Belliveau et al., 2006; Bleda & Shackley, 2008), this relationship still requires empirical confirmation.

Second, while they do not find evidence that *Vulnerability* is related to adaptation, it is important to note that their measure of *Vulnerability* did not objectively capture the amount of *Climate Change Exposure* experienced by each ski resort, or the *Sensitivity* of firms' business model to climate change. Rather, they asked managers' the proportion of winters that were snowy enough to be profitable, thereby assessing the construct through managers' expert opinion. Such a measure, however, may be biased. Firms' strategy and

managers' cognitive limitations can influence managers' assessments of how much snow is really required for profitability, since other corporate actions also have positive or negative effects of firm performance. Further, the measure may not be valid, since one component of *Corporate Climate Change Vulnerability*, *Exposure*, is exogenous to firm behavior and should therefore be assessed independently of corporate attributes, such as profitability.

Indeed, *Climate Change Exposure* is a product of geoclimatic events in the earth's atmosphere that occur irrespective on any one firms' behavior (Winn et al., 2010). While there is now a scientific consensus that human actions leading to GHG emissions and the destruction of carbon sinks is greatly exacerbating climate change (IPCC, 2001; 2007), it would still occur in some form irrespective of the human presence on the earth. Further, while the actions of some extremely large multinational corporations in the financial, oil and gas, and perhaps transportation industries could alter the future anthropogenic effects on the earth's climate regulatory system (Costanza et al., 1997), local expressions of climate change that lead to *Corporate Climate Change Exposure* are disconnected both temporarily and spatially from any one firm's GHG emissions or destruction of carbon sinks (Pogutz & Winn, 2009). The anthropogenic contributors to the build-up of GHGs in the earth's atmosphere, and the ultimate effects that this build-up has had on the earth's global climate regulatory functions, have evolved over generations from the sum of human activity in the aggregate. Further, the processes associated with timing and location of local climatic manifestations are still poorly understood (IPCC, 2007). It is in fact impossible to predict exactly when are where extreme weather events associated with climate change will occur; further, the timing and

geographic extent of droughts and flood zones are also impossible to predict with precision (IPCC, 2001).

Therefore, it is possible to improve on this study's measures of both *Adaptive Capacity* and *Vulnerability*. *Adaptive Capacity*, in particular, could account not only for firms' resources that could be deployed in adaptations, but also the flexibility in firms' external environment for facilitating adaptations. *Vulnerability* could, at very least, account for the exogenous nature of *Corporate Climate Change Exposure* by measuring it objectively with independent and mechanical instruments.

2.3 Institutional Influence and Environmental Performance in the Ski Industry

Finally, it is important to review studies by Rivera and de Leon (2004) and Rivera and colleagues (2006) of the effectiveness of the Sustainable Slopes Program (SSP) at improving the environmental performance of western U.S. ski resorts. While these works do not focus on *Corporate Climate Change Vulnerability* and *Adaptation*, they do assess the impact of pressures from firms' business environment on corporate environmental performance using the same population of firms in the current study[8]. The SSP is a voluntary self-regulation program developed by the National Ski Area Association (NSAA) that addresses the issue of environmental performance in the industry. The NSAA developed the SSP in response to intense scrutiny from environmental activists who are concerned with many dimensions of ski resorts' environmental performance. In turn, the NSAA has put a great deal of "peer pressure" on its members to join the program, so it can send broad signals to activists that the industry at large is trying to take

[8] The current study, Rivera and de Leon (2004) and Rivera and colleagues (2006) each measure environmental performance using data on the western U.S. ski resort industry collected by the Ski Area Citizens Coalition. The population and data will be described in more detail in Chapter 5: Methods, Section 5.1 Data.

responsibility for its environmental impacts. Once in the program, ski resorts are exposed to a variety of programmatic mimetic and normative pressures that are designed to improve corporate environmental performance (Rivera & de Leon, 2004; Rivera et al., 2006). The pressures behind the emergence of this program, its means of attracting members, and its mechanisms of influence on members are consistent with those common to other industry-led voluntary self-regulation efforts (Arora & Cason, 1995; Delmas, 2002; Delmas & Toffel, 2008; Khanna & Damon, 1999; King & Lennox, 2001; Rivera & de Leon, 2004; Rivera et al., 2006).

The most relevant findings in these studies concern the effectiveness of the SSP. Ski resorts' motivations for participating in the SSP were also analyzed; however, these results are not as pertinent to the current study. Indeed, firms may experience a variety of externally generated pressures that could motivate them to participate in a voluntary self-regulation program; however, these pressures are function of firms' environmental behaviors, not the biophysical effects of climate change. Thus, climate change impacts on firms are not likely directly associated with participation in the SSP.

With respect to the effectiveness of the SSP, Rivera and colleagues (2006) found that the program was only associated with better environmental performance practices that had high benefits and/or low costs to firms. More specifically, they concluded that "it appears that once enrolled, program participants may predominantly adopt those environmental management practices that are highly visible, such as recycling, or those that offer immediate short-term benefits with relatively small investments, such as energy and water conservation (p. 213). They attribute the program's limited effectiveness to "weak institutional mechanisms" that fail to screen free-riders out the program, and

ensure credible commitments from firms who do participate. Credible commitments, in the case of voluntary self-regulation programs, seem to require coercive mechanisms, including expressions of sanctioning power against firms from their broader external business environment unless they participate, independent oversight of firms' compliance with the programs objectives, and real sanctions for non-compliance with program requirements (withholding program certification) (King & Lennox, 2000; Olson, 1965; Rivera et al., 2006; Tashman & Rivera, 2010).

They conclude that SSP firms tend to improve environmental performance when it is convenient, while normative and mimetic pressures associated with the program appeared to lack the "teeth" that are necessary to induce more costly and difficult efforts to protect the environment. In support of their position, other studies in the area have found that the coercive mechanisms described above can work, because they allow programs to credibly evaluate firm performance and withhold certifications from non-performing firms, and firms generally must earn a certification to comply with powerful external pressures (Khanna & Damon, 1999; Rivera, 2010). In other words, these programs can induce better performance from firms when they have the power to do so. In these cases, power is derived from their ability to withhold a critical resource, certification. Certification is critical to these firms because it helps them earn legitimacy from their legitimacy-conferring stakeholders (Tashman & Rivera, 2010).

2.4 Summary

Even though research on corporate climate change adaptation is at a very early stage, scholars have developed some important conceptual foundations. First, scholars

have described the determinants of corporate climate change adaptation, primarily through the constructs of vulnerability and adaptive capacity. Vulnerability is the degree to which firms are simultaneously exposed and sensitive to climate change. Adaptive capacity refers to the resilience of firms to impacts created by climate change. Vulnerability can be specific to geographic region and industry sector, since different regions have different patterns of climate change exposure and different sectors exhibit different forms of sensitivity. Further, vulnerability can become manifest through firms' dependence on biophysical and/or social systems. Ultimately, vulnerability associated with firms' social environments involves indirect biophysical vulnerability, since the ultimate source of systemic climate change vulnerability is necessarily biophysical. Adaptive capacity depends on institutional environment, industry, and firm-level factors that shape the resources available to firms for adaptation. Scholars have observed that institutional environments' strength at developing social capacity and providing public goods, industry innovation, and firms' dynamic capabilities are positively associated with adaptive capacity.

Scholars have also described theoretical mechanisms of corporate climate change adaptations, including the use of dynamic capabilities to initiate organizational learning processes that facilitate adaptations. These capabilities should help firms develop "learning cycles" that reconfigure their business models to a state that reflects less vulnerability and/or greater adaptive capacity. In particular, types of corporate climate change adaptations can include changes to commercial strategy, such as entering new businesses that are not vulnerable and exiting those with vulnerability. In addition, they can include developing new capabilities that improve firms' ability to cope with

vulnerability, changing financial strategy by altering allocations to insurance and investments in other vulnerable organizations, and altering information gathering and feedback mechanisms by increasing emphasis on climate-related information.

The extant literature does, however, contain specific gaps that are pertinent to the research questions in this dissertation. First, existing theoretical applications (involving theories of organizational learning) cannot wholly explain how exogenous events in firms' biophysical environments, such as climate change, can create vulnerability and impact firms. As described earlier, corporate climate change vulnerability can be a function of direct dependence on biophysical systems that are vulnerable to climate change (IPCC, 2001; Lash & Wellington, 2007; Schlenker, Hanneman & Fisher, 2005; Spittlehouse & Stewart, 2003; Straussfogel, 2006; WTO, 2003). Further, the first research question of this study (p. 7) posits that vulnerability may be associated with firms' direct impacts on biophysical environments. Theories of organizational learning, however, focus only on describing mechanisms used by firms to create a "dynamic fit" between their competencies and their socioeconomic business environments (Teece, Pisano & Shuen., 1997), and do not account for the direct firm-ecological environment relationship. In addition, these perspectives are, by and large, more focused on describing internal organizational attributes rather than the interplay between organizations and the systems in which they are embedded (Scott, 2008). Therefore, I argue that organization-centric theories can only incompletely explain corporate climate change vulnerability and adaptations, and the biophysical impacts of these adaptations.

Other organizational theories, such as resource dependence theory and new institutional theory, are more concerned with the dynamics between organizations and

their environments. For this reason, scholars have applied them often in research that interprets the firm-ecological environment relationship as a function of firms' external market pressures, industry economic power, government regulatory pressure and uncertainty, and normative pressures from the firms' salient institutional environments (Aragon-Correa & Sharma, 2003; Berchicci & King, 2007; Christmann, 2000). Further, scholars have used these theories to explain outcomes of this relationship, such as corporate environmental, social, and financial performance (Berchicci & King, 2007; Darnall & Sides, 2008; Elkington, 1997). However, like the organization-centric theories described above, these do not incorporate explanations of the mechanisms associated with firms' direct dependence and/or impacts on biophysical environments, without mediating influences of social and market institutions (Pogutz & Winn, 2009). Thus, while it might be possible to rely on one of these organizational theories to interpret the phenomena of interest, one would still need to extend the chosen theory to address the direct firm-natural environment relationship.

CHAPTER 3. RESOURCE DEPENDENCE AND NATURAL RESOURCE DEPENDENCE

3.1 Introduction

In a call to address the gap identified in the immediately previous section, Starik and Rands (1995) suggested that resource dependence theory might be used to explore the direct linkages between firms and their ecological environments. Many years later, Pogutz and Winn (2009) developed this idea somewhat, by describing firms' ecological "embeddedness," involving both its dependence on its salient biophysical environment and the impacts that it has on the same environment. Both articles imply that firms can face ecological uncertainty when they depend on resources embedded in their salient biophysical environments, and ecological change can undermine firms' access to those resources. The following sections develop this notion more completely, first by describing the rationale for explaining ecological influences and impacts through the lens or resource dependence theory, reviewing the extant theory's core arguments, and then accounting for the unique components and mechanisms of resource dependence on the natural environment (natural resource dependence).

3.2 Rationale for Using Resource Dependence Theory

I base my theoretical interpretation of the phenomena of interest in resource dependence theory for two reasons. First, the early evidence indicates that corporate climate change vulnerability often involves effects on ecological resources in firms' biophysical environment that are critical to firms' business model (Belliveau et al., 2006; IPCC, 2001; WBCSD, 2008). While extant resource dependence theory does focus on the resources controlled by other organizations in the firm's socioeconomic environment, it

does not contain assumptions that preclude the possibility that uncertainty can also be associated with accessing critical resources provisioned by their salient ecological systems. Second, climate change is, in fact, a powerful force from the external environment of business that is creating uncertainty for firms with corporate climate change vulnerability (Emanuel 1998; 2003; 2005). While the theory explicitly focuses on the uncertainty associated with the distribution of power in socioeconomic environments (Pfeffer & Salancik, 1978), it does not contain assumptions that preclude the potential for forces in the ecological environment, like climate change, to create uncertainty with respect to resource access (Hoffman, 2006; Lash & Wellington, 2007; Pogutz & Winn, 2009; Smit, Burton & Klein, 2000).

3.3 Resource Dependence Theory Reviewed

According to Pfeffer and Salancik (1978), resource dependence is a function of the criticality of resources controlled by other organizations in firms' salient socioeconomic environments. Criticality describes how important resources are for the day–to-day functioning of organizations, and the proportion of output that relies upon them. Without access to critical resources, firms would have to substantially change their business models. Resource dependence and uncertainty occur because firms are not self-contained entities. Rather, they are embedded in bounded open systems (Katz & Kahn, 1966) of organizational networks, called inter-organizational fields, which contain a finite quantity of potentially critical resources. Organizations, in an ongoing quest to secure their specific external resource requirements, become networked by their dependencies or, more aptly, interdependence. Interdependence describes the reciprocal dependencies

that tend to characterize the relationships between organizations within a field. A simple example illustrates this notion: firms are dependent upon their suppliers and customers; customers, in turn, depend on firms for goods and services, and suppliers depend on them for sales. As a result, a firm's capacity to manage its own resource dependence is a function of *organizational interdependence* in their interorganizational field (Pfeffer & Salancik, 1978).

According to the theory, the mechanism linking patterns of interorganizational interdependence to firms' resource dependence management strategies is power (Casciaro & Piskorski, 2005). Bierstedt (1950) defined power as the ability of a social actor to introduce force into a social situation to induce certain behaviors from other social actors, where force is defined as the "application of sanctions" (733). Power, therefore, can be conceived of as latent force, which a powerful subject can threaten to use against others for the purpose of getting them to do something they are not already inclined to do (Mitchell, Agle & Wood, 1997). Social power is not solely an attribute of the actor who possesses it; it is also enacted by the social relationships in which an actor finds itself enmeshed (Pfeffer & Salancik, 1978). In other words, power must not only have a subject, but also an object, and the character and degree of one actor's power over another depend on the relationship that exists between the two. Emerson (1962: 32) accounted for the relational component of power in his definition: "The power of actor A over actor B is the amount of resistance on the part of B which can be potentially be overcome by A."

The source of organizational power is the subject's control of physical, financial, intellectual, relational, and/or symbolic resources that are needed by others (Casciaro &

Piskorski, 2005; Emerson, 1962; Frooman, 1999; Pfeffer & Salancik, 1978). In other words, one organization's resource dependence on another gives the latter organization power over the former. If an organization possesses a resource that is critical to another, it can exercise its power over the dependent entity by threatening to withhold a critical resource from it (Frooman, 1999). The dependent organization is left with a choice: acquiesce to the demands of the powerful organization, or lose its access to the resource in question (Casciaro & Piskorski, 2005)

The condition of organizational interdependence, however, implies that organizations have reciprocal needs from each other, implying that power is bi-directional and can be applied as a countervailing response. The distribution of power depends upon the symmetry of resource dependence between organizations, where, typically, the less dependent organization has a power advantage over the other (Pfeffer & Salancik, 1978). It is important to note that interdependence and the distribution of power among organizations are functions of the characteristics of the socioeconomic networks in which these organizations are embedded, as well as the individual needs of organizations. As the critical resource becomes more abundant in the network, firm-specific power associated with controlling the resource declines, since the overall supply of the resource and dependent firms' options for procuring it become higher. In this case, an equally important implication is that one organization's power declines as the concentration of the resource across the network becomes more dispersed, because the dependent organization has more potential transacting partners and, by extension, more bargaining power (Pfeffer & Salancik, 1978; Porter, 1981).

FIGURE 1. Resource Dependence, Power and Organizational Interdependence

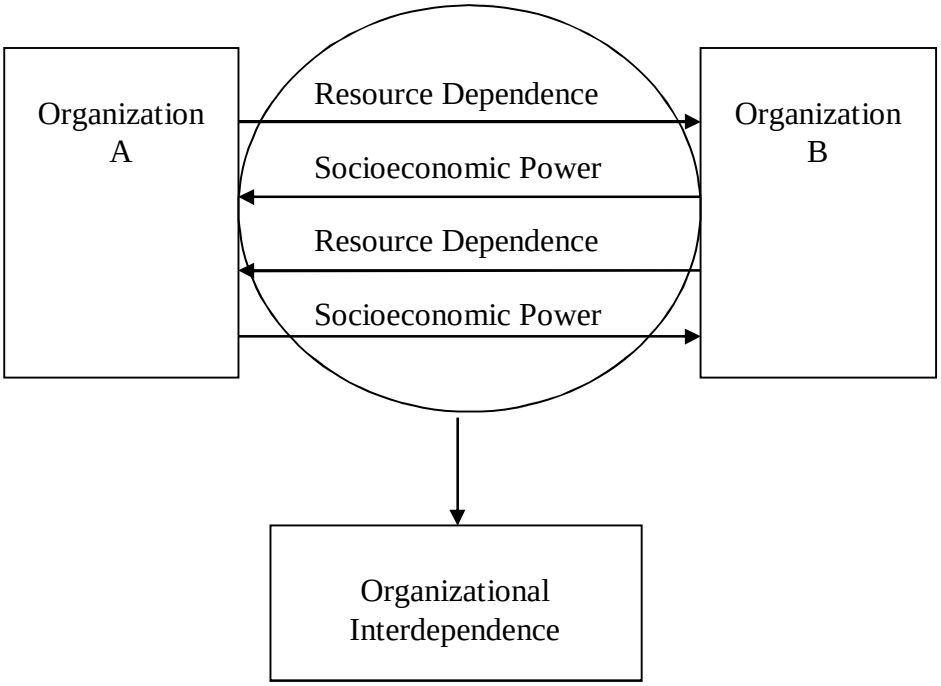


Figure 1 provides a stylized representation of the resource dependence, power, and organizational interdependence constructs.

There are two general strategies available to an organization for managing interdependence: first, it can adapt to its dependence by restructuring its internal demand for the resource (Pfeffer & Salancik, 1978). Organizations tend to do this when the external organization controlling the resource is more powerful, and they cannot expect to generate sufficient countervailing power. Adapting resource dependence can involve identifying substitute resources, or more radically, diversifying lines of businesses, or any other option that reduces underlying resource dependence. In addition, an organization can attempt to buffer itself from resource dependence by accruing inventories of the focal resource, thereby reducing the urgency of the uncertainty associated with changes in external supplies of the resource. However, this strategy only addresses the urgency of

uncertainty, and not its underlying cause (resource dependence). It leaves the organization potentially vulnerable in the future, while at the same time creating slack resources that might decrease efficiency (Cyert & March, 1963; Pfeffer & Salancik, 1978). The second general strategy involves attempting to assert control over the resource in question. A firm can reasonably expect to do this if it is more powerful than the organization controlling it. There are many strategies that firms can employ to gain control of resources, including bargaining, mergers and acquisitions, joint-ventures, collusion and cooptation (via interlocking boards). With the exception of bargaining, each of these strategies also creates new interdependencies for the focal organization, as they cede a certain degree of organizational autonomy and internalize the once-separate interdependencies that accompany its "new" partner(s) (Pfeffer & Salancik, 1978).

Finally, while the theory articulates a variety of strategies for managing resource dependence, it assumes a limited role for managerial discretion; the focal determinant of strategy in this view is the uncertainty arising from power relationships in the firms' socioeconomic system. The theory conceives of managers not necessarily as entrepreneurial, but rather as agents who are constantly managing and disposing of interdependence, by either using power over other organizations or acquiescing to their demands when they have more power. It also assumes that managers enact their business environments rather than rationally interpret them; this means that managers' capacities to accurately make sense of their socioeconomic environments are subject to their own cognitive limitations and imperfect access to complete information about the environment (Pfeffer & Salancik, 1978). As a result, managerial discretion is itself a function of the unique sense-making processes of managers. By implication, organizations can impact

their socioeconomic environments in unpredictable ways as they adapt to their interdependence, uncertainty and power relations, because their adaptations are a function of imperfect sense-making processes. Therefore, even though organizations and their managers might have limited discretion when managing problems associated with resource dependence, they do participate in the social construction of their socioeconomic environments (Pfeffer & Salancik, 1978; Scott, 2008).

3.4 Natural Resource Dependence

The natural environment is, however, to some extent exogenous from markets and institutions that comprise the socioeconomic environments described in resource dependence theory. In fact, the natural environment could exist wholly without society, whereas the reverse would be impossible. Thus, it is reasonable to suggest that organizations can be directly dependent upon the natural environment, without the mediating influence of their own institutions or other organizations. Pogutz and Winn (2009) develop this argument by describing organizations as "ecologically embedded" to differing degrees. The concept of ecological embeddedness is based on Granovetter's (1985) theory of the social embeddedness of economic action, which describes how economic behaviors of individuals and firms are embedded in social systems and cannot be interpreted without understanding their social contexts[9] (Granovetter, 1985; Pogutz & Winn, 2009). With regard to ecological systems, the concept implies that economic behavior is also embedded in the natural environment, and that we cannot entirely make sense of organizations without understanding their ecological contexts. The concept is

[9] Granovetter argued that scholars who did so often presented either under- or over-socialized accounts of reality, depending on whether they adopted an exclusively economic or social account of their research context, respectively.

also built around the notion that organizations depend on the natural environment, since they cannot exist without their biophysical environments and the critical ecosystem services they provide. In this sense, it is an analog to the organizational embeddedness in institutional fields described by resource dependence theory, since organizations also cannot exist without their socioeconomic environments and the critical resources they provide (Pfeffer & Salancik, 1978).

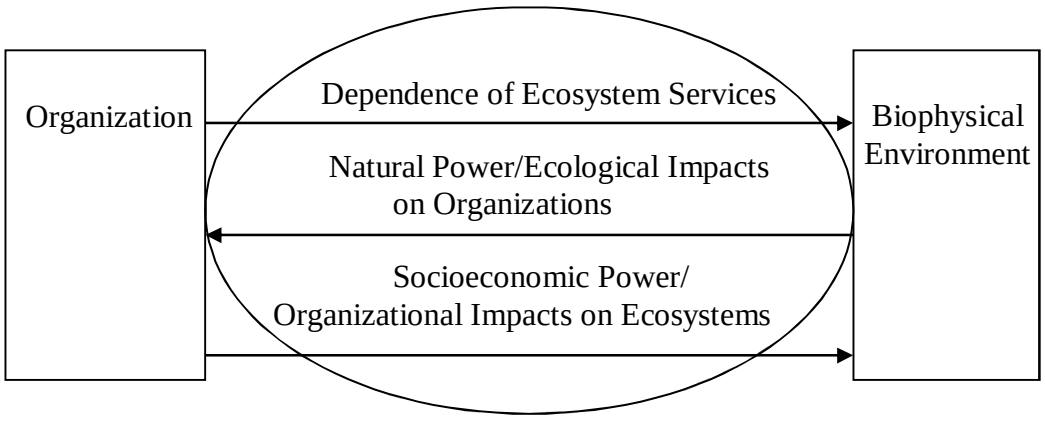
Unlike socioeconomic dependence, natural resource dependence involves natural forces and resources that are directly provisioned by firms' biophysical environment. These problems, therefore, do not involve organizational interdependence. Building on Pogutz and Winn's (2009) notion of ecological embeddedness, I propose that natural resource dependence is, instead, a function of *organizational ecosystem dependence*, *ecological impacts on organizations*, and *organizational impacts on ecosystem* rather than organizational interdependence. I also, posit that natural resource dependence can also involve a feedback loop between *organizational impacts on ecosystems* and *ecological impacts on organizations*. In addition, strategies to manage natural resource dependence involve responses to natural power that rely on an organization's power to control the ecological systems that provision critical ecosystem services to the firm. Since organizational power, by definition, results in part from its network of socioeconomic relations and control of resources (Pfeffer & Salancik, 1978), I refer to this type of power as socioeconomic power. Figure 2 illustrates the various components of natural resource dependence.

3.41 Organizational Dependence on Ecosystems

Organizational dependence on ecosystems is a function of the criticality of *natural capital* and *ecosystem services* that the natural environment directly provisions to the firm. Natural capital has been defined as a stock of natural assets (biological or otherwise), the natural processes that link them together, and/or the structures that hold each of these components together in balanced systems (Wackernagel & Rees, 1997). Costanza and colleagues (1997: 254) define ecosystem services as "flows of material, energy and information from natural capital stocks which combine with manufactured and human capital services to produce human welfare."

Ecosystems can achieve stasis or at least trend towards it, because they consist of frameworks of natural capital that create their own self-regulating processes, which regenerate decaying or consumed sources of natural capital. Examples of ecosystem self-

FIGURE 2: The Components of Natural Resource Dependence



regulating processes include: atmospheric regulation, climate regulation, ecosystem regeneration following perturbation, soil formation processes, processes that lead to the breakdown of wastes, processes that organize natural capital stocks into renewable and

non-renewable resources, and a variety of other natural self-regulating processes (Costanza et al., 1997). These self-regulating processes yield ecosystem services, which can be defined as benefits provided by nature to society, such as air, air purification, water, water purification, soil formation, favorable climates, consumption of renewable resources, nature-based tourism, and a general feeling of appreciation for nature and the life it contains (Costanza et al., 1997). Some ecosystem services sustain life itself, while others provide quality of life to human and animal communities that value it (Starik & Rands, 1995).

Like humans, firms depend directly on natural capital and ecosystem services (Pogutz & Winn, 2009; Starik & Rands, 1995). Without air, water, a favorable climate, and a variety of natural resources, no organization is able to survive (Gladwin et al., 1995). Some ecosystem services are directly essential to the existence of specific organizations, such as wind for wind-power generation; water for hydro-power generation; timber for pulp, paper, lumber and furniture; fertile land and water for agriculture; and snow and water (used in snowmaking) for skiing. More generally, firms depend upon natural capital to generate ecosystems services that result in natural resources underpinning the raw material for all physical assets. Without iron, oil, gas, and coal, there would be no plant, property and equipment (Costanza & Daly, 1992). Thus, business organizations either depend directly on natural capital and/or its resulting ecosystem services when they represent specific components of their business models, or indirectly upon them as a source of raw materials for all kinds of manufactured capital. In addition, they indirectly depend upon natural capital and ecosystem services because

they sustain the human systems comprising firms' socioeconomic environments and critical stakeholder sets.

3.42 Ecological impacts on organizations

Natural forces create uncertainty for firms' access to critical ecosystem services by undermining the functioning of their source ecosystems. By implication, ecological impacts on organizations are a function of organizational dependence on ecosystems. If firms have low levels of organizational dependence on ecosystems, then they are less vulnerable to ecological change and its capacity to disrupt the provisioning of natural capital and ecosystem services (Winn et al., 2010). Ecological change causing impacts on firms with dependence on ecosystems can, in some cases, be too powerful for human intervention. Firms often manage the impact of natural forces on their biophysical environment when those forces are contained within the same space (Costanza & Daley, 1992; Pogutz & Winn, 2009). However, many ecological processes, including climate change, involve natural forces and expressions of power that are temporally or spatially removed from the firm's salient biophysical environment and involve levels of energy that operate on much larger scales than those used by any one business (Winn et al., 2010). In the case of climate change, firms are almost powerless to stop the natural force that is undermining the health and functioning of ecosystems comprising their biophysical environments. Localized expressions of climate change can be caused by past events taking place in distant geographic areas, leaving individual firms without options for preventing it from happening (Prugh et al., 1999). Therefore, natural power over firms can be nearly absolute and impossible to mitigate; firms facing loss of access to natural

resources due to ecological processes like climate change can only adapt to this resource dependence, since they cannot generate countervailing power capable of stopping these events (Winn at al., 2010).

Technology can in some cases slow the impact of widespread expressions of natural power on firms. In limited cases, technological solutions protect manmade structures and systems from some types of ecological change. For example, off-shore oil and gas drilling platforms have developed capabilities for protecting physical capital from the extreme weather events and ocean swells associated with climate change (Hoffman, 2006). However, physically protecting firms' biophysical environment from climate change would require isolating it in a biosphere and recreating the desired climatic systems for that ecosystem within the biosphere. This type of solution is prohibitively expensive for firms in industries that are natural-resource dependent. Further, technological solutions to affect the source of climate change on a global scale, which drives local expressions of climate change, currently do not exist (IPCC, 2007). As a result, the deployment of technology into natural systems to protect them against climate change is currently limited in application.

In broader applications, some have argued that technological solutions can replace ecosystem services that degraded sources of natural capital can no longer provide. For example, air conditioning can keep us cool even though the planets' ability to do so is waning. However, this is only possible on a local scale (it will obviously be impossible to air condition the earth's atmosphere), and in the process, it accelerates the depletion rate of the natural capital, and by extension, substitutes for ecosystem services no longer provided by degraded natural capital. The second law of thermodynamics explains how

this occurs (Wackernagel & Rees, 1997). All matter, including natural capital, is subject to entropy and is therefore constantly losing biomass because it is constantly bleeding energy. Natural capital is at a state of low entropy because it is typically organized into ecosystems that trend towards homeostasis by incorporating self-regulating systems that preserve the ecosystem's structure (Costanza & Daly, 1992). Technological substitutes for natural capital, on the other hand, are not produced via self-regulating processes, but rather via value-added chains that ultimately begin with the extraction of raw materials from the earth, i.e. natural capital. Further, their value-added chains can consume a variety of ecosystem services in the process of bringing technological substitutes for natural capital to the market, in aerobic, hydrological and terrestrial ecosystems (Wackernagel & Rees, 1997). As natural capital is processed and reconfigured into manufactured forms of capital that become technological substitutes for natural capital, waste is generated and entropy increases. In addition, as the organizing structure of natural capital becomes reconfigured during the transformation, it enters a higher entropy state, because its self-regulating processes become disrupted (Wackernagel & Rees, 1997).

Further, if that technology consumes energy and resources in the process of being a natural capital substitute, it will do so in a way that appropriates energy away from self-regulating ecosystems and their regenerative capacities (Wackernagel & Rees, 1997). For example, air conditioners or heating systems offer a technological substitute for climate regulation in localized indoor environments, but in the process they consume more energy from outside the system than is reflected in the local service provided. Even attempts to *invest in natural capital* that involve restoring and enhancing ecosystem

health (Pogutz & Winn, 2009) ultimately deplete global stocks of natural capital because they require reallocating natural capital from one locale to another, moving the origin locale and the reallocated capital into higher entropy states (Hinterberger, Luks & Schmidt-Bleek, 1997). For example, agricultural firms may plant rapidly growing species of poplar on farmlands to be used as pulp timber, as a technological substitute for natural forests. While tree farming may appear to be more ecologically sustainable than harvesting from natural forests, it still requires soil, fertilizer, and an energy conversion process that in the aggregate can rival or exceed the biomass depleted from traditional selective logging in natural forests. As a result, the more sustainable strategy actually involves sustainable harvesting in natural forests (Spittlehouse & Stewart, 2003).

Currently, technology cannot replace what the natural environment does for humanity in the aggregate. Its best uses, with respect to promoting sustainable development, are to either help human systems decouple themselves from their resource dependence on ecosystems and natural capital, or to invest in natural capital. Doing so could help prevent human systems from exceeding the carrying capacity of ecosystems and help protect ecosystem self-regulating processes and regenerative capabilities (Wackernagel & Rees, 1997).

3.43 Organizational impacts on ecosystems

Organizational impacts can occur when businesses use ecosystems to manage their organizational ecosystem dependence in three general ways (Marshall & Toffel, 2005). First, businesses facing natural resource dependence may be able to manage the associated uncertainty by creating buffers of vulnerable natural resources or using natural

capital to create substitutes for vulnerable natural resources. Farms that react to drought conditions by using more irrigation and ski resorts that use more water to create artificial snow reflect this strategy. However, developing substitutes for lost sources of natural capital by consuming others can lead to the over-consumption within that ecosystem. Overconsumption can be defined as a pace of natural capital consumption which exceeds ecosystems' *carrying capacity*, or the ability of ecosystems to maintain their organizing structures, self-regulating processes and self-regenerative capacities (Costanza & Daly, 1992; Arrow et al., 1995).

Second, firms may use or develop ecosystems to manage their natural resource dependence. As firms' natural resource dependence increases, so does the likelihood that managers consider their biophysical environments as valuable resources to leverage in business strategy. This should not exclude strategies to adapt to ecological change in firms' biophysical environment. In this case, leveraging the biophysical environment implies using it as the basis for new revenue-generating capabilities that are less vulnerable to ecological change. For example, ski resorts might develop summer recreation operations in their mountain environs, such as golf and mountain biking, to replace declining revenues from skiing operations because of climate change. This strategy can also disrupt the organizing structure of natural capital within ecosystems and self-regulating and regenerative processes, since it involves introducing social and technological elements into the system or physically destroying parts of the system. Third, pollution associated with business practices also can perturb ecosystems by disrupting their organizing structures (Costanza & Daly, 1992; Marshall & Toffel, 2005).

Control can motivate firms to leverage their biophysical environments before seeking resources from their socioeconomic environments when adapting to ecological change. Many ecosystems and ecosystem services are considered public goods, and their value to society is not reliably recognized by institutional governance mechanisms (Costanza & Daly, 1992; Costanza et al. 1997; Prakesh & Potaski, 2005; Berchicci & King, 2007). Thus, firms can often use natural capital and ecosystem services from their biophysical environments directly, without having to work through markets, where other organizations might have intermediary control of these resources. In addition, direct control can help firms avoid legitimacy concerns from non-market stakeholders who might publicly decry overconsumption of natural capital directly from firms' biophysical environments. Organizational impacts on ecosystems resulting from overconsumption can go unnoticed by other organizations, or can be temporally or spatially removed from the actions that caused them (Driscoll & Starik, 2004). In these cases, opposing stakeholder claims about firms' impacts on ecosystems may be difficult to substantiate, or may happen too late to prevent environmentally harmful corporate behaviors. For these reasons, influence mechanisms that constrain firm behavior in their socioeconomic environments can be less effective in their biophysical environments, inducing firms to use ecological resources of value from this domain more often, when given a chance (Wackernagel & Rees, 1997).

3.44 Organizational impacts on ecosystems feedback loop

In cases of overconsumption, firms that create organizational impacts on ecosystems might face new natural resource dependence problems, since affected

ecosystems could begin provisioning even fewer ecosystems services to those firms, or salient stakeholders might begin deploying withholding strategies against these firms (Frooman, 1999; Pogutz & Winn, 2009). For example, a ski resort that adapts to declining snowfalls by deploying snowmaking capabilities might overconsume local sources of water to overcome the impacts of lower levels of snow, thereby depleting that critical resource for future snowmaking activities. Another possibility is that it might draw too much water from community supplies, causing community stakeholders with concerns about water scarcity or other ecosystem effects to engage the firm confrontationally (Clifford, 2002). As another example, forestry firms using cut-block logging techniques often attempt to restore lost forest density by replanting clear-cut areas. While tree-planting can restore forest density, it does not restore biodiversity, which ironically makes forests more vulnerable to bark-beetle pandemics (Fettig et al., 2007).

Since feedback about corporate behavior can also be temporally and/or spatially removed from firms' adaptation strategies, organizational impacts on ecosystems may be difficult to foresee. For example, an offshore oil and gas exploration may flare methane in the process of producing crude oil, thereby contributing substantially to GHG emissions, which in turn contributes to global warming. At some point, the resulting climate change may be responsible for extreme weather that threatens the firm's offshore facilities; however, the timing and location of that extreme weather cannot be reliably predicted, nor can the firm's actual contribution to the global greenhouse effects that are associated with the weather event (Pogutz & Winn, 2009; Winn et al., 2010).

3.45 The interaction of socioeconomic and natural resource dependence

Thus far, the discussion of natural resource dependence has mainly focused on the direct relationship between firm and natural environment. This is done for analytical purposes. However, natural resource dependence should not be thought of as isolated from socioeconomic resource dependence. Rather, firms' direct relationship with its natural environment is likely to be contingent on its organizational interdependence within its socioeconomic environment and on the distribution of social and economic power that exists there. Thus, forces in the firm's market and institutional environments can magnify or constrain each of the four conditions of natural resource dependence described above.

A noteworthy institutional condition that is magnifying the problems associated with overconsumption and organizational impacts on ecosystems is that natural capital and ecosystem services are often freely available open-access common goods[10] even though their consumption can have real external costs for ecological, economic and sociological systems (Costanza et al., 1997; Prugh et al., 1999; Wackernagel & Rees, 1997). As a result, the market place does not send the signals to economic actors that reflect Pareto optimal corporate behaviors with respect to consuming scarce natural resources sustainably. Further, institutional systems do not currently provide comprehensive environmental protections for inducing sustainable development. While most of the earth's ecological systems are under some sort of regulatory control, even the most stringent environmental regulations do not always properly account for the value of

[10] There is a vigorous political debate about what goods and services should be public, private or communal; however, it is accurate to suggest that most of the globe's ecosystems are in some state of decline because of human overconsumption and/or perturbation, and that these behaviors would be constrained if ecosystem services were communal goods (Hardin, 1968), rationed public goods, or at very least, publically allocated goods that are monetized in a way that reflects their value to society through markets and political governances mechanism (Millennium Ecosystem Assessment, 2005).

ecosystems (Millennium Ecosystem Assessment, 2005). For example, when a stand of trees is harvested, the value of the raw materials may be captured in fees, and the pollution to firms' biophysical environments may be minimized by effective regulations and pollution control practices. However, the value of carbon sequestration services provided by those trees is not yet subject to mandatory valuation through fees or carbon pricing in countries that have the overwhelming majority of the globe's viable commercial forests (United States, Canada, Brazil and Russia). Even when tree planting is required where trees have been harvested, it takes many years to reestablish the carbon sequestration capacity of mature or maturing forests (Dewar & Cannell, 1992). Further, tree-planting does not quickly reestablish lost biodiversity, which in many cases takes centuries to regenerate, even if no other ecosystem perturbations occur. Biodiversity is associated with many other ecosystem services, such as organic compounds used in new medicines, resistance to forest fires, resistance to pine-bark beetle infestations, and spiritual well-being to citizens who value nature (Costanza & Daly, 1992; Pogutz & Winn, 2009; Starik & Rands, 1995).

3.46 An Illustrative Vignette

The following vignette describes a process that links organizational interdependence, organizational dependence on ecosystems, ecological impacts on organizations, organizational impacts on ecosystems, and feedback loops to the organizational and socioeconomic resource dependence.

Forestry firms operating in the Kinbasket region of British Columbia (BC) during the 1970s and 1980s substantially depleted available commercial timber in the region, so that a once-vibrant industry and forest had all but disappeared by the late 1990s. The drivers of this collapse were a long-standing public policy and the competitive pressures it created, which favored unsustainable forestry practices across the region. The provincial forest practices code encouraged the local forestry industry to harvest at unsustainable rates through the policy of its annual allowable cut (AAC). This policy called for harvesting rates in the Kinbasket Region that were well beyond the carrying capacity of its natural forest resources. As a result, the BC Ministry of Forests, the provincial agency responsible for regulating commercial forestry and developing its forest practices code, rewarded firms that were efficient at harvesting with discounted stumpage rates and privileges to apply for newly designated forest tenures. Thus, forestry firms that could produce timber faster received better prices and access to timber, whereas those considering more sustainable harvesting practices were exposed to uncompetitive policy prescriptions. As the regional forests became depleted, so did their capacity to regenerate themselves, prevent erosion that damaged logging roads and waterways that were responsible for maintaining fisheries and fresh water, sustain wildlife habitats, and mitigate forest fire potential. The decline in ecosystem functioning also hastened the decline of commercial forests and created additional expenses for forestry activities associated with increasingly difficult access to timber. These conditions increased competitive pressures in the region, since a then-mature regional industry faced increasing costs, declining

access to timber, and increasing excess lumber production capacity. These pressures translated into increasingly ecologically destructive forestry practices to manage rising costs, further hastening the decline of the forest. In the early 1990s, public pressure to protect forests, and policy-makers' recognition that the existing policy regime had undermined the forest resources throughout the province, convinced the province to review forestry regulations, and, ultimately, develop a new BC forest practices code. The new code was exceptionally stringent, requiring extensive regulatory approvals and charging much higher timber stumpage rates. By the middle of the 1990s, the most prominent lumber mill in the Kinbasket Region closed its operations because of the decline in local timber supply and quality and increased costs. Without this prominent regional buyer, most of the upstream forestry industry in the region disappeared (Chappelle & Hein, 1993). In short, the AAC-based policy prescriptions induced the forestry industry to cause the rapid decline of the regional timber supply. This created feedback from the industry's ecological and socioeconomic environments that hastened its own collapse.

3.5 Summary

The existing body of scholarly research in the area of corporate climate change adaptations has been focused primarily on the organizational level of analysis, examining the relationship between organizational processes and their resulting adaptations. However, research in the area has yet to address research questions involving how climate change geophysically impacts firms, whether firms' resulting adaptations to

climate change create effects on the external environments where they are embedded, and whether forces in those external environments can constrain or enable adaptations that have effects in those environments (Winn et al., 2010).

Fortunately, there is a long tradition of applying organizational theories focused on the external environment of business to explain the drivers, impacts and contingencies of corporate sustainability. Research on corporate environmental performance in particular has applied contingency theory and neo-institutional theory to explanations of how marketplace conditions and institutional arrangements can be related to firms' impacts on the natural environment (e.g. Aragon-Correa & Sharma, 2003; Rivera et al., 2006). Climate change is, however, a natural driver of corporate strategy that might lead to impacts in firms' biophysical environments under their direct control, without mediating influences from markets or society. As a result, organizational theories explaining the relationship between firms and their socioeconomic environments need to be extended to account for the direct firm-natural environment relationship (Pogutz & Winn, 2009; Starik & Rands, 1995). Some work has already occurred through the perspective of resource dependence theory and its ability to explain firms' dependence on externally controlled resources (Pfeffer & Salancik, 1978). In this chapter, I attempt to extend the theory by accounting for unique elements of natural resource dependence. These elements are organizational dependence on ecosystems, ecological impacts on organizations, organizational impacts on ecosystems, and the feedback that organizational impacts of ecosystems create for organization dependence on ecosystems. In explaining ecological impacts on organizations in particular, I incorporate a role for natural power to create uncertainty for firms' ability to access natural resources. In

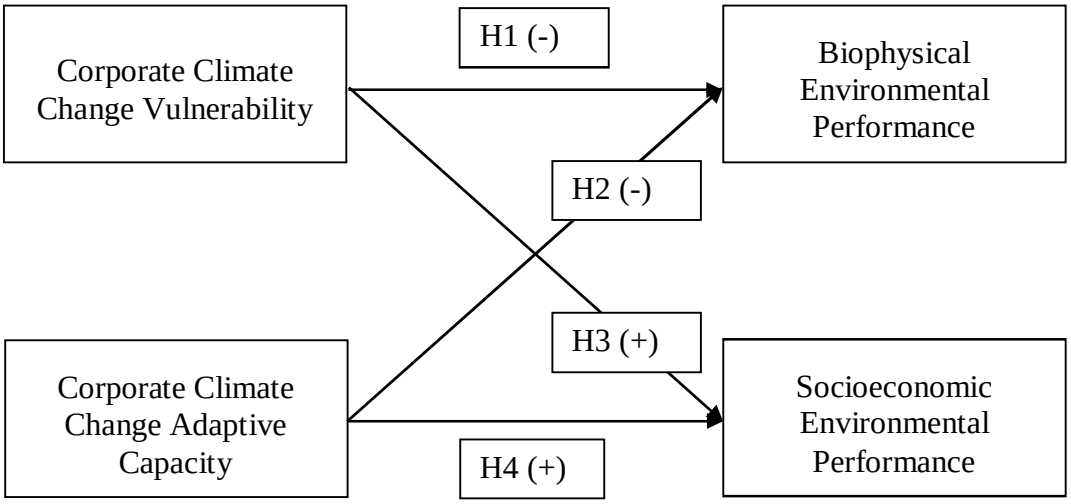
addition, I briefly propose that there is interplay between the elements of natural resource dependence and organizational interdependence, since firms are embedded in both socioeconomic and ecological environments. The next chapter develops a conceptual model and a set of empirically testable hypotheses that are based on the ideas described in this chapter.

CHAPTER 4. MODEL AND HYPOTHESES

4.1 Conceptual Model

As mentioned earlier, the dissertation involves a quantitative empirical study that assesses the impact of Corporate Climate Change Vulnerability and Adaptive Capacity on Biophysical and Socioeconomic Environmental Performance. Figure 3 illustrates the conceptual model diagrammatically:

FIGURE 3. Conceptual Model Framework



4.2 Hypotheses

Hypothesis 1: Corporate Climate Change Vulnerability is negatively related to Biophysical Environmental Performance.

As discussed in Chapter 2, firms are more likely to deploy climate change adaptations when they are vulnerable to the phenomenon (Adger, 2006; Berkhout et al., 2006; Hoffman et al., 2009). Resource dependence theory contains prescriptions for firms with climate change vulnerability to help them reduce the biophysical risk created by phenomenon. They include: protecting threatened resources, buffering inventories of threatened resources to make uncertainty less urgent, diversifying competencies with ones that are not vulnerable, adapting patterns of interdependence in firms' external environments to mitigate risk, or using inter-organizational collaboration so that firms can share or shift risk created by climate change (Pfeffer & Salancik, 1978). However, some of these prescriptions are specific to conditions of organizational interdependence (Winn et al., 2010). The unique aspects of natural resource dependence can preclude adaptation options that involve protecting the organizing structures of ecosystems comprising firms' biophysical environments, stopping climate change (adapting firms' external environment to reduce firms' interdependence), or using inter-organizational partnerships to share or shift climate change risk.

First, while protecting firms' biophysical environment from climate change is consistent with the type of adaptation that protects threatened resources, doing so is most often a prohibitively difficult task, or it causes harm to ecosystems outside of firms' biophysical environments. As an example of the first case, some ski resorts have attempted to preserve snow by slowing glacial melt with glacial blankets; however, this technology is only feasible on glaciers (it cannot protect snow on regular earth from

geothermal energy that will melt it from below), is extremely expensive, and slows, but does not stop glacial melt (Olefs & Fischer, 2008). In the second case, agricultural firms with climate change exposure are protecting arable land with irrigation and fertilizers (Schlenker et al., 2005). However, these techniques necessarily involve consuming ecosystem services from other ecosystems, or creating pollution that perturbs them. Currently, business organizations lack the capability to protect their biophysical environments from global sources ecological change, without consuming ecosystem services from another ecosystem (Pogutz & Winn, 2009; Wackernagel & Rees, 1997).

Second, firms are powerless to stop global ecological forces, such as climate change, because they operate at different scales of energy than those generated by firms and can be spatially and temporarily removed from firms (Pogutz & Winn, 2009). There have been experiments with weather modification (cloud-seeding) that have shown some promise in releasing super-cooled precipitation from clouds in ideal conditions; however, cloud-seeding specifically affects and depends upon conditions in local stratospheres, and does not have the capacity to alter climate patterns on a larger scale (Huggins, 2006).

Finally, firms in some industries have been able to share or shift risk associated with extreme weather events with external socioeconomic actors. This type of adaptation is consistent with resource dependence adaptation strategy of using inter-organizational action (Pfeffer & Salancik, 1978). For example, offshore oil exploration companies have obtained insurance for their equipment in case of damage resulting from hurricanes and/or high seas (Hoffman, 2006). However, insurance is prohibitively expensive or unavailable to firms experiencing vulnerability associated with organizational dependence on ecosystems, because these risks are difficult or impossible to price (Scott

& McBoyle, 2007). Thus, firms vulnerable to climate change in this manner may lack the bargaining power to use these tactics.

On the other hand, it is likely that firms have the power to use one of three options to manage their climate change vulnerability by altering the use of their biophysical environments: first, they can create buffered inventories of natural capital to lower the urgency of the uncertainty they might face in accessing affected resources; second, they can develop substitutes for threatened resources by consuming other sources of natural capital and ecosystems ecosystem services; and, third, they can diversify their competencies using their biophysical environment in ways that reduce their climate change vulnerability. Firms' propensity to alter their use of their biophysical environments is based on control and economic incentives. If firms have the license to operate within a defined geographic space, they have direct control over the ecosystems that comprise it, since institutional mechanisms often cannot perfectly monitor or evaluate firms' impacts on those ecosystems (Wackernagel & Rees, 1997). According to Pfeffer and Salancik (1978), direct control of a resource is a basis for decision-making power over the allocation of that resource. Further, firms' may have economic incentives to use these ecosystems strategically if the value of those ecosystems and the services they provide to society is not reflected in their true costs to firms (Costanza & Daly, 1992; Wackernagel & Rees, 1997).

The first of these natural resource dependence management options, buffering, is consistent with the climate change adaptation type of protecting vulnerable businesses (as opposed to vulnerable ecosystem services) (Berkhout et al., 2006). Buffering necessarily involves stockpiling ecosystem services and/or the natural capital that yields them. For

example, some forestry firms are increasing their harvesting rates of forests that are in the path of bark-beetle pandemics, to stockpile commercial timber before the pandemic diminishes the value of that timber (Straussfogel, 2006). The second natural resource dependence management option, developing substitutes for threatened resources, is also consistent with the climate change adaptation type of protecting vulnerable businesses. In the ski resort industry, many firms use local sources of water in snowmaking capabilities when the climate is uncooperative. In this case, water is the ecosystem service used as the basis for making artificial snow, the substitute resource. Third, vulnerable firms might be able to diversify their competencies by developing ones that are not vulnerable to the phenomenon. This strategy is consistent with adaptations that bear and manage risks and opportunities, which can involve reconfiguring firms' resource base so that the firm is less vulnerable overall (Berkhout et al., 2006). For firms with direct biophysical vulnerability, this type of adaptation might be most economically deployed in firms' biophysical environment, since these types of firms tend to operate in renewable natural resource based industries[11] (IPCC, 2001; WTO, 2003), where the use of firms' biophysical environment is essentially the entire basis their revenue. Adaptations not involving firms' biophysical environment require developing new competencies without leveraging their most valuable resource, a difficult means of competing (Prahalad & Hamel, 1990).

Unfortunately, this constrained set of resource dependence management options for firms with climate change vulnerability might also be associated with organizational impacts on ecosystems. Consuming natural capital and ecosystem services in the context

[11] It should be noted that in the future, it is more likely that firms in a wider array of industries may become vulnerable to climate change (Hoffman et al., 2009).

of deploying buffering or resource substitution strategies can push those ecosystems closer to their carrying capacities. In addition, firms diversifying competencies within their biophysical environments can perturb the ecosystems that comprise them (Costanza & Daly, 1992; Marshall & Toffel, 2005). Both strategies can also pollute firms' biophysical environments as they are carried out. For example, climate change adaptations in the ski resort industry include increasing use of snowmaking, which consumes more water; expanding ski terrain and ski lifts to areas with high elevation and/or more northerly facing areas, which increase consumption in, and perturbs those areas; and diversifying business activities into real estate development and summer mountain tourism not only perturbs their areas, but also involves increasing the human presence and local demand for water resources (Scott & McBoyle, 2007). In light of these considerations, I predict that higher levels of *Corporate Climate Change Vulnerability* are associated with lower levels of *Biophysical Environmental Performance*.

Hypothesis 2: Corporate Climate Change Adaptive Capacity is negatively related to Biophysical Environmental Performance.

Chapter 2 also reviews the concept of *Corporate Climate Change Adaptive Capacity* as a driver of firms' climate change adaptations (Hoffman et al., 2009). The current study identifies three forms of this construct that could be negatively associated with *Biophysical Environmental Performance*: *Ownership Structure, State Environmentalism*, and *Regulator Resource Dependence*.

The firm-level characteristic of *Ownership Structure* reflects firms' abilities to access capital and make investments in environmental adaptations (Burgelman, 1991; Williamson, 1991). Public companies, in particular, tend to have closer ties to capital

markets and investment banks (Thomsen & Pedersen, 2000). This gives them more access to capital and, potentially, greater financial means to deploy climate change adaptations. At the same time, *Ownership Structure* could create resource dependence problems for firms that induce environmentally harmful adaptations from them. Shareholders can use efficient capital markets to liquidate shares if firms do not achieve expected levels of return on investment. Thus, publicly-traded firms' resource dependence on shareholders and shareholder economic power over publicly-traded firms can affect firms' profit motives, which can induce them to pursue strategies that deemphasize corporate environmental protection (Mattingly & Berman, 2006; Rivera & de Leon, 2004; Rivera et al., 2006). This includes strategies that favor economically efficient and effective climate change adaptations that are harmful to firms' biophysical environment.

Second, *State Environmentalism* reflects the normative pressures from firms' salient institutional environments that can affect firms' propensity to adapt climate change in ways that harm their biophysical environments (Bansal & Clelland, 2004; Mazur & Welch, 1999; Rivera & de Leon, 2004; Rivera et al., 2006). In the United States, normative pressure concerning corporate environmental protection tends to be geographically determined by states (Mazur & Welch, 1999; Rabe, 1997). While the National Environmental Protection Agency (NEPA) provides a federal regulatory framework to guide corporate environmental performance, states implement many environmental regulations when they demonstrate the capacity to do so. Further, states increasingly are responsible for developing their own environmental regulations to govern intrastate issues. As a result, states with citizens who have higher expectations for

environmental protection are more likely to elect governing officials who pursue more stringent implementation of federal laws, pass stricter state laws, and appoint civil servants that implement those laws with more vigor (Mazur & Welch, 1999).

State Environmentalism can also influence firms' corporate environmental performance without the mediating influence of state government (Frooman, 1999; Maur & Welch, 1999; Rivera & de Leon, 2004; Rivera et al., 2006). Social values and expectations for corporate environmental performance diffuse directly into firms, since firms are open systems that allow institutional pressures to permeate into their organizational boundaries through interactions with critical stakeholders (Clarkson, 1995; Scott, 2008). Normative pressures associated with *State Environmentalism* introduce firms to civil society's environmental values in a myriad of ways, including through the non-governmental organization (NGO) activities, the media and/or purchasing behavior (Scott, 2008). If civil values favor environmental protection within a state, NGOs can advocate for better corporate environmental performance, media outlets will be more likely to cover issues associated with it, and/or concerned consumers can inform firms with potentially illegitimate environmental performance that they expect better. On the other hand, when civil values are less favorable for environmental protection, NGOs can have less support for advocacy efforts, the media can view issues as less newsworthy, and/or consumers can care more for the economic utility created by firms than their corporate environmental performance.

Once these values enter organizations, it is likely that will have some sort of lasting influence, as organizational members reinterpret and integrate them into their organizational cultures (Nelson & Winter, 1982). Even if managers' cultural templates

for their organizations are incongruent with these incoming values, they will have to determine how to respond to them if they are sufficiently strong, since normative pressures reflect civil society's expectations for legitimate organizations, and legitimacy is a critical organizational resource (Pfeffer & Salancik, 1978; Scott, 2008). Therefore, as these pressures increase in strength, so should the likelihood that firms will conform in some way to these pressures (DiMaggio & Powell, 1983; Oliver, 1991; Rivera, 2010). Finally, since these pressures demand conformity to value systems that favor corporate environmental protection, they should diminish firms' ability to adapt to climate change in ways that create negative impacts on their biophysical environments. Given that higher levels of *State Environmentalism* reflect lower levels of *Corporate Climate Change Adaptive Capacity*, I posit that it should be positively related to *Biophysical Environmental Performance*.

Third, stakeholders' resource dependence on firms can generate firm power over those stakeholders, which can enable firms' ability to deploy adaptations that have negative biophysical environmental impacts. Firms create economic development, pay taxes, make donations to political campaigns, are philanthropists, and create organizational cultures that influence the identities of their members (Fort, 2001). As a result, each of the stakeholders deriving benefits from firms has some level of resource dependence on them. As levels of this form of dependence increases, so should firms' capacity to deploy corporate strategies that might otherwise be constrained by stakeholders influence (Pfeffer & Salancik, 1978; Frooman, 1999). In their regulatory environments, in particular, firms frequently make campaign contributions and fund public works projects, and then subsequently call in favors to influence the degree of

regulatory stringency facing them (Oliver, 1991). Further, when firms cooperate with one another to consolidate their power to advocate for an issue, as they often do in the context of political influence strategies adopted by business and industry associations, they may have the capacity to contest or shape regulatory requirements (Levy & Kolk, 2002; Levy & Egan, 2003). Therefore, *Regulator Resource Dependence* on firms might enable firms to influence the stringency of the environmental oversight facing them, giving them more flexibility to deploy business practices that create environmental impacts.

As argued above, business practices that lower *Biophysical Environmental Performance* may be the most effective way for firms to mitigate climate impacts. However, powerful stakeholders, such as regulators, might be responsible regulating *Biophysical Environmental Performance* (Rivera et al., 2010). On the other hand, if these powerful stakeholders depend upon firms for economic benefits, their resulting resource dependence on firms could induce them to soften their expectations for *Biophysical Environmental Performance*. As a result, *Regulator Resource Dependence* represents a form of *Corporate Climate Change Adaptive Capacity* that might enable adaptations, including those that create negative biophysical environmental impacts.

Hypothesis 3: Corporate Climate Change Vulnerability is positively associated with firms' Socioeconomic Environmental Performance.

Pfeffer and Salancik (1978) describe how strategies for managing one source of resource dependence can create new ones. By extension, they can create new sources of uncertainty for firms with regard to accessing critical resources that are controlled by other organizations. For example, diversification strategies can reduce firms' resource dependence associated with their existing portfolio of businesses, while creating

interdependence with other organizations in their new markets and/or stretching corporate offices' management capabilities (Ramanujam & Varadarajan, 1989). The same undesired consequences can hold true for firms managing natural resource dependence. If firms manage natural resource dependence associated with climate change vulnerability through adaptations, they might create new resource dependence problems for themselves. In particular, adaptations that lead to negative environmental impacts can subsequently lead to new resource dependence problems associated with firms' legitimacy[12] (Oliver, 1991; Pfeffer & Salancik, 1978; Suchman, 1995).

If firms' *Biophysical Environmental Performance* were to decline, concerned stakeholders could be more likely to withhold legitimacy from firms (Bansal, 2005; Bansal & Clelland, 2004; Frooman, 1999), whether or not the decline occurs in the context of climate change adaptations. Faced with this risk, firms might attempt to protect their legitimacy by mitigating their negative environmental impacts, to signal to legitimacy-conferring stakeholders that they do in fact care about the environment (Bansal & Clelland, 2004; Rivera, Oetzel, de Leon & Starik, 2009; Tashman & Rivera, 2010). In some cases, firms can do so via offsetting practices, such as purchasing carbon offsets in response to creating carbon emissions (Kotchen, 2009). Such strategies represent a form of "acquiescence" to institutional logics that define legitimate behaviors, by complying with rules or following norms that are considered legitimate business

[12] Suchman defines legitimacy as "…a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman,1995: 574). Corporate legitimacy refers to the degree to which firms behaviors are socially desirable and acceptable (Scott, 2008). According to Pfeffer and Salancik, it is a critical resource conferred to firms by their stakeholders (Pfeffer & Salancik, 1978). If firms fail to obtain legitimacy from their stakeholders, they risk alienating ones who are critical to firm performance and survival (Clarkson, 1995).

behavior by powerful legitimacy-conferring stakeholders (Oliver, 1991; Bansal & Clelland, 2004; Rivera, 2010).

When firms are vulnerable to climate change, they may decide not to acquiesce to institutional pressure by mitigating the impact of adaptations to their biophysical environments, because the adaptations themselves necessarily involve those impacts. In these cases, acquiescence might preclude firms' desired adaptations. Oliver (1991) argues that firms will tend to "avoid" rather "acquiesce" to institutional pressures when acquiescence is inconsistent with firms' strategies. Avoidance strategies include methods of "concealment," in which firms "disguise nonconformity behind a façade of acquiescence" (Oliver, 1991: 10). One method of concealment of firms' environmental impacts in the aggregate, in light of their declining levels of *Biophysical Environmental Performance*, is to adopt business practices that improve other dimensions of environmental performance that are not associated with corporate climate change adaptations. This includes developing or improving business practices associated with *Socioeconomic Environmental Performance*. Such business practices could include measures to conserve energy and reduce carbon emissions, green purchasing and sourcing, improved solid waste management and recycling, and/or the sponsoring of community-oriented sustainability initiatives. Since these practices do not involve reducing the use of ecological resources in firms' biophysical environments, they do not interfere with firms' adaptations designed to reduce their biophysical climate change vulnerability.

Interestingly, scholars have characterized many of these business practices as "beyond compliance" and elements of "proactive environmental strategies" that "good"

firms tend to do (Bansal, 2005; Hart, 1995; Rivera, 2010; Sharma & Henriques, 2005; Sharma & Vredenberg, 1998). In fact, many firms in pursuit of the ideal of being an "ecological sustainable organization" (Starik & Rand, 1995) and/or of competitive advantages that can be derived from corporate sustainability (Porter & van der Linde, 1995) implement similar measures to reduce pollution and to "green" their supply chains (Hart, 1995). In this case, however, the proposed underlying rationale for ski resorts to adopt business practices associated with better *Socioeconomic Environmental Performance* is to divert attention away from the increasing levels of harm they cause in their biophysical environments. Business practices associated with improving *Socioeconomic Environmental Performance* are often very visible to ski resorts' most important market stakeholder: skiers. Skiers can directly see efforts aimed at recycling, energy efficiency, carpooling, and community programs, and resorts are adept at promoting other measures like green sourcing via a variety of public relations and marketing channels (NSAA, 2010; Rivera et al., 2006). Ski resorts' effects on biophysical environments, however, are more difficult to observe and understand without scientific expertise. Most skiers will not perceive the impacts of snowmaking on local water tables, new terrain development of wildlife, or valley bottom condominium developments on riparian zones that no longer exist. As a result of the high visibility of *Socioeconomic Environmental Performance* versus *Biophysical Environmental Performance*, business practices associated with improving the former type might effectively help to "conceal" firms' performance in the latter type.

Hypothesis 4: Corporate Climate Change Adaptive Capacity is positively associated with firms' Socioeconomic Environmental Performance.

The logic linking *Corporate Climate Change Adaptive Capacity* and *Socioeconomic Environmental Performance* mirrors the logic underpinning Hypotheses 3. If firms' climate change adaptive capacity is linked with negative biophysical environmental impacts, by extension, it might indirectly cause concern among stakeholders who value the ecosystems comprising firms' biophysical environments. More specifically, as *Ownership Structure*, *State Environmentalism* and *Regulator Resource Dependence* facilitate more negative corporate environmental impacts in firms' biophysical environments, they should also be linked with increasing levels of environmental legitimacy problems with firms' legitimacy-conferring stakeholders, who care about the environment. These stakeholders, in turn, might deploy legitimacy-withholding influence strategies against firms (Bansal, 2005; Bansal & Clelland, 2004; Frooman, 1999). Since legitimacy is a critical resource that firms require to thrive and survive over the long-term, legitimacy protection and maintenance are strategic issues for firms (Oliver, 1991; Pfeffer & Salancik, 1978; Suchman, 1995). Thus, firms facing environmental legitimacy problems (Bansal & Clelland, 2004) are more likely to take steps that address the concerns of the salient stakeholders in these cases. Sometimes firms respond to environmental legitimacy problems with "acquiescence" strategies (Oliver, 1991), involving direct mitigation or offsetting of environmental impacts (Kotchen, 2009). However, firms experiencing biophysical vulnerability to climate change may rely on business practices that create negative biophysical environmental impacts in the course of climate change adaptations. Accordingly, these firms should be more inclined to strategically manage their legitimacy problems. In these cases, Oliver (1991) observes

that firms tend to pursue “concealment” strategies. One method of concealment involves improving other dimensions of environmental performance that are not directly involved with firms’ climate change adaptations. The socioeconomic domain of environmental performance contains many such dimensions. In the cases of *Ownership Structure* and *Regulator Resource Dependence*, I posit that *Corporate Climate Change Adaptive Capacity* is positively associated with firms’ *Socioeconomic Environmental Performance*. Given that *State Environmentalism* is a reverse indicator of *Corporate Climate Change Adaptive Capacity*, this measure should be negatively related to *Biophysical Environmental Performance*.

CHAPTER 5. METHODS

5.1 Population, Sample, and Sources of Data

5.11 Population

The population used for the study is the U.S. ski resort industry. There are several reasons for using this population to study corporate climate change adaptation. First, the ski industry, broadly, serves a significant sub-segment of the global tourism market, which accounts for approximately 10% of global trade, is growing rapidly and is already the largest industry earner of foreign exchange globally (Eilat & Einav, 2004). Further, the global tourism industry is dependent upon climate. Sun and warmth are essential to beach-related destinations, as is wind for sailing, waves for surfing, and snow for skiing. Thus, climate change creates risks and opportunities for the entire industry by making some locations more or less desirable over time (Hamilton, Maddison & Tol, 2005). Second, the winter tourism segment has been specifically identified as acutely vulnerable to climate change, since by and large climate change implies warmer weather that is incongruent with the core products and services in this set of industries (IPCC, 2001; Scott, 2003; Scott & McBoyle, 2007). Third, the ski resort industry in particular has demonstrated measurable climate change vulnerability. Further, firms within the industry have been implementing adaptations, such as snow-making, or expanding into invulnerable businesses for decades (Hoffmann et al., 2009; Scott et al., 2003). Given the importance of the tourism industry to the global economy and its potential to be influenced by climate change, studying climate change adaptations in a segment of the industry that has measurable experience with the phenomena should provide early evidence for the sector at large. Many tourism-based industries, including the ski resort

industry, depend on their biophysical environments for ecosystem services[13] (Costanza et al., 1997; Scott, 2003). Therefore, studying these phenomena within this population may generalize to other industries, such as agriculture, forestry, or renewable energy industries, that have biophysical climate change vulnerability and natural resource dependence.

5.12 Sample

The sample is restricted to ski resorts in the western U.S., specifically in Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming (NSAA, 2008). The basis for this sampling restriction is the availability of corporate environmental performance data. At the time of the study, the only comprehensive, publicly available ski resort environmental performance database was developed by the Ski Area Citizens Coalition (SACC), an NGO that has monitored ski resort development in this region since 2001. Given the difficulties in obtaining comprehensive environmental performance data for the ski resort industry (Rivera & de Leon, 2004; Rivera et al., 2006), using the SACC database was the best possibility for facilitating the current study. Following Rivera and de Leon (2004) and Rivera and colleagues (2006), I did attempt to collect alternative environmental performance data from the National Ski Area Association (NSAA), which maintains a database of surveyed measures similar to the SACC database. It collects this data in conjunction with the Sustainable Slopes Program. However, the NSAA was unwilling to respond to my requests to gain access to this data.

[13] Costanza and colleagues. (1997) identify tourism as an ecosystem service provided by the natural environment.

Using the SACC database, I was able to initially identify an unbalanced panel of 83 ski resorts in the U.S. for the period between 2001 and 2009, respectively, for which environmental performance data were available. Out of these 83 firms, climatic data used for constructing the measure of *Corporate Climate Change Vulnerability* were available for 76 firms. As I describe in the next section, I used archived NWS cooperative weather station readings from the years 2000-2009[14] to construct the measure. These restrictions yielded the final data set, which consists of an unbalanced panel of 76 ski resorts and 612 firm-year observations, for an average of 8.1 observations per ski resort. The geographic distribution of ski resorts across western U.S. states is shown in Table 1.

TABLE 1. Geographic Distribution of Ski Resorts across U.S. States

State	Number of Ski Resorts in Sample	Number of Ski Resorts in the State
Arizona	1	4
California	18	29
Colorado	20	28
Idaho	5	16
Montana	7	17
Nevada	1	5
New Mexico	4	10
Oregon	2	13
Utah	9	14
Washington	7	16
Wyoming	2	8
Total	76	162

5.13 Data Collection

The data for this study include firm-level environmental performance and climatic data, and other firm-, market-, and institutional-level factors that might have effects on

[14] I matched weather stations to ski resorts if they were within 10 miles of the resort and if they were at least 500 vertical feet above the base of the ski resort.

environmental performance. As indicated above, I measured the dependent variables, *Biophysical Environmental Performance* and *Socioeconomic Environmental Performance* using ratings from the SACC database. These ratings are a unique data source for environmental performance of the industry at large, and have been used in previous studies involving ski resort environmental performance (e.g. Rivera & de Leon, 2004; Rivera et al., 2006). Appendix One provides a description of these ratings. The ratings are based on the occurrence of ski resort business practices that affect environmental performance. For example, ski resorts that expand their operating area footprints in a given year will receive a lower score in the category of *Maintaining Ski Resort within Existing Footprint*. The SACC develops its rating from mixed sources and methods of data collection. Archival sources include government documents from federal agencies, such as the U.S. Forest Service and the U.S. Fish and Wildlife Service, websites and corporate reports produced by ski resorts, media reports, business press and trade journals. In addition, they administer a survey annually to the ski resorts that they rate[15]. The SACC sample comprises only approximately 49% of the ski resorts in the western U.S. (in 2009 there were 168 ski resorts operating in the western U.S.), implying that its coverage is substantial within this region of the U.S. It should be noted that the NSAA has called the SACC scorecard "an unaudited, inherently flawed, and biased measure of environmental performance" (Dorsy, 2004:11; in Rivera et. al, 2006). A particular criticism stems from the SACC's emphasis on real estate development and penalizing ski areas for not responding to their surveys (Dorsey, 2004). However, the cognitive biases that may be inherent in this database are not uncommon in the collection of environmental performance data. Further, the integrity of "hard" accounting and

[15] Source: http://www.skiareacitizens.com/index.php?nav=how_we_grade. Access date: October 11, 2009.

financial measures might also be subject to the same biases, and have been shown on occasion to be fallible, as evidenced by the rash of high profile frauds and scandals involving these instruments during the past decade (Rivera et al., 2006; Waddock, 2003).

I collected climate data used to measure *Corporate Climate Change Vulnerability* from the National Climatic Data Center (NCDC), a division of the National Oceanographic and Atmospheric Association (NOAA) responsible for archiving NOAA data sources. They include longitudinal climatic data measured through the National Weather Service (NWS) cooperative weather station network. The network contains 18,000 weather stations located within the United States. Some of the weather stations in the network have been operational since the 1880s[16].

I collected data for measures of *Corporate Climate Change Adaptive Capacity* from several sources. These measures included proxies for ski resorts' *Ownership Structure*, *State Environmentalism*, and firms' *Regulator Resource Dependence*. To measure ski resorts' *Ownership Structure*, I first determined whether ski resorts were subsidiaries of larger parent companies. The SACC[17] website contains a list of parent companies and ski resorts that they own. I also looked at individual ski resort webpages to corroborate the SACC list. Second, I researched press releases from the parent companies to determine when they acquired the ski resort and recorded changes of ownership during the current study's sampling history. Finally, I matched each parent company name and year or non-parent-owned ski resort name and year, with records from the Compustat database of public-owned companies.

[16] Source: http://www.ncdc.noaa.gov/oa/climate/climatedata.html#monthly. Accessed February 25, 2010.
[17] Source: http://www.skiareacitizens.com/index.php?nav=ownership. Accessed February 28, 2010.

To measure *State Environmentalism*, I obtained state membership data from the national chapter of the Sierra Club for each of the years in the sampling history (2001-2009). The Sierra Club is the largest environmental NGO in the U.S., making its state-level membership concentration a good proxy for the degree to which civil society is engaged in state-level environmental activism (Fremeth & Holburn, 2010). I also obtained the League of Conservation Voter (LCV) House of Representatives and Senate scorecards for each state in the sample over the sampling history[18]. The LCV is a non-profit organization that advocates for federal and state environmental protection policies. In addition, each year they rate congressional delegations from each state on their support of environmental protection policies, by percentage of votes in favor of such policies. While LCV ratings measure states' propensity to elect environmentally conscious officials for federal rather than state legislative offices, the ratings were highly correlated with other indicators of *State Environmentalism* (Mazur & Welch, 1999).

To measure firms' *Regulator Resource Dependence*, I collected data from the U.S. Forest Service through a Freedom of Information Act (FOIA) request, measuring the contribution of ski resorts to regional Forest Service districts' annual operating budgets. 71 of the76 ski resorts in the sample operate on publicly-owned land administered by the U.S. Forest Service. Under the U.S. National Forest Ski Area Permit Act of 1986, each of these resorts is required to obtain a special use permit from the individual forest service district office that governs the district where the ski resort operates (16USC§497c, 1986). In addition, under this same Congressional act, each ski resort is required to pay a user fee of 1.5 to 4.0 percent of their adjusted gross revenue to their respective forest service

[18] Source: http://www.lcv.org/scorecard. Access date: February 16, 2010

district office each year[19]. To assess the relative economic importance of the ski industry within each of the districts, I requested the budgetary figures for the total number of ski resort special use permit fees collected by each Forest Service district for each year in my sample, and the total expenses for each of these districts for each year over the same time span, via a Freedom of Information Act request.

I generated some control variable measures using geospatial analysis (more commonly known as geographical information system analysis) using the ESRI (Environmental Systems Research Institute) ArcMap 9.2.1 software suite in conjunction with data collected from the U.S Census Department and the National Operational Hydrologic Remote Sensing Center (NOHRSC). The census department provided census tract data, which I used to generate measures of the local market size for each ski area[20]. In addition, they provided data regarding the location of U.S. national parks and U.S. airports with jet service[21], which I used to generate proxy measures for the ski resort's desirability as a summer tourism location and destination tourism location respectively. The NOHRSC provided data regarding the location of U.S. ski resorts[22], which I used to calculate the competitive intensity of the industry in each resort's local market. I collected data used for developing other control variables from ski resort corporate websites, National Forest Service web pages, the NEPA web pages, and the NSAA web pages. The descriptions of these data sources and the control variable measures constructed from them are in *Section 5.23 Control Variables*.

[19] The marginal rate of this fee increases progressively with revenue. The 1.5 percent rate applies to revenues below $3,000,000. Revenues between $3,000,000 and $15,000,000 incur fees of 2.5 percent. Revenues of between $15,000,000 and $50,000,000 incur fees of 2.75 percent. Revenues over $50,000,000 incur fee of 4.0 percent.
[20] Source: http://www.census.gov/popest/states/NST-ann-est.html. Access date: July 27, 2010
[21] Source: http://www.census.gov/geo/landview/. Access date: July 27, 2010
[22] Source: http://www.nohrsc.noaa.gov/gisdatasets/. Access data July 27, 2010

5.2 Measures

5.21 Dependent Variables

Biophysical Environmental Performance. I developed a standardized score from the sum of SACC ratings associated with environmental performance confined to ski resorts' biophysical environments to measure this construct. These ratings included: (i) maintenance of existing areas within the existing footprint; (ii) preservation of undisturbed lands from development; (iii) protection or maintenance of threatened and endangered species and their habitats; (iv) preservation of environmentally sensitive areas; (v) avoiding new snowmaking; and, (vi) protection of water quality (See Appendix One). To build standardized scores, I first summed the ratings for each firm-year observation. Second, I standardized the summed scores based on the average and standard deviation of scores across firms for that year. This procedure was necessary, because the SACC ratings scale did change from year to year, from time to time[23].

Socioeconomic Environmental Performance. I also standardized the summed scores of ratings associated with *Socioeconomic Environmental Performance* to measure this construct. The included ratings were: (i) use of renewable energy; (ii) water energy and energy efficiency; (iii) employee and guest transportation programs; (iv) waste stream management; (v) purchasing; and (vi) community sustainability (see Appendix One).

[23] This procedure was proposed and used by Mattingly and Berman (2006) and Tashman and Rivera (2010) in their treatment of multi-year corporate social performance data from Kinder, Lydenberg and Domani database, where ratings needed to be aggregated into categories and standardized within years because of intra-year variation in the ratings associated with those categories.

5.22 Independent Variables

Corporate Climate Change Vulnerability. Corporate Climate Change Vulnerability was defined earlier as the joint pressures of corporate climate change exposure and corporate climate change sensitivity. To capture this effect, I created an interaction term from two separately constructed measures of *Corporate Climate Change Exposure* and *Corporate Climate Change Sensitivity*. I measured the first-order terms as follows:

1. *Corporate Climate Change Exposure.* Following several winter climate change studies in both the natural[24] and social sciences[25], I measured climate change exposure at ski resorts as the annual change in average depth of winter snowpack, in inches. Snowpack depth has the desirable property of being functionally dependent on many important climate indicators, such as temperature, humidity, precipitation type, precipitation intensity, exposure to sun, exposure to wind, and snow water equivalent (McClung & Shaerer, 1993). Thus, changes in winter snowpack depths reflect changes in winter climate indicators broadly. NWS weather stations used in this study measure snowpack depths each hour. I collected the hourly readings for each day between October 1 and April 15 of the following year, the timeframe when mountain regions typically build and maintain snowpack (Hauer et al., 1997; McClung & Shaerer, 1993). I then averaged these hourly measurements for each ski season to calculate the average annual depth of winter snowpack for each firm-year. From these figures, I calculated the annual change in average depths of winter snowpack across years. This procedure yields a linear, time-invariant measure for each firm. I then grand-mean centered the metric to improve

[24] See for example Band, MacKay, Creed, Semkin and Jeffries (1996), Hauer, Baron, Campbell, Fausch, Hofstettler, Leavesly, Leavitt, Mcknight, and Stanford (1997) and Taylor (1995).
[25] See for example Scott and McBoyle (2007) and Scott and colleagues (2003).

the interpretability of regression coefficients associated with it and reduce its potential for being collinear with the other first-order term comprising common the interaction term (Aiken & West, 1991). Finally, I reverse-coded the grand-mean centered measure by multiplying it by -1, since negative annual growth rates in the average winter snowpack depths at ski resorts reflect increasing levels of climate change exposure, and vice-versa.

2. *Corporate Climate Change Sensitivity.* Since corporate climate change sensitivity reflects the potential of firms' business model to be affected by climate change (Hoffman et al., 2009; Smit et al., 2000), it captures the degree to which firms can withstand the geophysical impacts of the phenomenon. To capture this effect, I calculated a measure of the average winter snowpack across time for each firm. Average winter snowpack depth represents the degree to which ski resorts are buffered from climate change sensitivity, since snow on the ground is the critical ecosystem service that is sensitive to climate change, and greater amounts of snow on the average represent greater inventories of this resource. As average annual winter snowpacks deepen, so does the length of time in years that ski resorts can withstand any level of climate change exposure. Since deeper average annual winter snowpack depths reflect lower levels of corporate climate change sensitivity, I transformed the measure by taking its inverse, so lower levels of the transformed measure would reflect deeper average annual snowpack depths[26]. Finally, I grand-mean centered the measure to reduce its potential for being collinear with other first-order terms comprising common interaction terms (Aiken & West, 1991).

[26] Prior to using this transformation, I chose to reverse-code the measure by multiplying it by -1. However, this measure was highly-correlated to the *Exposure* and *Vulnerability* measures. The inverse-transformed Sensitivity measure mitigated some of this multicollinearity.

It is important to reaffirm that each of the first-order terms and the resultant joint-effect is time-invariant. On the surface, it may seem counter intuitive to use a time-invariant measure to reflect a construct that is associated with change, such as *Corporate Climate Change Vulnerability*. Still, the component reflecting *Exposure* does capture an average rate of change over time in firms' snowpack depths. In addition, time-invariant rates of change capture broad trends that are likely more salient to managers that must make decisions about climate change adaptations in this context. Ski resort adaptations typically involve long-term and capital intensive investments in capabilities such as snowmaking or strategies such as terrain expansion, real estate development, retail and summer recreation operations. Thus, resorts' strategic planners must consider long-term climate trends when considering these decisions. Year to year climate variation likely will not correlate directly to these decisions, and the environmental impacts that result from them. Year to year climate forecasts involve a great deal of uncertainty and inaccuracy, and are themselves dependent upon many other factors that are endogenous to global atmospheric conditions. Further, favorable climate values in one year are often embedded in unfavorable long-term climate trends (IPCC, 2001). While the time-invariant measure used in this study may appear crude, since it is based on average climate values and rates of change of climate values, it does inherently capture the long-term trends associated with firms' *Exposure* and *Sensitivity*. Further, given the uncertainty associated with long-term climate forecasts, time-invariant measures may be as accurate planning tools as more complicated models that are capable of making equally inaccurate, albeit nuanced, predictions (Tashman & Tashman, 1993).

Corporate Climate Change Adaptive Capacity. I developed three measures of *Corporate Climate Change Adaptive Capacity*. These measures reflect firm-level and interorganizational forms of the construct that involve resource dependence on stakeholders who could exert influence over corporate environmental performance. *Ownership Structure* reflects both firms' access to financial capital that could be used towards climate change adaptations, as well as firms' resource dependence on shareholders that expect high returns on investment. *State Environmentalism* reflects the degree of strength of environmental activism within a state for corporate environmental responsibility. Firms' *Regulator Resource Dependence* reflects the degree of resource dependence that regulatory stakeholders have on firms.

1. *Ownership Structure.* This is a dummy variable. A value of 1 indicates that the ski resort is publicly owned or owned by a public corporation, whereas a value of 0 indicates that it is either privately owned or a non-profit organization.

2. *State Environmentalism.* To measure this construct, I calculated the Sierra Club membership per one thousand people in each state-year. For alternative measures, I also used the LCV House of Representative and Senate Scorecards for environmentally proactive congressional voting for each state-year. I used the latter measures in separate analyses to perform reliability checks of the Sierra Club-based measure.

3. *Regulator Resource Dependence.* To measure this construct, I calculated the ratio of annual ski resort special use permitting fees collected by each forest service district to the total annual expenses for those districts. This figure is intended to reflect the relative importance of the ski industry in each of the districts where these ski resorts operate. The advent of the *National Forest Ski Area Permit Act* in 1986 and its special use permit user

fee system coincides with decreasing levels of Congressional appropriations to each forest service district and the decline of the commercial forestry industry in many forest districts in the U.S. (Clifford, 2002). Thus, revenues generated from ski resorts have taken on increasing levels of importance for individual forest district offices, whereas, at the same time, ski resorts have become more important drivers of economic development within the communities that reside in these districts (Gorte, 2000). Critics of the forest service's relationship with the ski industry have argued that some forest service districts that are dependent on the ski industry have promoted ski resort development on forest service lands in spite of environmental impacts. In addition, some have claimed that district offices have, on occasion, intervened in processes typically governed by the NEPA[27] with regard to approving ski resort development applications.

5.23 Control Variables

Several firm-level and industry environment characteristics might be associated with ski resort environmental performance and are therefore included in the analyses as statistical controls.

- At the firm level, Rivera and colleagues (2006) found *Membership in the Sustainable Slopes Program*to be positively associated with some natural resource conservation measures.
- A ski resort's *Size* might influence environmental performance (Rivera & de Leon, 2004; Rivera et al., 2006), since ski resorts with more terrain have more extensive

[27]42USC§4332, section 42 (1969), of the National Environmental Protection Act, requires the preparation of an environmental impact statement (EIS) for all federal actions that could significantly threaten social and/or environmental values.

and potentially more complex environmental issues to manage (Clifford, 2002). *Size* was measured in 1000s of acres for each firm-year by reviewing current ski resort websites, researching any ski resort expansions reflected in NEPA Environmental Impact Statements (EIS)[28] between 2001 and 2009, and subtracting the size in acres of expansion areas from the ski resort size in that year.

- *Age* (in years) might contribute to a ski resort's experience and thereby capability for managing environmental issues.
- Ski resorts operating on *Public Land* might receive stricter environmental oversight (Rivera et al., 2006; Clifford, 2002; Briggs, 2000). To capture this effect, I include dummy variables to measure if the ski resort's terrain is located on *Public Land*, *Private Land* or a combination of both in any given year (the reference group includes ski resorts operating on both public and private land).
- Some ski resorts are owned by horizontally integrated skiing companies. Such companies might be less vulnerable to climate change in the aggregate since they have diversified their vulnerability across different ski resorts (Scott & McBoyle, 2007). On the other hand, some civil organizations have argued that horizontally integrated ski resort companies tend to engage in more terrain expansion and real estate development, both of which are practices that can have negative implications for *Biophysical Environmental Performance* (Clifford, 2002; SACC, 2008). To capture this effect, I included a dummy variable called *Group*, which indicates whether or not the ski resort was part of one in any given year.

[28] U.S. ski resorts are regulated at the federal level by EPA (Clifford, 2002; National Forest Ski Area Permit Act, 1986). If they wish to expand their ski area footprints, they must receive approval from the EPA.

In a ski resort's industry environment, several characteristics could affect corporate strategy formulation and implementation in ways that have implications for environmental performance.

- *Distance to Airports with Jet Service* indicates ease of travel to the ski resort for destination travelers with demand for lodging and real estate services.
- *Population Density within a 75 Mile Radius* (Logged) indicates the size of the local skiing market, which might be positively associated with *Biophysical Environmental Performance*, since local skiers require less lodging and real estate development. I natural log-transformed this measure, because some ski resorts were in the neighborhood of Seattle or Los Angeles, making the highest values of the unlogged measure skewed towards the right side of the distribution. I also calculated logged population densities within 50 and 100 mile radii to be used in robustness checks for the validity of this measure (in each case, the results were similar).
- *Ski Resorts within a 75 Mile Radius* indicates both the competitive intensity of the regional skiing market and a differentiating attribute for destination skiers who might prefer ski resort variety. I also calculated the number of competitors within 50- and 100-mile radii to be used in robustness checks for the validity of this measure (in each case, the results were similar).
- *National Parks within a 75 Mile Radius* indicates the desirability of ski resorts as tourism destinations in the summer. Proximity to national parks attracts summer travelers to local service businesses since the parks tend to be pastimes of intra-American tourism. I also calculated the number of national parks within 50- and 100-mile radii to be used in robustness checks for the validity of this measure (in each case, the results were similar).

5.3 Methodology[29]

5.31 Statistical Procedure – Panel Corrected Standard Errors (PCSE)

Since the sample contains multiple yearly observations for each ski resort, it is effectively a pooled-time series or panel data set (Johnson, 1995). Panel data are potentially problematic for standard regression procedures involving continuous dependent variables, such as ordinary least squares (OLS), because they often violate one or more of the assumptions of normality. The problem of serial correlation will arise if within-firm observations are correlated over time, violating the OLS assumption of independent errors. This problem is often called intra-panel serial correlation. In addition, the error variances might not be homogeneously distributed across firms, violating the assumption of homoscedasticity. To determine whether these violations of the assumptions of normality were present, I first conducted ordinary least squares (OLS) regressions for each model. Second, I tested for intra-panel serial following procedures outlined by Wooldridge (2002) and Drukker (2003), by calculating a Wooldridge F-test (I used Stata's *xtserial* post-estimation procedure to calculate this statistic). In this test the null hypothesis is within-panel independence. To assess whether heteroscedasticity was present in each model, I conducted Breusch-Pagen χ^2 test for heteroscedasticity (using Stata's *hettest* post-estimation procedure). In this test the null hypothesis is homoscedastic error variances.

If the model errors violated either OLS assumption, I implemented panel-corrected standard errors regression (PCSE) (using Stata's *xtpcse* procedure). This procedure has options to perform single or double transformations to the data, to correct for serial correlation and/or heteroskedasticity, a procedure suggested by Kmenta (1986).

[29]All analyses were conducted with statistical estimation software Stata SE 10.0.

PCSE regression has been used extensively in the management sciences by researchers with panel data, and has appeared in numerous articles in high ranking management journals (e.g. Banker, Field, Schroeder & Sinha, 1996; Berman, Wicks, Kotha & Jones, 1999; Ethiraj, Kale, Krishnan & Singh, 2005; Gimeno, 1999; He & Heli, 2009; Miller & Shamsie, 2001; Yu, Subramanium & Cannella, 2009). Management scholars have used other analytical options for panel data including using fixed and random effects regression (Johnson, 1995), or feasible generalized least squares (FGLS) regression (Beck & Katz, 1995). Fixed effects regression, while advantageous because of its statistical control of unobserved effects associated with cross-sectional units, was inappropriate for this study because it precludes the use of time-invariant independent variables of interest, such the climate change metrics of this study. FGLS was inappropriate because the panel in the current study consists of a large number of cross-sections and small number of time-periods. Via Monte Carlo simulations, Beck and Katz (1995) showed, in these cases, that this procedure often led to significant Type I errors. In comparison, they found that PCSE regression produced accurate and efficient estimations in simulations of the same models and data. Finally, random effects regression uses the Generalized Least Squares (GLS) procedure to estimate models with a randomly varying error-term for each cross-sectional unit. Thus, the procedure requires estimating an additional parameter estimate beyond the set estimated by each of the other regression procedures described here, including OLS. Random effects specifications can be problematic because they assume that the cross-section-specific error term varies randomly, and is therefore uncorrelated with the independent variables. Further, the procedure assumes a normal distribution for the randomly-varying error term (Greene,

2000). If these assumptions do not hold, the procedure can produce biased estimates (Johnson, 1995). Typically, one can test for the existence of random effects by specifying models with both random-cross-sectional-effects and fixed-cross-sectional-effects, and then conducting a Hausman χ^2 test. This test indicates whether the cross-sectional effect is correlated with the independent variables. A significant test indicates that such correlation does exist, and that the assumptions of random effects have not been met. Unfortunately, I was precluded from using this procedure, because fixed effects regression jettisons time-invariant independent variables of interest from the model, such as the climate measures used in the current study. Thus, I could not use the fixed effects procedure to estimate one of the necessary comparison models for the Hausman χ^2 test.

Given the availability of statistical procedures, I chose PCSE regression as the primary analytical technique. I attempted to corroborate the results of this procedure using OLS robust standard errors when heteroskedasticity was present, clustered standard errors when serial correlation within panels was present, and both standard error adjustments when both conditions were present. I also attempted to corroborate the results from the PCSE regressions using random effects regression. To see if the assumptions of normality and independence of the random effect held in these specifications, I post-predicted the random effect, tested them for normality using the Shapiro-Wilk W test, and then calculated the correlations between the effect and the independent variables. Significant W tests would indicate that random effects were non-normally distributed; significant correlations between the effect and independent variables would indicate that the independence assumption was untenable.

5.32 Model Specification for Biophysical Environmental Performance

Biophysical environmental performance, in tests of Hypotheses 1 and 2, was estimated using the following regression model using PCSE regression:

$$Y_{it} = \beta_0 + \beta_1 X1_i + \beta_2 X2_i + \beta_3 X1_i X2_i + \beta_4 X3_{it} + \beta_5 X4_{it} + \beta_6 X5_{it} + \beta_n C_{it} + U_{it} \qquad (1)$$

where:

Y_{it} = predicted *Biophysical Environmental Performance* for ski resort i year t,

β_0 = the intercept (estimated grand mean) of Y_{it},

β_1 = the direct effect of $X1_i$ on Y_{it},

$X1_i$ = climate change exposure, ski resort i[30],

β_2 = the direct effect of $X2_i$ on Y_{it},

$X2_i$ = climate change sensitivity, ski resort i[31],

β_3 = the joint effect of $X1_i$ and $X2_i$ on Y_{it},

β_4 = the direct effect of $X3_{it}$ on Y_{it},

$X3_{it}$ = *Ownership Structure*, ski resort i year t,

β_5 = the direct effect of $X4_{it}$ on Y_{it},

$X4_{it}$ = *State Environmentalism*, ski resort i year t,

β_6 = the direct effect of $X5_{it}$ on Y_{it},

$X5_{it}$ = *Regulator Resource Dependence*, ski resort i year t,

β_n = the direct effects of the C_{it} on Y_{it},

C_i = vector of control variables for ski resort i year t,

[30] Even though the focus of this test is the effect of $X1_{it}X2_{it}$ on Y_{it}, I still chose to model the direct effects of climate change exposure and sensitivity independently ($X1_{it}$ and $X2_{it}$ respectively) since it is possible that both factors can still have unique effects on the dependent variable event when the joint effect is in play. According to Kmenta (1986), the only justification for omitting lower order terms from regression equations that include interaction effects is when there is a theoretical rationale for assuming that the lower order terms should be 0.

[31] Same as footnote 28.

U_{it} = the unique error contributed by ski resort i year t to β_0, after implementing the PCSE procedure.

For Hypothesis 1 (*Corporate Climate Change Vulnerability is negatively related to the Biophysical Environmental Performance*), I tested H_a: $\beta_3<0$ in equation (1).

For Hypothesis 2 (*Corporate Climate Change Adaptive Capacity is negatively related to the Biophysical Environmental Performance*), I conducted three separate tests. First, H_a: $\beta_4<0$ in equation (1) tests whether *Ownership Structure* is negatively related to *Biophysical Environmental Performance*. Second, H_a: $\beta_5>0$ in equation (1) tests whether *State Environmentalism* is positively related to *Biophysical Environmental Performance*. As described in Chapter 2, Section 4.2, this construct is a reverse indicator of *Corporate Climate Change Adaptive Capacity*, implying that it should have the opposite relationship with the dependent variable that adaptive capacity has. Third, H_a: $\beta_6<0$ in equation (1) tests whether *Regulator Resource Dependence* is negatively related to *Biophysical Environmental Performance*.

5.33 Model Specifications for Socioeconomic Environmental Performance

Socioeconomic Environmental Performance, in tests of Hypotheses 3 and 4, was estimated using the following regression model using PCSE regression:

$$Y_{it} = \beta_0 + \beta_1 X1_i + \beta_2 X2_i + \beta_3 X1_i X2_i + \beta_4 X3_{it} + \beta_5 X4_{it} + \beta_6 X5_{it} + \beta_n C_{it} + U_{it} \qquad (2)$$

where:

Y_{it} = predicted *Socioeconomic Environmental Performance* for ski resort i year t,

β_0 = the intercept (estimated grand mean) of Y_{it},

β_1 = the direct effect of $X1_i$ on Y_{it},

$X1_i$ = climate change exposure, ski resort i[32],

β_2 = the direct effect of $X2_i$ on Y_{it},

$X2_i$ = climate change sensitivity, ski resort i[33],

β_3 = the joint effect of $X1_i$ and $X2_i$ on Y_{it},

β_4 = the direct effect of $X3_{it}$ on Y_{it},

$X3_{it}$ = *Ownership Structure,* ski resort i year t,

β_5 = the direct effect of $X4_{it}$ on Y_{it},

$X4_{it}$ = *State Environmentalism,* ski resort i year t,

β_6 = the direct effect of $X5_{it}$ on Y_{it},

$X5_{it}$ = *Regulator Resource Dependence,* ski resort i year t,

β_n = the direct effects of the C_{it} on Y_{it},

C_i = vector of control variables for ski resort i year t,

U_{it} = the unique error contributed by ski resort i year t to β_0, after implementing the PCSE procedure.

For Hypothesis 3 (*Corporate Climate Change Vulnerability is positively related to Socioeconomic Environmental Performance*), I tested H_a: $\beta_3>0$ in equation (2). For Hypothesis 4 (*Corporate Climate Change Adaptive Capacity is positively associated with the Socioeconomic Environmental Performance*), I conducted three separate tests. First, H_a: $\beta_4>0$ in equation (2) tests whether *Ownership Structure* is positively related to *Socioeconomic Environmental Performance*. Second, H_a: $\beta_5<0$ in equation (2) tests whether *State Environmentalism* is negatively related to *Socioeconomic Environmental Performance*. As described in Chapter 2, Section 4.2, this construct is a reverse indicator

[32] Same as footnote 28.
[33] Same as footnote 28.

of *Corporate Climate Change Adaptive Capacity*, implying that it should have the opposite relationship with the dependent variable that adaptive capacity has. Third, H_a: $\beta_6>0$ in equation (2) tests whether *Regulator Resource Dependence* is positively related to *Socioeconomic Environmental Performance*.

5.34 Regression Procedures to Corroborate Results from PCSE Regression

As mentioned briefly above, I also specified each of the models using both OLS regression and random effects regression. For the OLS regression models, I chose the robust standard errors option when Breusch-Pagen χ^2 tests indicated that heteroscedasticity was present and/or the clustered standard errors option when the Wooldridge F-test indicated that panel specific serial correlation was present in the models. For random effects regression models, I estimated new regression models using the GLS procedure that included the term a_i, which represents the additional parameter for the randomly varying error term for each cross-sectional unit. Thus, the random effects regression model equations are equivalent to the PCSE and OLS equations (1), (2) and (3), except that they also each include the parameter a_i. As indicated above, this procedure assumes a_i: $N(0,\sigma^2)$ and that a_i is uncorrelated with the independent variables (Greene, 2003). To see if the models' estimates met these assumptions, I post-predicted the parameter a_i, conducted a Shapiro-Wilk test on it (H_o: a_i:(N, σ^2)) to assess whether the normality criterion had been satisfied, and I examined the correlation between a_i and the independent variables to assess whether the independence criterion had been satisfied. These results and their interpretations are in Appendix Two.

CHAPTER 6. RESULTS

6.1 Descriptive Statistics

Table 2 contains descriptive statistics for the sample and provides a general picture of the characteristics of the sampled ski resorts. The dependent variables, *Biophysical Environmental Performance* and *Socioeconomic Environmental Performance*, have mean standardized scores near, but not exactly equal to, 0. Similarly, the standard deviations of these scores are near 1. These numbers are appropriate, since the measures were standardized. As mentioned above, this involves centering the scores within a time period, and then normalizing them by dividing them by their within time period standard deviation. This method of standardization produces scores that are close to, but not necessarily exactly, normally distributed with a mean of 0.

In describing the independent variables, I will begin with the first-order components of *Corporate Climate Change Vulnerability*, which are *Exposure* and *Sensitivity*. The mean of *Exposure*[34] indicates that, on average, ski resorts in the sample were losing 0.98 inches of snowpack depth each winter. The standard deviation (2.71 inches/year) and range (-11.34 inches/year to 7.77 inches/year) of this measure suggest its significant heterogeneity in the sample. The mean of *Sensitivity*[35] indicates that, on the average, sampled ski resorts have 38.68 inches of snowpack depth during the winter months. Its standard deviation (22.99 inches) indicates an absence of kurtosis; however, its range (0.94 inches to 112.15 inches) suggests that resorts had a wide range of average annual snowpack depths, from nearly no natural snow to nine feet of natural snow on the average. *Vulnerability* is a non-linear term and therefore is not interpretable without

[34] Non reverse-coded measures were used to calculate descriptive statistics to aid in interpretation.
[35] Same as footnote 34.

holding one of the first-order terms constant. However, its mean (-11.11 inches^2/year) indicates that, on the average, firms in the sample did have declining rates of change of average annual winter snowpack depth, since the reverse-coded *Sensitivity* measure is always negative, and declining rates of change of average annual winter snowpack depth are reflected in positive scores of *Exposure*. In addition, its standard deviation (97.42 inches^2/year) and range (-727.52 inches^2/year to 137.88 inches^2/year) suggest substantial heterogeneity in the measure. The mean of the dichotomous variable *Public Company* suggests that approximately 13% of sample ski resorts were publicly-owned. The mean of *State Environmentalism* indicates that there are approximately 3.54 people per thousand people per state who are members of the Sierra Club. The standard deviation of the measure (1.21 people per thousand people per state) suggests that it does not suffer from kurtosis. The mean of the final independent variable of interest (*Regulator Resource Dependence*) indicates that, on the average, ski resort special use permit fees comprise approximately 11% of a forest service district office's annual budget. Its standard deviation (23%) and range (0% to 96%) do indicate significant heterogeneity in this measure of firms' *Regulator Resource Dependence*.

Finally, the descriptive statistics of the control variables help to illustrate the general characteristics of ski resorts in the sample. The mean of *Sustainable Slopes Program Membership* (0.86) indicates that approximately 86 percent of program members participated in the voluntary environmental program. The mean of *Size* (1.63) indicates that the average size in acres of sampled ski resorts is approximately 1,630 acres. The smallest ski resort in the sample contained about 140 acres, while the largest resorts contained about 5,290 acres. The mean of *Age* (48.37) indicates that, on the

average, ski resorts in the sample have been operating for approximately 48 years. The youngest ski resort had been operating for 6 years, while the oldest resort had been operating for 73 years. Approximately 67 percent of the sample operated exclusively on *Public Land*, while approximately 10 percent of the sample operated only on *Private Land*. By implication, approximately 23 percent of the sample operated on a combination of publicly and privately-owned land. The mean of *Group* indicates that approximately 43 percent of the sample was part of a consortium of ski resorts. On the average the *Distance to an Airport with Jet Service* from ski resorts was approximately 70.15 miles. The closest airport was about 5 miles, while the furthest was about 217 miles. The *Population within a 75 Mile Radius* of a ski resort was, on the average, 1,974,471 people. There was a substantial heterogeneity in this figure across the sample, as indicated by the standard deviation (2,766,228 people) and the range (76,009 people to 17,100,000 people). The average *Number of Ski Resorts within a 75 Mile Radius* for the sample was about 13. The minimum number of competitors within this proximity for the sample was 0, while the maximum number was 29. Finally, on the average, there were approximately 3 *National Parks within a 75 Mile Radius* of sampled ski resorts, with a range of 0 national parks to 8 national parks.

6.2 Correlations

Table 3 contains the correlation matrix. Below, I interpret the correlations between the dependent variables and the independent variables of interest. Column 1 contains the correlations between *Biophysical Environmental Performance* and the independent variables. As expected, these statistics provide preliminary evidence that this

TABLE 2. Descriptive Statistics[a]

	Variable	Mean	s.d.	Min	Max
1.	Biophysical Environmental Performance	-0.01	0.88	-2.55	1.60
2.	Socioeconomic Environmental Performance	0.02	1.00	-1.64	3.38
3.	Sustainable Slopes Program Membership	0.86	0.35	0.00	1.00
4.	Size (000 acres)	1.63	1.12	0.14	5.29
5.	Age	48.37	12.66	6.00	73.00
6.	Public Land[b]	0.67	0.47	0.00	1.00
7.	Private Land[b]	0.10	0.30	0.00	1.00
8.	Group	0.43	0.49	0.00	1.00
9.	Distance to Airport with Jet Service	70.15	46.47	5.00	217.00
10.	Population within 75 Mile Radius[c]	1,974,471.00	2,766,228.00	76,009.03	17,100,000.00
11.	Number of Ski Areas within 75 Mile Radius	12.51	9.45	0.00	29.00
12.	Number of National Parks with 75 Mile Radius	2.26	1.77	0.00	8.00
13.	Ownership Structure[d]	0.13	0.34	0.00	1.00
14.	State Environmentalism	3.54	1.21	1.33	6.10
15.	Regulator Resource Dependence	0.11	0.23	0.00	0.96
16.	Exposure[c]	-0.98	2.71	-11.34	7.77
17.	Sensitivity[c]	38.68	22.99	0.94	112.15
18.	Vulnerability (Exposure x Sensitivity)	0.01	0.16	-0.42	1.18

[a] n=612 observations for 76 firms

[b] The reference group is Mixed Public and Private Land

[c] Non-transformed measures of these variables was used in this table.

[d] The reference group is Private or Non-Profit Organization.

* $p < .10$

** $p < .05$

*** $p < .01$

TABLE 3. Correlation Matrix[a]

Variable	1	2	3	4	5	6	7	8
1. Biophysical Environmental Performance	1							
2. Socioeconomic Environmental Performance	-0.04	1						
3. Sustainable Slopes Program Membership	-0.11***	0.16***	1					
4. Size	-0.29***	0.06	0.17***	1				
5. Age	0.27***	-0.02	-0.09**	-0.17***	1			
6. Public Land[b]	0.13***	-0.01	0.00	-0.15***	0.26***	1		
7. Private Land[b]	0.01	0.07*	-0.05	0.20***	-0.27***	-0.48	1	
8. Group	-0.11***	0.17***	0.23***	0.31***	-0.12***	0.01	0.20***	1
9. Distance to Airport with Jet Service	0.10**	-0.12***	-0.26***	-0.32***	0.11***	0.16***	-0.19***	-0.16***
10. Population within 75 Mile Radius[c]	0.13***	-0.19***	-0.04	-0.20***	0.34***	0.12***	-0.04	0.14***
11. Number of Ski Areas within 75 Mile Radius	-0.13***	-0.01	0.11***	0.21***	-0.13***	-0.03	0.05	0.34***
12. Number of National Parks with 75 Mile Radius	-0.10**	0.05	-0.18***	-0.14***	-0.08**	0.03	-0.20***	-0.20***
13. Ownership Structure[d]	-0.33***	-0.02	0.10**	0.31***	-0.12***	0.00	-0.11***	0.44***
14. State Environmentalism	0.01	0.07*	0.06	-0.09**	0.07*	0.19***	-0.28***	0.21***
15. Regulator Resource Dependence	-0.21***	0.31***	0.18***	0.12***	-0.17***	0.13***	-0.17***	0.44***
16. Exposure	0.07	-0.04	-0.25***	-0.03	-0.06	0.08**	0.05	-0.08**
17. Sensitivity	0.11***	-0.08**	0.03	-0.17***	0.17***	0.05	-0.02	0.01
18. Vulnerability (Exposure x Sensitivity)	-0.03*	0.01	0.18***	-0.07*	0.17***	0.01	0.01	0.10**

[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
[d] The reference group is Private or Non-Profit Organization.
* p < .10
** p < .05
*** p < .01

TABLE 3. Continued

9	10	11	12	13	14	15	16	17	18
1									
0.13***	1								
-0.14***	0.18***	1							
0.16***	-0.22***	-0.43***	1						
-0.13***	0.05	0.22***	0.04	1					
0.11***	0.28***	0.38***	0.04	0.13***	1				
0.00	-0.07*	0.35***	0.02	0.43***	0.18 ***	1			
0.15***	0.06	0.21***	-0.07*	-0.17***	0.13 ***	-0.04	1.00		
0.10**	0.27***	0.00	-0.08*	0.09**	0.08 **	-0.03	0.04	1.00	
-0.05	0.26***	-0.07*	-0.10***	0.15***	0.02	-0.01	-0.12	0.15*	1.00

dependent variable is uncorrelated with *Exposure* (ρ = 0.07, n.s.), since climate change exposure alone is not predicted to induce environmental harmful adaptations from firms. *Sensitivity*, however, is positively correlated with *Biophysical Environmental Performance* (ρ = 0.11, p<.01), which give a preliminary indication of a possible unexpected association with this dependent variable. As expected, the joint effect of these two predictors, *Vulnerability*, appears to be negatively correlated with the first dependent variable (ρ = -0.03, p<.10). In addition, *Public Company* is negatively correlated with *Biophysical Environmental Performance* (ρ = -0.33, p<.01), as is *Regulator Resource Dependence* (ρ = -0.21, p<.01). *State Environmentalism*, however, is not significantly correlated with this dependent variable (ρ = -0.01, n.s.).

Column 2 contains the correlations between *Socioeconomic Environmental Performance* and the independent variables. This dependent variable also appears to be uncorrelated with *Exposure* (ρ = -0.04, n.s.). *Sensitivity* is negatively correlated with this dependent variable (ρ = -0.08, p<.05), providing preliminary evidence that this variable might have another unexpected effect. *Vulnerability* is uncorrelated with *Socioeconomic Environmental Performance* (ρ = 0.01, n.s.), indicating that support for H3 can occur only if the partial effects of other independent variables are suppressing *Vulnerability*'s effect on this dependent variable. With respect to the independent variables measured to test Hypothesis 4, as expected, *Regulator Resource Dependence* is positively correlated with Socioeconomic Environmental Performance (ρ = 0.31, p<.01). Contrary to expectation, *State Environmentalism* is as well (ρ = 0.07, p<.10). *Public Company*, however, is not significantly correlated with this dependent variable (ρ = -0.02, n.s.).

6.3 Hypothesis 1

Table 4 reports the results of PCSE regressions of *Biophysical Environmental Performance*. In this table, Model 1 regresses the dependent variable on the set of control variables to obtain baseline model fit statistics. The Breusch-Pagen χ^2 (2.36) was insignificant, meaning that the model had homoscedastic residual variances. In addition, the Wooldridge F-test (0.35) was also insignificant, i.e. the errors were not correlated with panels. Thus, neither error correction was applied to this model. The Wald χ^2 statistic (137.25, $p<.01$) indicates that the set of controls significantly explains variance in the dependent variable. As expected, *Size* (b =-0.21, $p<.01$), *Ski Areas within a 75 Mile Radius* (b =-0.01, $p<.10$), and *National Parks within a 75 Mile Radius* (b =-0.07, $p<.01$) were negatively associated with the dependent variable, whereas *Age* was positively associated with it. *Public Land* (b =0.20, $p<.05$) and *Private Land* (b =0.44, $p<.01$) were also both positively related to the dependent variable, signifying that ski resorts operating on combinations of public and private land were more likely to have lower *Biophysical Environmental Performance* than those operating on solely public or private land. A possible explanation for this result may be that many ski resorts have engaged in land swaps with the Forest Service in the last decade, exchanging privately owned land for Forest Service land proximal to resorts' main operating areas. Critics of the Forest Service's relationship with some ski resorts have observed that many resorts then use the newly privatized lands to develop new facilities, which can degrade their biophysical environments (Clifford, 2002). *Sustainable Slopes Program Membership, Group, Distance to Airport with Jet Service,* and the natural log of *Population within a 75 mile*

TABLE 4. Results of PCSE Regression of Biophysical Environmental Performance[a]

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Sustainable Slopes Program Membership	-0.14	-0.10	-0.16***	-0.17***	-0.16***
Size	-0.21***	-0.19***	-0.13*	-0.13*	-0.13*
Age	0.02***	0.02***	0.01***	0.01***	0.01***
Public Land[b]	0.20**	0.20**	0.18***	0.18***	0.19***
Private Land[b]	0.44***	0.44***	0.22**	0.28***	0.24**
Group	-0.01	0.02	0.21***	0.19***	0.24***
Distance to Airport with Jet Service	0.00	0.00	0.00	0.00	0.00
Population within 75 Mile Radius[c]	-0.03	-0.01	-0.01	-0.02	-0.03
Number of Ski Areas within 75 Mile Radius	-0.01*	-0.01**	-0.01***	-0.01***	-0.01***
Number of National Parks within 75 Mile Radius	-0.07***	-0.08***	-0.07***	-0.07***	-0.07***
Exposure		-0.04	-0.07**	-0.07**	-0.07**
Sensitivity		2.85***	4.01***	4.11***	4.08***
Vulnerability (Exposure x Sensitivity)		-2.32***	-3.04***	-3.13***	-3.10***
Ownership Structure[d]			-0.74***	-0.73***	-0.69***
State Environmentalism				0.05**	0.05*
Regulator Resource Dependence					-0.27
Intercept	0.19	0.06	0.12	0.32	0.38
Wald χ^2	137.25***	150.70***	211.07***	220.98***	228.15***
R^2	0.18	0.20	0.25	0.25	0.25
ΔR^2		0.02	0.05	0.00	0.00
Breusch-Pagen χ^2	2.36	1.77	3.78*	4.31**	4.80**
Wooldridge F-test[e]	0.35	0.36	0.26	0.26	0.16
(df)	(1, 70)	(1, 70)	(1, 70)	(1, 70)	(1, 70)

[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
[d] The reference group is Private or Non-Profit Organization
* $p < .10$
** $p < .05$
*** $p < .01$

Radius were non-significant effects in this model.

Model 2 in Table 4 regresses *Biophysical Environmental Performance* on the set of controls, *Exposure*, *Sensitivity* and *Vulnerability*, and thus contains the first test of Hypothesis 1 (*Corporate Climate Change Vulnerability is negatively related to Biophysical Environmental Performance*). The Breusch-Pagen χ^2 (1.77, n.s) indicates that error variances were homoscedastic, and the Wooldridge F-test (0.36, n.s.) indicates that errors were independent within panels. Thus, I did not apply a correction to the standard errors in this model. The Wald χ^2 statistic (150.70, $p<.01$) indicates that the set of predictors significantly explain variance in the dependent variable.

The test for Hypothesis 1 is the coefficient on *Vulnerability (Exposure x Sensitivity)*. This coefficient is negatively and significantly related to *Biophysical Environmental Performance* ($b = -2.32$, $p< .01$), thus supporting the hypothesis. The interpretation of the coefficient is that a 1 unit change in *Vulnerability* is associated with 2.32 z-scores worse *Biophysical Environmental Performance*. Since *Vulnerability* is operationalized as the interaction of *Exposure* and *Sensitivity*, and is therefore a non-linear measure, it is necessary to consider the conditional effects of the first-order terms for interpretations based in the units of analyses of these terms. This can be done in two ways, depending on which first-order effect is of interest. First, a 1 unit increase in *Exposure* (1 inch decrease in the rate of change of average winter snowpack depth) is associated with a decline in the coefficient of *Sensitivity* on *Biophysical Environmental Performance* of 2.32 units. The second interpretation, where *Exposure* is the first-order effect of interest, is complicated by measuring *Sensitivity* as the inverse transformation of average winter snowpack depth (1÷ average winter snowpack depth). Since inverse

transformations are non-linear variables, it is possible to interpret the effect of *Sensitivity* on *Biophysical Environmental Performance* as the result of percentage, rather than absolute changes in the transformed variable. Determining this effect requires 2 calculations. First, one must determine the effect of a percentage change in the untransformed variable on the inverse-transformed variable. Given that the formula for applying an inverse transformation is:

$$X_1 = 1/x_1 \quad (3)$$

where:

X_1 = the inverse transformed measure

x_1 = the untransformed measure,

calculating the effect of the percentage change of the untransformed measure on the transformed measure can be done simply via the following algebra:

$$\Delta X_1 = 1/\Delta x_1. \quad (4)$$

Following this equation, a 10% decrease in average winter snowpack depth causes *Sensitivity* to increase by approximately 11% (0.11 = 1.00 /(1.00-0.10)). Once this effect is calculated, one can substitute it into the interaction term to determine its impact on the slope of the first-order term of interest on the dependent variable (Aiken & West, 1991). This calculation is shown in the equation below:

$$\Delta Y = \beta \Delta X_1 \Delta X_2 \quad (5)$$

where:

ΔY = effect of a 1-unit change in X_2 on Y when β and ΔX_1 have been estimated,

β = the estimated coefficient for X_1X_2,

ΔX_1 = the effect of Δx_1 on X_1 calculated in equation (4),

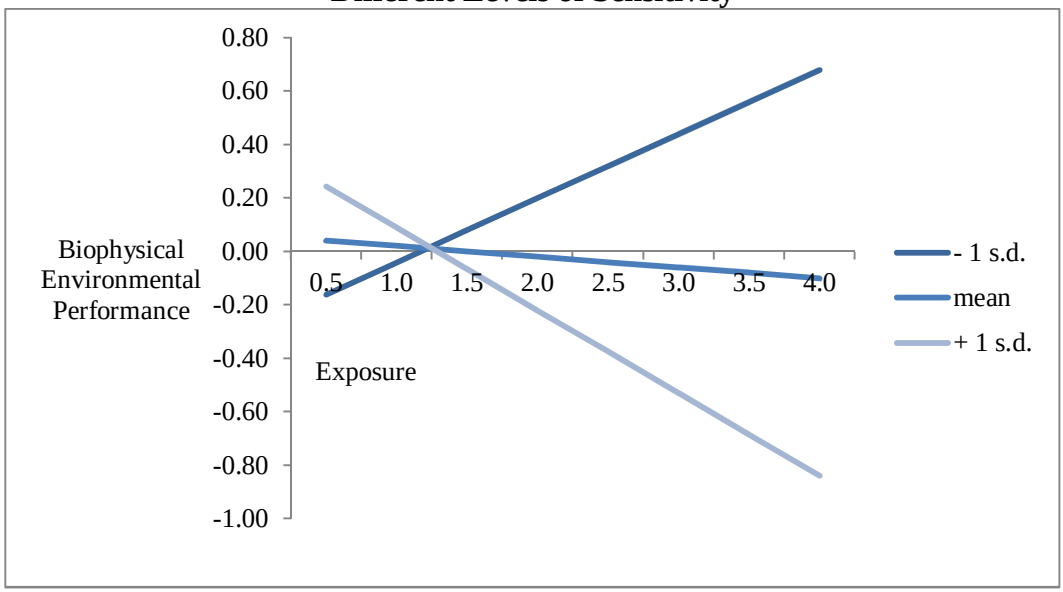
ΔX_2 = a 1-unit change in the first-order term of interest.

Following this equation, an 11% increase in *Sensitivity* would cause a 0.26 z-score decline (0.11 × -2.32) in the slope of *Exposure* on *Biophysical Environmental Performance*.

There is a second consequence of operationalizing *Vulnerability* as the interaction of *Exposure* and Sensitivity. A full interpretation of its effect required analyses of the simple slopes[36] of *Exposure* at different levels of *Sensitivity*, and vice versa. Aiken and West (1991) argue that this procedure is necessary for researchers to develop a clearer picture of how the joint effects of two variables impact the dependent variable. Table 5 contains the regression models of *Biophysical Environmental Performance* for combination of different levels of *Exposure* and *Sensitivity*, where each variable could be 1 δ below or above its mean. Figure 4 illustrates the different slopes of *Exposure* on *Biophysical Environmental Performance* at these three levels of *Sensitivity*. Model 6 indicates that, at low levels of *Sensitivity*, *Exposure* is positively related to *Biophysical Environmental Performance* ($b = 0.24$, $p<.01$). Thus, resorts with deep snowpacks tend to be 0.24 z-scores better at *Biophysical Environmental Performance* for every additional 1 inch/year of *Exposure* (1 inch decrease in the rate change of average winter snowpack depth). This result is, on the surface, counter to the prediction in Hypothesis 1; however, deep snowpacks are not urgently threatened by declining rates of change in snowpack depth unless those rates are extremely negative. Thus, this result arguably does not explain the behavior of ski resorts that have vulnerable natural snowpacks.

[36] To determine these simple slopes, I created two additional measures of both Exposure and Sensitivity, one by adding one standard deviation of the respective variable's value to its mean, and one by subtracting one standard deviation of the respective variable's value to its mean. I then ran 8 additional PCSE regression models, for each possible combination of Exposure and Sensitivity, excluding a model where both variables were measured at their mean, since I had already done this with Model 2.

FIGURE 4. Effect of Exposure on Biophysical Environmental Performance at Different Levels of Sensitivity



As Model 2 indicates, at mean levels of *Sensitivity*, *Exposure* appears to be insignificantly related to *Biophysical Environmental Performance* (b = -0.04, n.s.). Finally, at high levels of *Sensitivity*, Model 7 indicates that *Exposure* is negatively related to *Biophysical Environmental Performance* (b = -0.31, p<.01). Thus, resorts with shallow snowpacks tend to be 0.31 z-scores worse at *Biophysical Environmental Performance* for every additional 1 inch/year of *Exposure*. Viewed together, these results indicate that *Exposure* is only negatively related to *Biophysical Environmental Performance* when *Sensitivity* becomes significantly higher than its mean levels. However, they also clearly demonstrate that, as *Sensitivity*, and by extension, *Vulnerability* increases, the coefficient of *Exposure* on *Biophysical Environmental Performance* consistently becomes lower (from .24 to -.04 to -.31). Thus, I conclude that these tests, along with negative and significant coefficient on *Vulnerability*, provide support for Hypothesis 1.

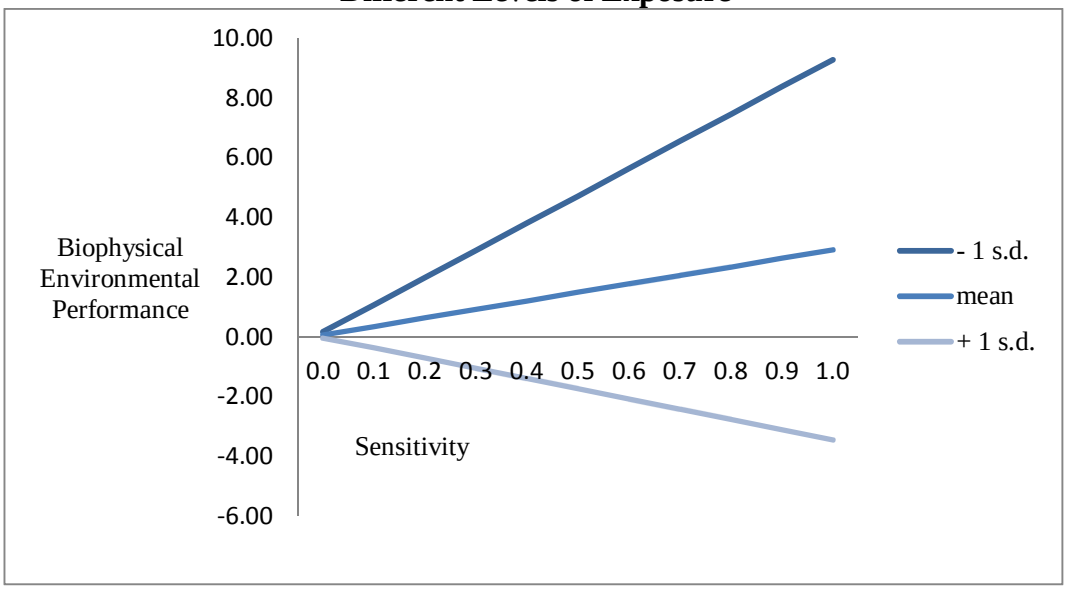
TABLE 5. Results of PCSE Regression of Biophysical Environmental Performance Probing the Exposure x Sensitivity (Vulnerability) Interaction[a]

Variables	Model 6 Exposure X Sensitivity (-1 δ)	Model 7 Exposure X Sensitivity (+1 δ)	Model 8 Exposure (- 1δ) X Sensitivity	Model 9 Exposure (+ 1δ) X Sensitivity
Sustainable Slopes Program Membership	-0.10	-0.10	-0.10	-0.10
Size	-0.19***	-0.19***	-0.19***	-0.19***
Age	0.02***	0.02***	0.02***	0.02***
Public Land[b]	0.20**	0.20**	0.20**	0.20**
Private Land[b]	0.44***	0.44***	0.44***	0.44***
Group	0.02	0.02	0.02	0.02
Distance to Airport with Jet Service	0.00	0.00	0.00	0.00
Population within 75 Mile Radius[c]	-0.01	-0.01	-0.01	-0.01
Number of Ski Areas within 75 Mile Radius	-0.01**	-0.01**	-0.01**	-0.01**
Number of National Parks within 75 Mile Radius	-0.08***	-0.08***	-0.08***	-0.08***
Exposure	0.24***	-0.31***	-0.04	-0.04
Sensitivity	2.85***	2.85**	9.12***	-3.42***
Vulnerability (Exposure x Sensitivity)	-2.32***	-2.32***	-2.32***	-2.32***
Intercept	-0.28	0.40	0.16	-0.04
Wald χ^2	150.71	150.69	150.70	150.70
R^2	0.20	0.20	0.20	0.20

[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
* p < .10
** p < .05
*** p < .01

It is also instructive to interpret the simple slopes of *Sensitivity* on *Biophysical Environmental Performance* at different levels of *Exposure*. Figure 5 illustrates the different slopes of *Sensitivity* on *Biophysical Environmental Performance* at these three levels of *Exposure.* At low levels of *Exposure*, Models 8 indicates that *Sensitivity* is positively related to *Biophysical Environmental Performance* (b = 9.12, p<.01). Once again, however, to properly interpret the effect of lower average winter snowpack depths on *Biophysical Environmental Performance*, it is once again necessary to develop interpretations based on percentage increases in the untransformed measure. Using equations (3), (4) and (5), one can estimate that a 10% lower level of average winter snowpack depth is associated with approximately 11% higher level of *Sensitivity* and by extension, a 1.00 z-score (0.11×9.12) higher level of *Biophysical Environmental Performance*. As Model 2 indicates, at mean levels of *Exposure, Sensitivity* is again positively related to *Biophysical Environmental Performance* (b = 2.85, p<.01). The coefficient implies that 10% lower average winter snowpacks are associated with approximately 11 % higher levels of *Sensitivity* and by extension a 0.31 z-score higher level of *Biophysical Environmental Performance*. While on the surface these positive effects run counter to the prediction in Hypothesis 1, they do not occur when firms have high *Exposure*, and, therefore, should not be associated with vulnerability to climate change. Finally, at high levels of *Exposure*, Models 9 indicates that *Sensitivity* is negatively related to *Biophysical Environmental Performance* (b = -3.42, p<.01). Here, resorts with high levels of *Exposure* tend to have a 0.38 z-score lower level of the dependent variable with 10% lower average winter snowpack depths or 11% higher

FIGURE 5. Effect of Sensitivity on Biophysical Environmental Performance at Different Levels of Exposure



Sensitivity. This trend lends support to Hypothesis 1. On the other hand, the direct effect of *Sensitivity* on the dependent variable is positive when the conditional effect of *Exposure* is one standard deviation below its mean, or at its mean. On the surface, this appears counter to the prediction in Hypothesis 1. To reconcile this apparent contradiction, it is worth recalling that the theory of *Corporate Climate Change Vulnerability* requires that significant thresholds of *Exposure* and *Sensitivity* must be simultaneously present for vulnerability to exist (Belliveau et al., 2006). Thus, the unconditional direct effects of either first-order term do not indicate whether vulnerability is affecting the dependent variable.

Still, it is important to develop a plausible explanation for the positive effects of *Sensitivity* of *Biophysical Environmental Performance*. One explanation is that lower average winter snowpack depths cause ski resort managers to shift attention towards ecosystem protection management, holding firms' rate of change of winter snowpack

depth constant. Lower average annual snowpacks, in general, are associated with more dynamic winter ecosystems (Band et al., 1996; Hauer et al., 1997). For example, lower snowpack areas are more likely to contain habitat for non-hibernating wildlife. In addition, year-round ecosystem health can be more difficult to manage because of the lower levels of spring run-off, affecting stream and riparian zone health. Lower snowpacks also mean higher probability of disturbing flora and saplings during the ski season. In addition, Forest Service district offices have standard policies governing these types of ecosystem dynamics and requirements for ski resorts to include wildlife habitat protection in their own planning processes (U.S. Department of Agriculture, 2002). As a result, it is possible that the ecological dynamics and governance of lower snowpack mountain ecosystems induce ski resorts to better manage their biophysical environments, while corporate climate change exposure decreases the magnitude of this positive effect.

6.31 Alternative Regression Procedures to Corroborate PCSE Results

Table 6 contains a summary of all of the regressions done of *Biophysical Environmental Performance* using PCSE, OLS and random effects regression. As indicated in section 5.34, I utilized the latter two techniques to see if the PCSE results were robust across different statistical procedures[37]. The column labeled *Vulnerability* contains the summary of results for tests of Hypothesis 1. Each of the PCSE models yielded similar results. Further, the OLS procedures produced identical coefficients and similar levels of significance. These similarities were expected since the PCSE models

[37] The complete set of statistics for the OLS and random effects regressions on *Biophysical Environmental Performance* can be seen in Appendix Two, in Tables 13 and 14, respectively.

TABLE 6. Summary of Regressions on Biophysical Environmental Performance

Model Number (Procedure)	Vulnerability	Ownership Structure	Sierra Club Membership per 1000 people	LCV HR Score	LCV Senate Score	Regulator Resource Dependence
Model 2 (PCSE)	-2.32***					
Model 3 (PCSE)	-3.04***	-0.74***				
Model 4 (PCSE)	-3.13***	-0.73***	0.05**			
Model 5 (PCSE)	-3.10***	-0.69***	0.05*			-0.27
Model 10 (PCSE)				0.03*		
Model 11 (PCSE)					0.00	
Model 25 (OLS)	-2.32*					
Model 26 (OLS)	-3.04***	-0.74***				
Model 27 (OLS)	-3.13***	-0.73***	0.05*			
Model 28 (OLS)	-3.10***	-0.69***	0.05			-0.27
Model 30 (Random Effects)	-2.12					
Model 31 (Random Effects)	-2.67*	-0.50***				
Model 32 (Random Effects)	-2.71*	-0.49***	0.03			
Model 33 (Random Effects)	-2.70*	-0.48***	0.03			-0.12

did not include corrections for intra-panel correlations. Finally, the random effects regressions produced somewhat smaller effect sizes and somewhat less significant effects. In particular, Model 30's coefficient was insignificantly related to *Biophysical Environmental Performance* (b = -2.12, n.s.). However, these random effects regressions results need to be considered as potentially biased, since Shapiro-Wilk statistics for each of those models indicate that the random effect estimates are non-normally distributed. In addition, the random effect in Model 30, in particular, was significantly correlated with 11 of the 14 independent variables in that model, suggesting that the effect is indeed not random, but rather is significantly correlated with most of the independent variables in the model[38]. Given that Model 30 is the only model that did not indicate a significantly negative effect of *Vulnerability* on *Biophysical Environmental Performance*, and the assumptions of random effects were untenable in this model, the results on the whole appear to be supportive of Hypothesis 1. Thus, I conclude that *Corporate Climate Change Vulnerability* is negatively related to *Biophysical Environmental Performance*.

6.4 Hypothesis 2

Models 3, 4 and 5 in Table 4 provide tests for Hypothesis 2 (*Corporate Climate Change Adaptive Capacity is negatively related to Biophysical Environmental Performance*). Model 3 added *Ownership Structure* to the model to test whether this variable was negatively related to *Biophysical Environmental Performance* as predicted. The Breusch-Pagen χ^2 (3.78, $p<.10$) indicates that error variances were heteroscedastic, although barely so, and the Wooldridge F-test (0.26, n.s.) indicates that errors were

[38] The correlations between the random effects and independent variables for each of the random effect regressions on *Biophysical Environmental Performance* can be seen in Table 15 in Appendix Two.

independent within panels. Thus, I selected the option to correct for heteroscedasticity when I implemented this PCSE regression. The Wald χ^2 statistic (211.07, $p<.01$) indicates that the set of predictors do significantly explain variance in the dependent variable. In Model 3, the coefficient on *Ownership Structure* is negative and significant ($b= -0.74$, $p<.01$), indicating some support for Hypothesis 2. The interpretation of the coefficient is that ski resorts that are publicly owned and traded tend to have 0.74 z-scores lower *Biophysical Environmental Performance* than privately owned or non-profit organizations.

Model 4 added *State Environmentalism* to the model to test whether this variable was positively related to *Biophysical Environmental Performance* as predicted. The Breusch-Pagen χ^2 (4.31, $p<.05$) indicates that error variances were heteroscedastic, and the Wooldridge F-test (0.26, n.s.) indicates that errors were independent within panels. Thus, I selected the option to correct for heteroscedasticity when I ran this PCSE regression. The Wald χ^2 statistic (220.98, $p<.01$) indicates that the set of predictors do significantly explain variance in the dependent variable. The coefficient on *State Environmentalism* in this model is positive and significant ($b= 0.05$, $p<.05$), providing additional support for Hypothesis 2. The interpretation of the coefficient is that *Biophysical Environmental Performance* increases 0.05 z-scores for every increase of 1 person per 1000 people in ski resorts' states that are members of the Sierra Club. I tested the reliability of this measure of *State Environmentalism* by running the same model using two alternative measures: League of Conservation Voter (LCV) House of Representative (HR) Scorecards for each state and LCV Senate Scorecards for each state. The results of these models are in Table 7. Model 10 uses the HR scores for this measure.

TABLE 7. Results of PCSE Regression of Biophysical Environmental Performance, Using League of Conservation Voter (LCV) Records to Measure State Environmentalism[a]

Variables	Model 10 Using LCV House of Representatives Voting Record Scores	Model 11 Using LCV Senate Voting Record Scores
Sustainable Slopes Program Membership	-0.17***	-0.17***
Size	-0.12*	-0.13*
Age	0.01***	0.01***
Public Land[b]	0.17***	0.18***
Private Land[b]	0.26***	0.21**
Group	0.20***	0.22**
Distance to Airport with Jet Service	0.00**	0.00
Population within 75 Mile Radius[c]	-0.04	-0.01***
Number of Ski Areas within 75 Mile Radius	-0.01***	-0.01***
Number of National Parks with 75 Mile Radius	-0.07***	-0.07**
Exposure	-0.08***	-0.07***
Sensitivity	4.36***	4.09***
Vulnerability (Exposure x Sensitivity)	-3.29***	-3.10***
Public Company[d]	-0.73***	-0.75
State Environmentalism	0.03*	0.00
Intercept	0.52	0.03
Wald χ^2	722.42***	611.21***
R^2	0.25	0.26
Breusch-Pagen χ^2	7.00***	2.72*
Wooldridge F-test (df)	0.01 (1, 70)	0.01 (1, 70)

[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
[d] The reference group is Private or Non-Profit Organization
* $p < .10$
** $p < .05$
*** $p < .01$

Here, the coefficient on *State Environmentalism* is again positive and significant, but barely so (b= 0.03, p<.10), providing some evidence that the original measure is reliable. Model 11 uses the Senate scores for the measure. In this case, the coefficient on *State Environmentalism* is not significant (b= 0.00, n.s.), meaning that the results of this model do not confirm the reliability of the original measure. Given that the original measure of State Environmentalism and HR voting records are both positively related to *Biophysical*

Environmental Performance, but Senate voting records are not significantly related to the dependent variable, I conclude that these tests provide some support for Hypothesis 2.

Model 5 added *Regulator Resource Dependence* to the model to test whether this variable was negatively related to *Biophysical Environmental Performance* as predicted. The Breusch-Pagen χ^2 (4.80, $p<.05$) indicates that error variances were heteroscedastic, and the Wooldridge F-test (0.16, n.s.) indicates that errors were independent within panels. Thus, I selected the option to correct for heteroscedasticity when I ran this PCSE regression. The Wald χ^2 statistic (228.15, $p<.01$) indicates that the set of predictors significantly explain variance in the dependent variable. In Model 5, the coefficient of *Regulator Resource Dependence* is insignificant (-0.27, n.s.), implying that the percentage of Forest Service districts' budget that comes from ski resort special use permit fees does not negatively and significantly affect *Biophysical Environmental Performance*.

6.41 Alternative Regression Procedures to Corroborate PCSE Results

Table 6 also contains alternative regression procedures used to corroborate the results of the PCSE tests of Hypothesis 2. The column labeled *Ownership Structure* contains the summary of tests of the prediction that public-ownership is negatively related to *Biophysical Environmental Performance*. These results indicate that regardless of the regression technique or the set of independent variables entered into the model, this variable was in fact positively and significantly related to the dependent variable. Thus, I conclude that this form of *Corporate Climate Change Adaptive Capacity* is negatively related to *Biophysical Environmental Performance*.

The columns labeled Sierra Club Membership (per 1000 people), LCV HR Score and LCV Senate score contain the summaries of tests of the prediction that *State Environmentalism* is positively related to *Biophysical Environmental Performance*. The PCSE regressions using Sierra Club Membership per thousand people per state provide mixed evidence. Models 4 and 5 did yield positive and significant results. However, the effect in Model 5 was barely significant. OLS regressions show even weaker support. Model 27 yielded positive and barely significant results. Model 28, which added *Regulator Resource Dependence* to the set of explanatory variables, produced an insignificant effect for Sierra Club membership per thousand people per state. In addition, neither random effects regression model (Models 32 and 33) produced significant results. Finally, PCSE regression tests of the effect of alternative measures of *State Environmentalism* on *Biophysical Environmental Performance* produced weak support for the Hypothesis. LCV HR score was positively related to *Biophysical Environmental Performance*, but barely so ($b = 0.03$, $p<.10$). The effect of LCV Senate Score was not significantly related to the dependent variable. Given that PCSE regressions of *State Environmentalism* positively impact *Biophysical Environmental Performance* in 3 out of 4 models (Models 4, 5 and 10, but not 11), but alternative procedures produce positive in significant results in 1 out of 4 models (Model 27, but not 28, 32 and 33), I conclude that these test provide some evidence that the reverse indicator of this form of *Corporate Climate Change Adaptive Capacity* is positively related to *Biophysical Environmental Performance*.

TABLE 8. Results of PCSE Regression of Socioeconomic Environmental Performance[a]

Variables	Model 12	Model 13	Model 14	Model 15	Model 16
Sustainable Slopes Program Membership	0.25**	0.19	0.19	0.19	0.15
Size	0.00	0.00	0.00	0.00	0.00
Age	0.01**	0.01**	0.01**	0.01**	0.02***
Public Land[b]	-0.07	-0.13	-0.14	-0.10	-0.17
Private Land[b]	0.44*	0.18	0.11	0.25	0.30
Group	0.16	0.16	0.23	0.19	0.07
Distance to Airport with Jet Service	0.00	0.00	0.00	0.00	0.00
Population within 75 Mile Radius[c]	-0.15**	-0.19*	-0.20*	-0.23*	-0.23**
Number of Ski Areas within 75 Mile Radius	0.01	0.01	0.01	0.01	0.00
Number of National Parks within 75 Mile Radius	0.10***	0.09***	0.09***	0.08**	0.05
Exposure		0.17***	0.17***	0.17***	0.22***
Sensitivity		-8.55***	-8.40***	-8.46***	-10.00***
Vulnerability (Exposure x Sensitivity)		7.12***	7.05***	7.09***	8.50***
Ownership Structure[d]			-0.13	-0.14	-0.32
State Environmentalism				0.06	0.05
Regulator Resource Dependence					1.19**
Intercept	0.97	1.45	1.52	1.95	2.30*
Wald χ^2	296.65***	272.92***	290.68***	320.98***	544.74***
R^2	0.04	0.07	0.07	0.07	0.12
ΔR^2		0.03	0.00	0.00	0.05
Breusch-Pagen χ^2	41.79***	36.85***	37.98***	30.26***	17.00***
Wooldridge F-test	63.09***	62.81***	62.82***	62.63***	62.81***
(df)	(1, 70)	(1, 70)	(1, 70)	(1, 70)	(1, 70)

[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
[d] The reference group is Private or Non-Profit Organization
* $p < .10$
** $p < .05$
*** $p < .01$

Finally, the column labeled *Regulator Resource Dependence* contains the summary of tests of the prediction that ski resort influence over the Forest Service Districts' budgets is negatively related to *Biophysical Environmental Performance*. The PCSE, OLS and random effects regressions testing for evidence of this relationship each yielded insignificant results. Therefore, there is no evidence that this form of *Corporate Climate Change Adaptive Capacity* negatively impacts *Biophysical Environmental Performance*.

6.5 Hypotheses 3

Table 8 reports the results of PCSE regressions of *Socioeconomic Environmental Performance*. Model 12 regresses the dependent variable on the set of control variables to obtain baseline model fit statistics. The Breusch-Pagen χ^2 (41.79, $p<.01$) indicates that the model had heteroscedastic error variances. In addition, the Wooldridge F-test (63.09, $p<.01$) indicates panel specific error dependence. Thus, both error corrections were applied to this model. The Wald χ^2 statistic (296.65, $p<.01$) indicates that the set of controls do significantly explain variance in the dependent variable. As expected, *Sustainable Slopes Program Membership* (b=0.25, $p<.05$) and *Age* (b= 0.01, $p<.05$) were positively related to *Socioeconomic Environmental Performance*. However, in models that included the independent variables of interest (Models 13, 14, 15, 16 and 17), *Sustainable Slopes Program Membership* became insignificant, implying that these variables may be mediating the effect of the program on *Socioeconomic Economic Performance*. *Private Land* (b=0.44, $p<.10$) was also positively related to the dependent variable in this model, indicating that ski resorts that owned all of their land were more likely to have better *Socioeconomic Environmental Performance* than those operating on

public land or a mix public or private land. However, like *Sustainable Slopes Program Membership*, this effect became insignificant as soon as independent variables of interest were entered into the model. *Number of National Parks within a 75 Mile Radius* of ski resorts was also positively related to the dependent variable ($b = 0.10$, $p<.01$). A possible explanation for this result is that proximity to national parks might bring more summer traffic to ski resorts, creating both market and social pressures for firms to improve these areas of environmental performance. Finally, *Population within 75 Mile Radius* of ski resorts had a negative effect on the dependent variable ($b = -0.15$, $p<.05$). A possible explanation for this effect is that this variable is a proxy for the strength of ski resorts' local day-skier market, which reduces resorts' dependence on destination skiers as a market segment. As a result, resorts in more densely populated areas are less likely to need extensive lodging, food, beverage and retail facilities to attract skiers. Finally, resorts that do not have these additional revenue sources may be less likely to invest in capabilities that improve *Socioeconomic Environmental Performance*, such as energy efficient machinery, recycling programs, and/or community sustainability initiatives.

Model 13 in Table 8 regresses *Socioeconomic Environmental Performance* on the set of controls, *Exposure*, *Sensitivity* and *Vulnerability*, and thus contains the first explicit test of Hypothesis 3 (*Corporate Climate Change Vulnerability is positively associated with Socioeconomic Environmental Performance)*. The Breusch-Pagen χ^2 (36.85, $p<.01$) indicates that error variances were heteroscedastic, and the Wooldridge F-test (62.81, $p<.01$.) indicates that errors were correlated within panels. Therefore, I applied both corrections to the standard errors in this model. The Wald χ^2 statistic (272.92, $p<.01$)

indicates that the set of predictors do significantly explain variance in the dependent variable.

The test for Hypothesis 3 is the coefficient on *Vulnerability (Exposure x Sensitivity)*. This coefficient is positively and significantly related to *Socioeconomic Environmental Performance* ($b = 7.12$, $p < .01$), thus supporting the Hypothesis. The interpretation of the coefficient is that a 1 unit change in *Vulnerability* is associated with a 7.12 z-score better *Socioeconomic Environmental Performance*. Similar to Hypothesis 1, the interpretation of the first-order terms can be done in two ways, depending on which first-order effect is of interest. First, a 1 unit increase in *Exposure* (1 inch decrease in the rate of change of average winter snowpack depth) is associated with an increase in the coefficient of *Sensitivity* on *Socioeconomic Environmental Performance* of 7.13 units. The second interpretation, where *Exposure* is the first-order effect of interest, is again complicated by measuring *Sensitivity* as the inverse transformation of average winter snowpack depth. Again, it is possible to interpret the linear effect of average winter snowpack depth on the dependent variable as the result of percentage, rather than absolute changes in the transformed variable. Using equations (3), (4) and (5), one can estimate that a 10% lower level of average winter snowpack depth is associated with an approximately 11% higher level of *Sensitivity*, and by extension, a 0.78 z-score (0.11×7.12) higher level in the slope of *Exposure* on *Socioeconomic Environmental Performance*.

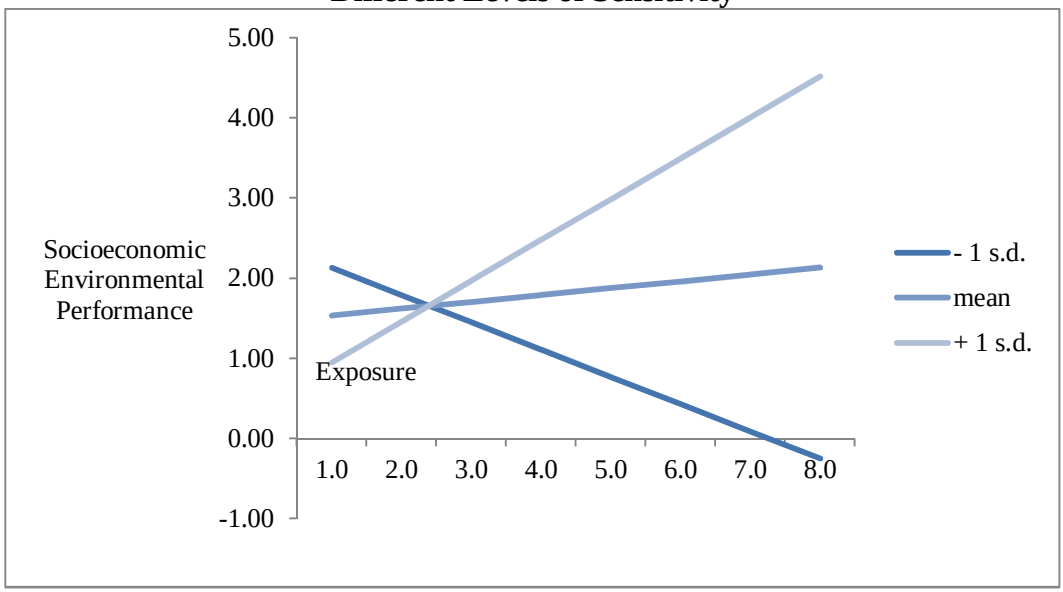
Once again, a full interpretation of the effect of *Vulnerability* required analyses of the simple slopes of *Exposure* at different levels of *Sensitivity*, and vice versa. Table 9

TABLE 9. Results of PCSE Regression of Socioeocnomic Environmental Performance Probing the Exposure x Sensitivity (Vulnerability) Interaction[a]

Variables	Model 17 Exposure X Sensitivity (-1 δ)	Model 18 Exposure X Sensitivity (+1 δ)	Model 19 Exposure (- 1δ) X Sensitivity	Model 20 Exposure (+ 1δ) X Sensitivity
Sustainable Slopes Program Membership	0.19	0.19	0.19	0.19
Size	0.00	0.00	0.00	0.00
Age	0.01**	0.01**	0.01**	0.01**
Public Land[b]	-0.13	-0.13	-0.13	-0.13
Private Land[b]	0.18	0.18	0.18	0.18
Group	0.16	0.16	0.16	0.16
Distance to Airport with Jet Service	0.00	0.00	0.00	0.00
Population within 75 Mile Radius[c]	-0.19*	-0.19*	-0.19*	-0.19*
Number of Ski Areas within 75 Mile Radius	0.01	0.01	0.01	0.01
Number of National Parks within 75 Mile Radius	0.09***	0.09***	0.09***	0.09***
Exposure	-0.68***	1.02***	0.17***	0.17***
Sensitivity	-8.55***	-8.55***	-27.82***	10.71***
Vulnerability (Exposure x Sensitivity)	7.12***	7.12***	7.12***	7.12***
Intercept	2.47*	0.44	0.99	1.92
Wald χ^2	272.90***	272.90***	272.90***	272.90***
R^2	0.07	0.07	0.07	0.07

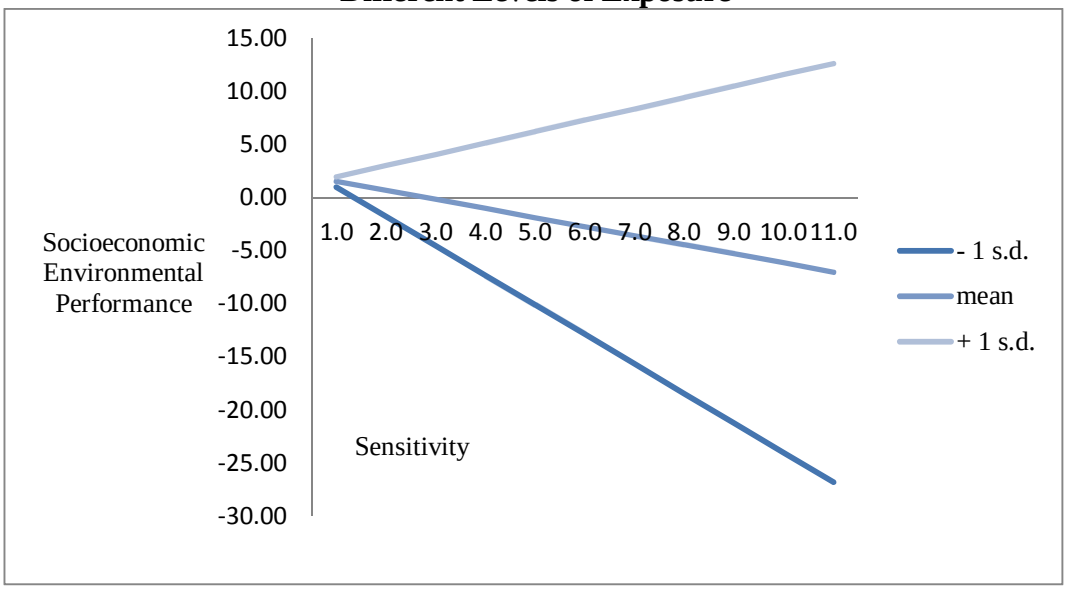
[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
[d] The reference group is Private or Non-Profit Organization
* p < .10
** p < .05
*** p < .01

FIGURE 6. Effect of Exposure on Socioeconomic Environmental Performance at Different Levels of Sensitivity



contains the regression models of *Socioeconomic Environmental Performance* for each combination of different levels of *Exposure* and *Sensitivity*, with each variable at 1 δ below or 1 above its mean. Figure 6 illustrates the different slopes of *Exposure* on *Socioeconomic Environmental Performance* at these three levels of *Sensitivity*. Model 17 shows that, at low levels of *Sensitivity*, *Exposure* is negatively related to *Socioeconomic Environmental Performance* ($b = -0.68$, $p<.01$). Thus, resorts with deep snowpacks tend to have a 0.68 z-score lower level of *Socioeconomic Environmental Performance* for every additional 1 inch/year of *Exposure* (1 inch decrease in the rate of change of average winter snowpack depth). This result is, on the surface, counter to the prediction in Hypothesis 3. However, resorts with deep snowpacks may not have incentives to be better than average at *Socioeconomic Environmental Performance*, because they do not perform worse at *Biophysical Environmental Performance*, and do not face environmental legitimacy issues associated with that performance-expectations

FIGURE 7. Effect of Sensitivity on Socioeconomic Environmental Performance at Different Levels of Exposure



gap. As Model 13 indicates, at mean levels of *Sensitivity*, *Exposure* appears to be positively related to *Socioeconomic Environmental Performance* (b = 0.17, p<.01). Thus, ski resorts with average snowpacks tend to have 0.17 z-scores better *Socioeconomic Environmental Performance* for every additional 1 inch/year of *Exposure*. Finally, at high levels of *Sensitivity*, Model 18 indicates that *Exposure* is positively related to *Biophysical Environmental Performance* (b = 1.02, p<.01). Therefore, resorts with shallow snowpacks tend to have a 1.02 z-score higher level of *Socioeconomic Environmental Performance* for additional 1 inch/year of *Exposure*. These results, when viewed together, indicate that *Exposure* becomes increasingly positively related to *Socioeconomic Environmental Performance* as *Sensitivity*, and by extension, *Vulnerability* increases. Thus, I conclude that these tests, along with positive and significant coefficient on *Vulnerability*, provide support for Hypothesis 3.

Figure 7 illustrates the different slopes of *Sensitivity* on *Socioeconomic Environmental Performance* at the three levels of *Exposure.* At low levels of *Exposure*,

Models 19 indicates that *Sensitivity* is negatively related to *Socioeconomic Environmental Performance* (b = -27.82, p<.01). Once again, it is necessary to develop interpretations based on percentage increases in the untransformed measure of *Sensitivity*. Using equations (3), (4) and (5), one can estimate that a 10% lower level of average winter snowpack depth is associated with an approximately 11% higher level of *Sensitivity*, and by extension, 2.98 z-score (0.11×-27.82) lower level of *Socioeconomic Environmental Performance*. Again, it might appear that this negative effect runs counter to the prediction in Hypothesis 3. However, it is associated with low *Exposure*, and, therefore, firms that are not vulnerable to climate change. As Model 13 indicates, at mean levels of *Exposure, Sensitivity* is again negatively related to *Socioeconomic Environmental Performance* (b = -8.55, p<.01). The coefficient implies that 10% lower average winter snowpacks (or approximately 11% higher levels of *Sensitivity*) are associated with a 0.94 z-score lower level of *Socioeconomic Environmental Performance*. Finally, at high levels of *Exposure*, Model 20 indicates that *Sensitivity* is positively related to *Socioeconomic Environmental Performance* (b = 10.71, p<.01). Here, resorts with high levels of *Exposure* tend have a 1.18 z-score higher level of *Socioeconomic Environmental Performance* for every 10% higher level of average winter snowpack depth (11% lower level of *Sensitivity*). Viewed together, these results do indicate that as *Exposure* increases, the relationship between *Sensitivity* and *Socioeconomic Environmental Performance* becomes increasingly positive. This trend lends support to Hypothesis 3.

On the other hand, the direct effect of *Sensitivity* on the dependent variable is negative when the conditional effect of *Exposure* is one standard deviation below its mean or at its mean. On the surface, this appears to be counter to the prediction in

Hypothesis 3. However, it is important to recall that significant thresholds of both *Sensitivity* and *Exposure* need to be present for firms to be vulnerable and that the unconditional direct effects of either first-order term should not be taken as indicators of vulnerability. A possible explanation for the negative relationship between *Sensitivity* and *Socioeconomic Environmental Performance* at low and mean levels of *Exposure* is that higher levels of *Sensitivity* at these levels of *Exposure* might divert managers' attention away from deploying practices that address *Socioeconomic Environmental Performance*. Since *Sensitivity* might make the management of issues associated with ecosystem protection more urgent, higher levels of the condition may induce managers to focus more of their attention on environmental issues that are embedded in firms' biophysical environment. Indeed, results in regressions of *Biophysical Environmental Performance* show *Sensitivity* is positively related to this dependent variable. Given managers' bounded-rationality and propensity to focus their attention on urgent issues (Dutton & Dukerich, 1991; Ocasio, 1997; Simon, 1946), higher levels of *Sensitivity* may cause them to emphasize *Biophysical Environmental Performance* and deemphasize *Socioeconomic Environmental Performance* regardless of the strategic importance of the latter outcome.

6.51 Alternative Regression Procedures to Corroborate PCSE Results

Table 10 contains a summary of all of the regressions done of Socioeconomic Environmental Performance using PCSE, OLS and random effects Regression[39,40]. The column labeled Vulnerability contains the summary of results for tests of Hypothesis 3.

[39] The complete set of statistics for the OLS and random effects regressions on *Socioeconomic Environmental Performance* can be seen in Appendix Two, in Tables 16 and 17, respectively.
[40] The correlations between the random effects and independent variables for each of the random effect regression of *Socioeconomic Environmental Performance* can be seen in Table 18 in Appendix Two.

TABLE 10. Summary of Regressions on Socioeconomic Environmental Performance[a]

Model Number (Procedure)	Vulnerability	Ownership Structure	Sierra Club Membership per 1000 people	LCV HR Score	LCV Senate Score	Regulator Resource Dependence
Model 13 (PCSE)	7.12***					
Model 14 (PCSE)	7.05***	-0.13				
Model 15 (PCSE)	7.09***	-0.14	0.06			
Model 16 (PCSE)	8.50***	-0.32	0.05			1.19**
Model 21 (PCSE)				0.00		
Model 22 (PCSE)					0.00	
Model 34 (OLS)	7.07***					
Model 35 (OLS)	6.86***	-0.22				
Model 36 (OLS)	6.67***	-0.21	0.11			
Model 37 (OLS)	6.48***	-0.46*	0.14**			1.71***
Model 39 (Random Effects)	6.87***					
Model 40 (Random Effects)	6.57***	-0.28				
Model 41 (Random Effects)	6.48***	-0.27	0.07			
Model 42 (Random Effects)	6.41***	-0.36*	0.09			1.04***

Each of the PCSE, OLS and random effects models produced results that indicate positive relationships between Vulnerability and Socioeconomic Environmental Performance. Thus, I conclude that Corporate Climate Change Vulnerability is positively related to Socioeconomic Environmental Performance.

6.6 Hypothesis 4

Models 14, 15 and 16 in Table 8 provide tests for Hypothesis 4 (*Corporate Climate Change Adaptive Capacity is positively associated with Socioeconomic Environmental Performance*). Model 14 added *Ownership Structure* to model to test whether this variable was positively related to *Socioeconomic Environmental Performance* as predicted. The Breusch-Pagen χ^2 (37.98, p<.01) indicates that heteroscedasticity was present, and the Wooldridge F-test (62.82, p<.01) indicates that errors were correlated within panels. Therefore, I selected both error correction options when I ran this PCSE regression. The Wald χ^2 statistic (290.68, p<.01) indicates that the set of predictors do significantly explain variance in the dependent variable. The

coefficient on *Ownership Structure* in this model is insignificant (b= -0.13, n.s), and, therefore, does not provide evidence in support of Hypothesis 4.

Model 15 added *State Environmentalism* to the model to test whether this variable was negatively related to *Socioeconomic Environmental Performance* as predicted. The Breusch-Pagen χ^2 (30.26, p<.01) indicates that heteroscedasticity was present, and the Wooldridge F-test (62.63, p<.01) indicates that errors were correlated within panels. Thus, I selected both error correction options when I ran this PCSE regression. The Wald χ^2 statistic (320.98, p<.01) indicates that the set of predictors do significantly explain

TABLE 11. Results of PCSE Regression of Socioeconomic Environmental Performance, Using League of Conservation Voter (LCV) Records to Measure State Environmentalism[a]

Variables	Model 21 Using LCV House of Representatives Voting Record Scores	Model 22 Using LCV Senate Voting Record Scores
Sustainable Slopes Program Membership	0.19	0.18
Size	0.00	0.00
Age	0.01**	0.01***
Public Land[b]	-0.12	-0.15
Private Land[b]	0.18	0.06
Group	0.21	0.25
Distance to Airport with Jet Service	0.00	0.00
Population within 75 Mile Radius[c]	-0.21*	-0.20*
Number of Ski Areas within 75 Mile Radius	0.01	0.01
Number of National Parks with 75 Mile Radius	0.09**	0.09***
Exposure	0.16***	0.17***
Sensitivity	-8.17***	-8.35***
Vulnerability (Exposure x Sensitivity)	6.87***	7.02***
Public Company[d]	-0.14	-0.15
State Environmentalism	0.00	0.00
Regulator Resource Dependence	1.75	1.47
Intercept	0.19	0.18
Wald χ^2	306.80***	92.96***
R^2	0.07	0.08
Breusch-Pagen χ^2	40.60***	37.49***
Wooldridge F-test (df)	63.76 (1, 70)***	62.72 (1, 70)***

[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
[d] The reference group is Private or Non-Profit Organization
* $p < .10$
** $p < .05$
*** $p < .01$

variance in the dependent variable. The coefficient on *State Environmentalism* in this model is insignificant (b= 0.06, n.s.). Therefore, this test provides no support for Hypothesis 4. I tested the reliability of this measure of *State Environmentalism* by running the same model using the two alternative measures: LCV HR Scorecards and LCV Senate Scorecards for each state. The results of these models are in Table 11. Model 21 uses the HR scores for this measure. Here, the coefficient on *State Environmentalism*

is again insignificant (b= 0.00, n.s.). Model 22 uses the Senate score for this measure. Again, the coefficient on *State Environmentalism* is insignificant (b= 0.00, n.s.). Thus, regressions using both alternative measures of *State Environmentalism* agree with the regression using the original measure and provide no support for the hypothesis.

Model 16 added *Regulator Resource Dependence* to the model to test whether this variable was positively related to *Socioeconomic Environmental Performance* as predicted. The Breusch-Pagen χ^2 (17.00, p<.01) indicates that heteroscedasticity was present, and the Wooldridge F-test (62.81, p<.01) indicates that errors were correlated within panels. Therefore, I selected both error correction options when I ran this PCSE regression. The Wald χ^2 statistic (544.74, p<.01) indicates that the set of predictors do significantly explain variance in the dependent variable. In Model 16, the coefficient on *Regulator Resource Dependence* is positive and significant (b=1.19, p<.05) as predicted, implying that the percentage of Forest Service districts' budget that comes from ski resort special use permit fees does positively affect *Socioeconomic Environmental Performance*. The interpretation of the coefficient is that a 1 percent increase in *Regulator Resource Dependence* is associated with a 0.0175 z-score (1.75/100) increase in *Socioeconomic Environmental Performance*. Given that this coefficient is positive and significant, I conclude in support of H4 that this form of *Corporate Climate Adaptive Capacity* is positively related to *Socioeconomic Environmental Performance*. However, the underlying logic for this specific prediction is not supported, since *Regulator Resource Dependence* is not simultaneously negatively associated with *Biophysical Environmental Performance*. Therefore, I explore a possible alternative explanation for this result in the *Chapter 7: Discussion* in section *7.1 Explanation of Unexpected Results*.

6.61 Alternative Regression Procedures to Corroborate PCSE Results

Table 10 also contains alternative regression procedures used to corroborate the results of the PCSE regression tests of Hypothesis 4. The column labeled *Ownership Structure* contains the summary of tests of the prediction that public-ownership is positively related to *Socioeconomic Environmental Performance*. PCSE regression Models 16 and 17 yielded similar results to Model 15, showing an insignificant relationship between *Ownership Structure* and *Socioeconomic Environmental Performance*. Similarly, OLS results in Models 35 and 36 and random effects results in Models 40 and 41 yielded insignificant results. However, when *Regular Resource Dependence* is added to the OLS model (Model 37) and random effects model (Models 42)[41] of *Socioeconomic Environmental Performance*, a negative and significant relationship emerges between *Ownership Structure* and the dependent variable. Thus, these models suggest that *Regulator Resource Dependence* may be suppressing the relationship between *Ownership Structure* and this dependent variable. Regardless, 7 of 9 regressions, including all of the PCSE regressions, indicate that *Ownership Structur*e is not significantly related to *Socioeconomic Environmental Performance*.

The columns labeled Sierra Club Membership per 1000 people, LCV HR Score and LCV Senate score contain the summaries of tests of the prediction that *State Environmentalism* is negatively related to *Socioeconomic Environmental Performance*. None of the PCSE regressions using Sierra Club membership per thousand people per state support the hypothesis. Models 15 and 16 yielded similarly insignificant results. Random effect regressions (Models 41 and 42) confirm these results. In addition, PCSE

[41] Table 17 in Appendix Two indicates that the random effect in Models 42 was generally independent of the independent variables.

regressions with alternative measures *of State Environmentalism* (Models 21 and 22) also corroborate the variable's insignificant relationship with the dependent variable. However, the OLS regression model that includes *Regulator Resource Dependence* in the model (Model 37) shows a positive relationship between the independent and dependent variables ($b=0.14$, $p<.05$). These models suggest that *Regulator Resource Dependence* might also be suppressing the relationship between *State Environmentalism* and *Socioeconomic Environmental Performance*, and that the focal relationship is in the opposite direction of the prediction. Nonetheless, 7 of 8 models, including all of the PCSE models, did not yield significant results. Thus, I cannot conclude that there is a relationship between *State Environmentalism* and *Socioeconomic Environmental Performance*.

Finally, the column labeled *Regulator Resource Dependence* contains the summary of tests of the prediction that ski resort influence over the Forest Service Districts' budgets is positively related to *Socioeconomic Environmental Performance*. The PCSE, OLS and random effects regressions testing for evidence of this relationship each yielded positive and significant results. Therefore, I conclude that this form of *Corporate Climate Change Adaptive Capacity* is positively related to *Socioeconomic Environmental Performance*, as predicted. However, the logic underpinning this prediction is not supported, since *Regulator Resource Dependence* is not simultaneously negatively related to *Biophysical Environmental Performance*. I explore a possible alternative explanation for this result in the *Chapter 7: Discussion* in section *7.1 Explaining of Unexpected Results.*

6.7 Explicit Tests for the Presence of Mediation for Hypotheses 3 and 4

The logic underpinning hypotheses 3 and 4 implies that *Biophysical Environmental Performance* mediates the relationships between *Corporate Climate Change Vulnerability* and *Adaptive Capacity*, respectively, and *Socioeconomic Environmental Performance*. The most popular procedure in management research for uncovering mediation in regression analysis is the four-step causal approach, even though this procedure has been widely criticized as having low power (Hayes, 2009). Still, given its popularity, I used this method to attempt to generate statistical evidence for the mediation components of the theory underpinning these hypotheses. The description of this procedure, and associated results and results discussions are in Appendix Three.

6.8 Summary of Support for the Conceptual Model

The following section summarizes the results from the study. Table 12 contains a list of the study's hypotheses and the levels of support that they received.

6.81 Vulnerability, Adaptive Capacity and Biophysical Environmental Performance

As the first row in Table 12 indicates, hypothesis 1 received fairly strong support in the study. 11 of the 12 regression models of *Biophysical Environmental Performance* indicated that *Vulnerability* was negative related to the dependent variable. The lone exception was random effects Model 30; however, in this model, the random effect was significantly correlated with 11 of 14 independent variables, implying that the effect was not random at all. Given that Model 30 violates one of the core assumptions of random effects estimation, I conclude that it is appropriate to deemphasize the insignificant effect

of *Vulnerability* on *Biophysical Environmental Performance* yielded in this model. Other supportive results were generated by tests of the simple slopes of the first-order terms comprising the interaction term *Vulnerability*. As Table 5 and Figures 4 and 5 show, the slopes of *Exposure* become increasingly negative as *Sensitivity* increases, as do the slopes of *Sensitivity* as *Exposure* increases. These findings support the theory that forces of global ecological change, such as climate change, can induce firms with biophysical vulnerability to those forces to adapt in ways that lower *Biophysical Environmental Performance*. Firms might do so because they have significant control over their biophysical environments (Pfeffer & Salancik, 1978; Wackernagel & Rees, 1997), their biophysical environments contain natural capital and ecosystem services that are effective for adaptations (Prahalad & Hamel, 1990; Scott & McBoyle, 2007), and/or using these ecological resources can be cost effective since they are obtained outside of markets, or from highly imperfect ones (Costanza & Daly, 1992).

Table 12 indicates that hypothesis 2 received mixed support. Of the three forms of *Corporate Climate Change Adaptive Capacity* measured in this study, only *Ownership Structure* was clearly negatively related to *Biophysical Environmental Performance*. This suggests that resource dependence on shareholders and the access to capital it creates may enable and induce corporate climate change adaptations that create biophysical environmental harm. Rivera and colleagues (2006) found similar results in a study of the effectiveness of the Sustainable Slopes Program, where *Ownership Structure* was associated with ski resorts propensity to expand into previously undeveloped wilderness. There was some evidence that *State Environmentalism*, a reverse indicator of *Corporate Climate Change Adaptive Capacity*, was positively related to the dependent variable,

with 4 of 8 models confirming the prediction. However, in the supportive models, 3 of the 4 effects were barely significant ($p<.10$). Thus, I conclude that the study has generated weak support that *State Environmentalism* positively impacts *Biophysical Environmental Performance*. In contrast, previous studies have shown mixed evidence surrounding this relationship. Rivera and de Leon (2004) found that *State Environmentalism* does positively impact corporate environmental performance; on the other hand Rivera and colleagues (2006) found that the constructs were unrelated on most dimensions, except *Pollution Management*, which was negatively related to *State Environmentalism*. Finally, the study yielded no evidence that *Regulator Resource Dependence*, or the magnitude of Forest Service districts' annual budgets that are funded by ski resort special use permit fees, is associated with negative biophysical environmental impacts.

6.82 Vulnerability, Adaptive Capacity and Socioeconomic Environmental Performance

Table 12 indicates that hypothesis 3 received very strong support. All 12 regression models indicated that *Vulnerability* was positively related to *Socioeconomic Environmental Performance*. Further, the study generated other supportive results with the tests of the simple slopes of the first-order terms comprising the interaction term *Vulnerability*. As Table 9 and Figures 6 and 7 show, the slopes of *Exposure* becomes increasingly positive as *Sensitivity* increases, as do the slopes of *Sensitivity* as *Exposure* increases. Therefore, I can conclude that ski resorts' with *Corporate Climate Change*

TABLE 12. Summary of Support for Hypotheses

Hypothesis	**Summary of Results**	**Level of Support**
Hypothesis 1: *Corporate Climate Change Vulnerability* is negatively related to *Biophysical Environmental Performance*.	11 of 12 models negative and significant. Random effects model with insignificant coefficient had dependent random effect, meaning model violated assumption of random effects.	Strong support
Hypothesis 2: *Corporate Climate Change Adaptive Capacity* is negatively related to *Biophysical Environmental Performance*.	*Ownership Structure*: 9 of 9 models negative and significant. *State Environmentalism*: 4 of 8 models positive and significant. *Regulator Resource Dependence*: 0 of 3 models negative and significant.	Strong support Weak support Unsupported
Hypothesis 3: *Corporate Climate Change Vulnerability* is positively related to firms' *Socioeconomic Environmental Performance*.	12 of 12 models positive and significant.	Strong support
Hypothesis 4: *Corporate Climate Change Adaptive Capacity* is positively related to firms' *Socioeconomic Environmental Performance*.	*Ownership Structure*: 1 of 9 models negative and significant. *State Environmentalism*: 1 of 8 models positive and significant. *Regulator Resource Dependence*: 3 of 3 models positive and significant.	Unsupported, very weakly contradicted Unsupported, very weakly contradicted Strong support

Vulnerability improve their *Socioeconomic Environmental Performance* to atone for the negative impacts they create in their biophysical environments as they adapt to climate change.

Hypothesis 4 received mixed support. Regressions models of *Socioeconomic Environmental Performance* indicated that *Ownership Structure* and *State Environmentalism* were not related to the dependent variable as predicted. In fact, there is some weak evidence that these tests contradicted the predictions in H4. Specifically, 1 of 9 models that regressed the dependent variable on *Ownership Structure* indicated a negative relationship, while 1 of 8 models regressing the dependent variable on *State Environmentalism* (a reverse indicator of *Corporate Climate Change Adaptive Capacity*) yielded a positive relationship. However, the models using the primary statistical technique, PCSE, did not yield significant results. Still, I explore possible explanations for contradictory results in *Chapter 7 Discussion* in section *7.1 Explaining of Unexpected Results*. Finally, each of 3 models regressing *Socioeconomic Environmental Performance* on *Regulator Resource Dependence* yielded positive and significant relationships. Thus, I can conclude that this form of *Corporate Climate Change Adaptive Capacity* is positively related to *Socioeconomic Environmental Performance*.

CHAPTER 7. DISCUSSION AND CONCLUSIONS

This dissertation was motivated by three factors. First, there is a dearth of research in the area of corporate climate change adaptations, even though climate change will create geophysical, impacts on firms, which will necessitate substantive changes to business models (Hoffman et al., 2009; Winn et al., 2010). Given the generally accepted forecasts that climate change will affect many of the earth's ecosystems and the social systems dependent upon them (IPCC, 2001; 2007), this will become a critical research area, even if it is currently on the fringe of the management discipline.

Second, this area, through the construct of *Corporate Climate Change Vulnerability*, provides evidence of the direct relationship between firms and ecological environments. Even in the field of corporate sustainability, few are studying this relationship (Pogutz & Winn, 2009; Starik & Rands, 1995), despite the overwhelming evidence that markets and institutions do not completely and consistently filter it (Costanza & Daly, 1992), and the lack of effective governance over most of the world's ecosystems is enabling human and corporate behavior to push them beyond their carrying capacities (Millennium Ecosystem Assessment, 2005). Economic accounts that view environmental degradation as a market failure implicitly recognize that a direct relationship between firms and ecology must exist, since the very idea of a market failure involves costs that are externalized from markets. Thus, given that there is only one earth, which can only absorb so many "externalities," it follows that scholars need to recognize and understand the direct firm-natural environment relationship, if they are to generate cumulative knowledge about sustainability.

Finally, management scholars need to pay more attention to the comprehensive corporate environmental performance, across multiple dimensions of the construct, to improve our understanding of firms' real impacts on the environment. Most studies focus on one aspect of corporate environmental performance, such as toxic releases, or carbon emissions, while performance can be systematically divergent in other aspects. For example, Levy and Kolk (2002) concluded that British Petroleum had an innovative internal carbon trading scheme and above industry average investments into renewable energy development in response to corporate values and European institutional pressures. At the same time, it underinvested into safety measures that were required to prevent accidents that had disastrous impacts on its biophysical environments. Still, scholars focused their discussions on the firm's carbon footprint and "Beyond Petroleum" marketing campaign, because of information availability bias: many knew of its carbon reduction efforts, while its environmental and human safety management systems were less observable and infrequently reported in research. A more comprehensive assessment recognizing this other dimension of corporate environmental performance would have likely resulted in markedly different conclusions about the firm's environmental record.

In the end, the dissertation helps generate knowledge for each of these gaps. It advances the area of *Corporate Climate Change Adaptations* by demonstrating empirically that ecological pressure induces firms to adapt in ways that create ecological impacts. More specifically, the dissertation study shows that *Corporate Climate Change Vulnerability* can be associated with both negative effects on *Biophysical Environmental Performance* and positive effects on *Socioeconomic Environmental Performance*, ceteris paribus. In doing so, it advances nascent attempts to theoretically account for the direct

firm – natural environment relationships, by extending resource dependence theory with a model of *natural* resource dependence. In addition, it generates new evidence that stronger environmental performance in one dimension can be systematically related to weaker environmental performance in other dimensions. Thus, firms might do "good" and "bad" to the environment simultaneously, implying that only assessing the "good" or the "bad" paints an incomplete picture about corporate environmental performance. Further, it generates evidence that divergent corporate environmental performance can occur in response to external pressures. Thus, scholars and practitioners can expect this behavior to occur as conditions in firms' business environments change. Finally, the dissertation study also yielded unexpected results with relevant implications for theory and practice. In unpacking the implications of both expected and unexpected results, the rest of this chapter is organized as follows: in the next section, I discuss the study's unexpected results. I then discuss the broader implications of the study for both theory and practice. Next, I identify some key limitations of the study and avenues for future research. Finally, I conclude will a brief discussion on the immediate future of the research contained in this dissertation.

7.1 Explaining Unexpected Results

The first set of unexpected results is the positive effects of *Sensitivity* on *Biophysical Environmental Performance* at low and average levels of *Exposure*. Given that *Sensitivity* is a component of *Vulnerability*, and that *Vulnerability* is negatively related to *Biophysical Environmental Performance*, it is reasonable for one to expect that *Sensitivity* should also be negatively related to this dependent variable. However, as

mentioned above, *Corporate Climate Change Vulnerability* is conditional on the joint effects of *Exposure* and *Sensitivity*. Thus, examining the direct effects of *Sensitivity* on *Biophysical Environmental Performance* should not necessarily be indicative of the nature of the relationship between *Vulnerability* and dependent variable. Rather the direct effect of *Sensitivity* speaks only to how firms react to this condition specifically. Above, I suggest that firms' *Sensitivity* might be positively related to *Biophysical Environmental Performance* at low and average levels of *Exposure* because it might cause managers to shift their attention to ecosystem protection management. Higher levels of *Sensitivity* imply that firms' biophysical environment is more sensitive to ecological change, making ecosystem protection in firms' biophysical environment a more urgent issue to manage. Managers that identify an issue as urgent tend to be more likely to address that issue and less likely to address others, whether or not they have vital strategic important (Dutton & Dukerich, 1991; Ocasio, 1997). In this, case, ecosystem protection management might be a strategic issue for sensitive firms, since there are federal regulations to govern firms management of low snowpack ecosystems (U.S. Department of Agriculture, 2002).

Further, as firms' *Sensitivity* increases, they may be more inclined to take steps to invest in the preservation of natural capital in their biophysical environments to reduce their natural resource dependence and improve their social legitimacy (Pogutz & Winn, 2009). Preserving natural capital can improve a local ecosystem's health and ability to provide ecosystem services. If these services are critical resources to firms, preserving natural capital can actual reduce *Organizational Dependence on Ecosystems* and *Ecological Impacts on Organizations*. Pogutz and Winn (2009) call such actions "sustainable fit strategies," which they define as "the ability of the firm to adapt to and

align dynamically with the resilience of the ecosystem where it is embedded, preserving ecosystem health to the extent that the provisioning of ecosystem services on which the firm depends is not jeopardized" (p.32).

The second set of unexpected results is the negative effects of *Sensitivity* on *Socioeconomic Environmental Performance* at low and average levels of *Exposure*. Again, it is possible to explain these results as a function of managers' attention span and priorities, or the lack thereof, with respect to *Socioeconomic Environmental Performance*. Given that higher levels of *Sensitivity* are also associated with higher levels of *Biophysical Environmental Performance*, managers' attention span under these conditions might cause them to deemphasize *Socioeconomic Environmental Performance*, since protecting firms' biophysical environment might be more urgent. In addition, since *Sensitivity* and *Biophysical Environmental Performance* are positively related under conditions of low and average *Exposure*, it is possible that, under these conditions, firms are less likely to face environmental legitimacy problems arising from sub-standard *Biophysical Environmental Performance*. As a result, they may be less likely to find utility in business practices associated with average or better than average *Socioeconomic Environmental Performance*, because they do not need to compensate for lower levels of *Biophysical Environmental Performance*.

The third unexpected result is that there is some, albeit weak, evidence that *Ownership Structure* was negatively related to *Socioeconomic Environmental Performance*, contrary to the prediction that these variables would be positively related (H4). The basis of the prediction was that publicly-owned ski resorts would improve their *Socioeconomic Environmental Performance* to atone for the negative relationship

between *Ownership Structure* and *Biophysical Environmental Performance*. Instead, *Ownership Structure* might be negatively related to both dimensions of ski resorts' environmental performance measured in this study.

A possible explanation for this finding is that public-ownership induces firms in this context to deemphasize the strategic value of corporate sustainability across the board, because of resource dependence on financial stakeholders. Decision-makers at these firms may tend to believe that they can satisfy profit-maximizing shareholders by allocating their attention and capital away from sustainability-oriented business practices that have uncertain long-term financial returns (Walley & Whitehead, 1994). In other words, instead of demanding better environmental performance, Wall Street "focuses on demanding consistent double-digit increases in financial performance which, in the case of ski resorts, is accomplished by focusing on aggressive real estate development and expansion activities that inherently have a negative impact on the environmental footprint of ski resorts" (Rivera et al., 2006: 215).

It is important to reaffirm that the evidence generated in the current study linking *Ownership Structure* to lower *Socioeconomic Environmental Performance* is very weak, and that 8 of 9 regression models showed an insignificant relationship between the constructs. Thus, the most sensible conclusion from the study is that *Ownership Structure* is negatively related to *Biophysical Environmental Performance* and unrelated to *Socioeconomic Environmental Performance.* These results are consistent with findings by Rivera and de Leon (2004) and Rivera and colleagues (2006), who found that publicly-owned ski resorts were significantly more to likely to demonstrate lower overall

environmental performance, mainly attributed to their propensity to develop new terrain for skiing (a components of *Biophysical Environmental Performance*).

A fourth unexpected result is that there is some, albeit very weak, evidence that *State Environmentalism* is positively related to *Socioeconomic Environmental Performance*. Originally, I had predicted in H4 that these variables would be negatively related, since *State Environmentalism* is a reverse indicator of *Corporate Climate Change Adaptive Capacity*, and that the latter construct should have been negatively related to *Socioeconomic Environmental Performance*. A plausible explanation for this potentially contradictory finding is that, in this context, firms' *State Environmentalism* promotes higher levels of corporate environmental performance broadly. If firms operate in states where there is more normative pressure to engage in corporate environmental protection, they may simply be more likely to institute pro-sustainability business practices across the board.

Normative pressure in states not only reflects the values of citizens with respect to corporate environmental protection, but also their propensity to elect politicians that institute stringent environmental regulations, become public employees that enforce them, and endorse governments' capacity to implement them (Rivera & de Leon, 2004). Further, normative pressures associated with corporate environmental protection can also influence firms' behavior indirectly through consumers' purchasing behaviors (Clarkson, 1995). Given the potentially diffuse outcomes of normative influences, it would not be surprising if its impacts on corporate behaviors were broadly distributed across many environmental issues. Nonetheless, it is important to recall the evidence from this study of a positive relationship between *State Environmentalism* and *Socioeconomic*

Environmental Performance is very weak. Thus, the most sensible conclusion from the study is that *State Environmentalism* is positively related to *Biophysical Environmental Performance* and unrelated to and *Socioeconomic Environmental Performance.* Similarly, Rivera and de Leon (2004) found that state environmental activism was positively related to aggregate measures of corporate environmental performance. However, Rivera and colleagues (2006) found that state environmental activism was generally unrelated to corporate environmental performance, with the exception of firms' ability to manage pollution. Surprisingly, they found that these variables were negatively related to each other.

Finally, while *Regulator Resource Dependence* is positively related to *Socioeconomic Environmental Performance* as predicted, it is also unrelated to *Biophysical Environmental Performance*. Thus, there is no evidence that *Regulator Resource Dependence* induces firms to improve their *Socioeconomic Environmental Performance* to atone for lower levels of *Biophysical Environmental Performance*. A possible alternative explanation for the positive relationship between *Regulator Resource Dependence* and *Socioeconomic Environmental Performance* is that the measure of independent variable also reflects the strength of the relationships between ski resorts and the Forest Service, and by extension, normative influence that the Forest Service might have on ski resorts. To explain, as ski resorts operating under Forest Service special use permits generate more revenue and contribute more in fees to Forest Service district offices, they also necessitate more administrative and oversight activity with those offices (16USC§497c, 1986; Briggs, 2000). As a result, the amount of coordination of these activities between ski resort managers and Forest Service district agents rises

commensurately with the scope of ski resorts' activities on Forest Service lands (Briggs, 2000). As the amount of coordination increases in scope and over time, so does the capacity of the relationship to act as a conduit of knowledge and/or normative influences across the connected organizations (Powell, Koput & Smith-Doerr, 1996; Rowley, 1997). Thus, these conditions might not be associated with ski resorts' enhanced power over Forest Service districts, but rather the districts' normative influence over ski resorts.

Regulator Resource Dependence also reflects the relative size of the ski industry within the communities that comprise individual Forest Service districts, since special use permit fees contributed to Forest Service district budgets are determined as a percentage of ski resorts' gross revenue (16USC§497c, 1986; Gorte, 2000; Rivera et al., 2006). As a result, *Regulator Resource Dependence* may also reflect the visibility of the ski industry to communities within Forest Service districts. Firm visibility, in turn, can increase civil society's attention toward firms' corporate environmental performance, and by extension, their expectation that those firms exhibit better environmental performance (Arora & Cason, 1996; King & Lenox, 2000; Rivera, 2000). Given Forest Service districts' increasing dependence on fee-based income to fund its administrative and operational expenses (Gorte, 2000), they have direct financial incentives to ensure that the local ski industry meets this scrutiny and maintains its environmental legitimacy within its local communities.

As a result, they may be more likely to apply coercive and normative pressure on ski resorts to adopt highly visible proactive environmental strategies. The business practices associated with these strategies tend to be those that are more widely institutionalized, linked to prevailing discourses surrounding corporate sustainability, and

are less technical in nature (i.e. more easily understood) (Rivera et al., 2006). Such practices include recycling, energy efficiency, clean technology, community sustainability initiatives, and other practices associated with better *Socioeconomic Environmental Performance*. On the other hand, practices associated with better *Biophysical Environmental Performance* may be less visible to a discerning civil society, because they are more difficult to observe and are more closely linked to technical sustainability discourses that are prevalent in scientific communities. Therefore, Forest Service districts may tend not to apply additional pressure to economically important ski resorts to adopt business practices that improve corporate environmental performance in firms' biophysical environment.

The previous discussions regarding isomorphic pressures generated by *State Environmentalism* and *Regulator Resource Dependence* suggest that it might be more appropriate to explain the theoretical linkages between these constructs and corporate environmental performance through the lens of neo-institutional theory rather than resource dependence theory. Coercive and normative isomorphism are foundational concepts for neo-institutional theory (see, for example, Dimaggio & Powell (1983)) and have been the subjects of hundreds of studies in the management discipline that have contributed to the development of an institutional perspective of organizational and interorganizational behavior (Heugens & Lander, 2009). It is true that resource dependence theory can be viewed as containing overlapping concepts, since it characterizes the social legitimacy of organizations as a critical, externally-controlled resource that is conferred by stakeholders (Pfeffer & Salancik, 1978). As a result, prominent institutional theorists have questioned whether these theories have

substantively unique explanatory power with respect to coercive and normative forces on organizations that cause them to establish, maintain, protect, and reestablish their legitimacy (Tolbert & Zucker, 1996). Nonetheless, neo-institutional theory may be better suited for describing the phenomena in question here, since the arguments presented above describe firms' conformity to institutional pressures rather than strategic responses. The predominant views regarding firms' response to institutional isomorphic pressures is that firms tend to conform to isomorphic pressures while they strategically adapt to problems of resource dependence (see, for example, Oliver, 1991; Suchman, 1995).

The "institutional" nature of these measures of *Corporate Climate Change Adaptive Capacity* raises a larger issue, namely with the broad conceptualization of the construct: can *Corporate Climate Change Adaptive Capacity* account for external conditions in firms' business environment, as argued by Bleda and Shackley (2008), or, rather, is it exclusively a firm-level construct? While the current study has taken the former approach, it is possible that the latter one is more appropriate. Typically, researchers have identified different corporate adaptive capacities as firm-level constructs that are associated with an individual organizations' ability to learn and change, rather than a construct that can diffuse in firms' institutional environments (see, for example, Cohen 1990; Eisenhardt & Martin, 2000; Newman, 2000; Zott, 2003). The basis for this approach is that firm-level conditions, rather than industry or institutional level forces, are the drivers of heterogeneous intra-industry performance (Barney, 1991). Firms do not, however, adapt to industry or institutional pressures in homogenous ways. Their responses depend on firm-level conditions, which can enable or constrain strategic responses to these pressures (Oliver, 1991). In addition, firms' portfolio of capabilities

may achieve heterogeneous degrees of fit with changing industry conditions and institutional pressures (Oliver, 1997). Finally, some firms are more nimble than others when faced with isomorphic pressure and can develop more creative and competitive responses (Eisenhardt & Martin, 2000). As a result, the current study might be examining the effect of broader institutional influences on corporate environmental performance rather than firm-specific forms of adaptive capacity that are associated specifically with the biophysical pressures created by climate change. To reconcile this issue, future research might reconceptualize *Corporate Climate Change Adaptive Capacity* and/or study the moderating effect of external institutional influences (i.e. *State Environmentalism*, *Regulator Resource Dependence*) and firm-specific proxies for *Corporate Climate Change Adaptive Capacity* (i.e. *Ownership Structure*) on corporate environmental performance.

It is important to note, also, that the results in supplemental PCSE regression analyses of *Biophysical Environmental Performance* on *Regulator Resource Dependence* that excluded outliers and influential observations (see Table 20, Models 43 and 44, in Appendix Two) are supportive of hypothesis 2. Specifically, in these models, *Regulator Resource Dependence* was significantly and negatively associated with the dependent variable (Model 43: $b = -0.34$, $p < 0.10$; Model 44: $b = -0.30$, $p < 0.10$). Thus, with the restricted sample, the importance of the ski industry to individual forest service districts' annual budgets is associated with declining levels of *Biophysical Environmental Performance*. This supports the theory that regulators' resource dependence on the industry enables firms within those districts to pursue climate change adaptations that harm firms' biophysical environment. In addition, it supports the theory underpinning

hypothesis 4, which predicted that firms with lower levels of *Biophysical Environmental Performance* will exhibit higher levels of *Socioeconomic Environmental Performance.* Here, it was argued that ski resorts would exhibit better *Socioeconomic Environmental Performance* as a compensatory measure to appease environmentally concerned stakeholders and local communities that also depend upon firms' biophysical environments for critical ecological resources. Given these conflicting sets of results with respect to the significance of the effect of *Regulator Resource Dependence* on *Biophysical Environmental Performance,* it appears that additional analysis may be necessary to more robustly uncover whether hypotheses 2 and 4 are supported by this study's data. This might include combining sample restrictions to exclude influential observations with modern techniques for testing the significance of mediation effects (see mediation analyses discussion in Appendix Three, section A.3.4).

7.2 Implications for Research

7.21 Implications for Organizational Theory

The study contributes to resource dependence theory by describing the unique aspects of natural resource dependence. To date, scholars have considered resource dependence to be solely a function of the distribution of socioeconomic power and interdependence among organizations (Cascario & Piskorski, 2005; Pfeffer & Salancik, 1978). The firm-natural environment relationship, however, can embody different dynamics, in cases when actors, organizations and institutions do not mediate this relationship (Winn et al., 2010). First, the natural environment, through expressions of geoclimatic and geophysical events, such as climate change and its associated

phenomena, subjects natural resource-dependent firms to expressions of natural power that might be temporally or spatially removed from the firm itself. Further, the scale of energy behind these forces can be much higher than those of firms. In addition, firms' socioeconomic power is orthogonal to globally dispersed ecological forces. For these reasons, firms are essentially powerless to influence the dispersion of such forces or stop their effects in their biophysical environments.

Second, firms can have direct power over their biophysical environments for the provisioning of critical ecological resources, because licenses to operate and/or property rights make them the sole day-to-day stewards of those ecosystems. Given that social entities and social constructed rules and norms provide governance over firms' use of important resources, their absence can give firms more direct control over their biophysical environments. As a result, regulatory and normative institutional stakeholders that attempt to influence firms' use of their biophysical environments may not have the capacity to observe, understand and/or mitigate firms' biophysical environmental impacts before they happen.

As a result of these two considerations, the resource dependence problems associated with the direct firm-natural environment relationship are not describable through the mechanisms of interdependence and countervailing socioeconomic power. Rather, they are more aptly described by conditions of unidirectional dependence and power. Firms depend on their biophysical environments, while the reverse is not true, given that ecology would continue to function if firms were not there. On the other hand, firms' can have the power to use their biophysical environments as they see fit, while the

ecosystems comprising them, as non-social entities, have no countervailing socioeconomic power against firms.

A final observation is that all resources ultimately originate in the natural environment, implying that firms are at least indirectly dependent on the earth for their entire resource base. By implication, one firms' natural resource dependence can create ripple effects through socioeconomic systems in both subtle and extreme ways. For example, Belliveau and colleagues (2006) describe a case where vineyards in rural British Columbia were not directly vulnerable to uncontrollable forest fires in the region during a period of prolonged drought conditions; at the same time, these fires had significant impacts on the local tourism economy, which was responsible for a significant portion of the local wine industry sales. Hurricane Katrina provides another stark example at a different scale; it had obvious direct effects on a variety of coastal industries, as well as the insurance industry. At the same time, because so many oil refineries in the region were rendered temporarily inoperable by the storm and resulting floods, gasoline prices in the U.S. soared, causing ripple effects throughout the global economy (Hoffman, 2006). Clearly, organizational theories that do not account for the power of the natural environment to affect firms cannot fully explain these events. As ecological change becomes an increasingly salient issue for business, and natural resources become increasingly scarce, it will become paramount for the management discipline to fully develop this organizational theory. For now, this study highlights some of its key departures from, and points of integration with, resource dependence theory.

7.22 Implications for the Study of Corporate Climate Change Adaptation

The study opens the area of corporate climate change adaptations to an open-systems perspective of the antecedents and outcomes of this type of corporate behavior. Before this work, scholars in the area had applied predominantly firm-level organizational theories to make sense of corporate climate change adaptation, by developing sorting logics for the resources, capabilities and processes that underpin these adaptations (e.g. Berkhout et al., 2006). However, it is well-recognized and easily observable that the antecedents of climate change adaptation involve forces in the external biophysical and socioeconomic environments of firms (Adger, 2006; Belliveau et al., 2006; Winn et al., 2010). The current focus on firm-level drivers of adaptations does not give the roles of these forces their due in research. For this end, the dissertation theorizes how these forces work to influence adaptations and how adaptations can generate impacts and feedback in firms' external environment where socioeconomic and natural forces originate.

In addition, it generates quantitative evidence that climate change adaptations involve open-systems, and the multilevel-multisystem effects on sustainability first articulated by Starik and Rands (1995). To date, inductive studies have articulated how global, national, and local institutions and institutional change occurring across these levels can moderate firms' climate change adaptive capacity and vulnerability and their effects on the form and intensity of their climate change adaptations. For example, Belliveau and colleagues (2006) describe how British Columbia vineyards responded to the pressure of economic globalization by planting species that were more valuable in the broader markets. The same species proved to be more difficult to grow as long-term weather patterns became more variable and contained more extreme weather events. As a

result, this group of firms requires more irrigation to buffer itself from the potential for drought conditions. The current study broadens the generalizability of these implications with a "larger N" sample.

Finally, the study is the first in the area to develop independent and objective measures of corporate climate change vulnerability that are unaffected by perceptions, cognitive limitations and imperfect availability of information. Instead of using surveys or interviews to measure firms' climate change vulnerability, I use climate data collected mechanically, to assess both firms' exposure and sensitivity to the phenomenon. Since climate change exposure, at very least, is an exogenous factor, it is important to minimize measurement error associated with endogenous forces such as managers' cognitive biases or imperfect access to information. In doing so, it answer some calls from researchers to measure and model the natural environment directly when it is a unit of analysis (Starik, Sharma, Egri & Bunch, 2005).

7.23 Implications for Study of Corporate Sustainability

The dissertation adds to the growing body of research that is showing that firms can perform well in some dimensions of environmental performance, but poorly in others (e.g. Kotchen, 2009; Mattingly & Berman, 2006; Rivera et al., 2006; Rivera & de Leon, 2004; Tashman & Rivera, 2010). This finding reiterates the importance of assessing multiple dimensions of firms' environmental performance. In addition, it also confirms that there are multiple reasons firms might perform both positively and negatively simultaneously with regard to how well they manage their relationships with the natural environment. The current study generates evidence this might occur so firms can atone

for weaknesses in other areas by improving in others. Other scholars have observed that this behavior occurs when firms try to directly off-set their negative environmental externalities (Kotchen, 2009). For example, many firms now compensate for carbon emissions by purchasing carbon offsets or credits, which may not have a direct impact on their own emissions, but does mitigate emissions elsewhere in the global economy. Finally, Mattingly and Berman (2006) and Rivera and colleagues (2006) suggest that institutional or policy weaknesses create incomplete incentives for firms, thereby inducing systematically diverging corporate environmental performance along different dimensions. Policy agendas tend to focus on large public issues, because, absent the leviathan, governments lack the capabilities of regulating every environmental market failure. Not surprisingly, the issues that policy-makers do tackle tend to receive widespread notoriety and/or public support (Preston & Prost, 1975). As a result, firms more often have incentives to address visible environmental performance issues that are well diffused in the public discourse, such as GHG emission reductions and recycling, than localized issues that are difficult to observe, such as the health of ecosystems comprising remote riparian zones. Future research could develop a model outlining why firms perform well in some areas, but not in others. The application of this research could help firms manage their sustainability and legitimacy more comprehensively, and help policy-makers develop more holistic sustainability prescriptions.

At the same time, the dissertation's assessment of firms' diverging *Biophysical* and *Socioeconomic Environmental Performance* provides evidence that significantly more research is necessary to effectively bridge our understandings of corporate sustainability and sustainable development. More specifically, it indicates that sampled

firms improved environmental performance when there was a clear rationale for them to do so, such as addressing *Socioeconomic Environmental Performance* to protect environmental legitimacy. At the same time, their environmental performance in domains that were external to regulations and markets declined, again, because of a clear rationale involving climate change vulnerability. This divergence in firms' corporate environmental performance begs the question: are firms' corporate sustainability efforts really contributing to a more sustainable global economy?

For over two decades, scholars have been observing innumerable instances of firms controlling and preventing pollution, managing the lifecycle impacts of their products and services, working to develop "green" products and technologies, and even on occasion engaging in multisectoral action to improve environmental governance (Hart, 1995; Starik et al., 2005; Zadek, 2007). These corporate sustainability efforts involve attempts by the firm at "meeting the needs of a firm's direct and indirect stakeholders (such as shareholders, employees, clients, pressure groups, communities, etc (*sic*)), without compromising its ability to meet the needs of future stakeholders as well. Towards this goal, firms have to maintain and grow their economic, social and environmental capital base while actively contributing to sustainability in the political domain" (Dyllick & Hockerts, 2002). While corporate sustainability seems to be focused on the things related to sustainable development, namely the preservation of firms' economic, social and environmental capital bases, it is still a firm-centric phenomenon that relies on an established "business" case. Sustainable development, on the other hand, is also concerned with "externalized" economic, social and environmental capital, including labor rights abuses in developing countries with institutional voids and the

protection of systems of natural capital that are outside of the protection of markets and regulations.

One can infer that corporate sustainability efforts by the global business community in the aggregate are only tenuously related to sustainable development, from strong evidence that the global political economy is continuing to push the earth farther beyond its carrying capacity (Millenium Ecosystem Assessment, 2005; Hart, 2007). For example, many firms are reducing their GHG emissions; however, GHG emissions from the private sector are continuing to increase drastically, mainly because of emerging market economy growth, and efforts to reduce emissions intensity rather than total emissions (Pinske & Kolk, 2009). The causes of this disconnect are well-documented, and generally can be categorized in one of three ways: as instances of collective action problems associated with the Volunteer's Dilemma, discouraging firms from pursuing greater sustainability because they fear competitive disadvantages (Ostrom, 1990); industrial power contesting more sustainable governance regimes because many firms care more about their profitability than the sustainability of human society (Levy & Kolk, 2002); and, of the widespread lack of understanding among citizens and consumers about the sustainability of the global political economy and their own behavior (Hart, 2007). However, much more can be done to study real attempts by firms at solving these problems, beyond the current focus, which is on factors that induce firms to move beyond central tendencies of environmental performance. Zadek's (2007) description of transformative corporate citizenship is an example of conceptual research that addresses these problems. Since real multisectoral solutions to the problems associated with sustainable development are still in the experimental stage, researchers should continue to

study what is working, what is not working, and what are the unintended consequences across levels and systems.

7.3 Implications for Policy and Practice

The findings suggest that policy prescriptions may be necessary to induce sustainable climate change adaptations. This task will be challenging since, irrespective of the impacts of corporate climate change adaptations, policy regimes globally have not determined how to protect the earth's natural capital (Millennium Ecosystem Assessment, 2005). Moreover, neither policy makers nor markets are properly accounting for the real value of many of the planet's ecological resources (Constanza et al., 1997; Wackernagel & Rees, 1997). As noted earlier, most of the world's ecosystems were in decline (Millenium Ecosystem Assessment, 2005). In addition, Constanza and colleagues (1997) found that the value of the "free" ecosystem services provided to human society was likely between $16 trillion and $54 trillion annually in 1997. Yet, until we monetize them appropriately, it seems unlikely that we can ensure that they will be managed sustainably (Costanza & Daly, 1992; Wackernagel & Rees, 1997), since freely (or cheaply) available goods induce both free-rider and tragedy of the commons behaviors (Harding, 1969; Olsen, 1965; Ostrom, 1990; Tashman & Rivera, 2010). A final complication stems from the integration of global markets, which make it essential to harmonize global policy initiatives across countries, to mitigate the potential for good global citizens to experience comparative disadvantages. Given these realities, the present study aims to reaffirm the importance of substantive and collective recognition, multi-laterally, of the value and the fragility of natural capital and ecosystem services.

The findings also suggest that climate change adaptations can exacerbate the already serious problems associated with corporate environmental performance and involve taking steps to improve *Socioeconomic Environmental Performance*. In some cases, the latter effect could induce other organizations in firms' value-added chains to improve their own *Biophysical Environmental Performance*, since *Socioeconomic Environmental Performance* can involve influencing other organizations to become "greener." However, since firms that are biophysically vulnerable to climate change are often suppliers that operate in renewable natural resource industries, their ability to influence environmental performance upstream might be constrained by their positions in value-added chains.

Finally, efforts to break the linkage between *Corporate Climate Change Vulnerability* and *Biophysical Environmental Performance* will require disruptive technologies, more innovative business models and broader institutional change. Current policy regimes, economic behaviors, and demographic trends are interacting in ways that are accelerating the depletion of the earth's natural capital. New paradigms are undoubtedly necessary. One example at the industry level involves agriculture, where firms are now dealing with droughts and infestations by using genetically-modified seed stocks (GMOs) and specialized pesticides, reducing their dependence on arable land and irrigation water. At the same time, they are facing civil opposition from groups that fear the effect of GMOs on ecology and the power that such firms may be amassing over food supplies. Thus, new paradigms may require institutional innovation to accompany technological innovation on a case by case basis. In addition, great care needs to be taken when developing new paradigms so that they do not also induce unintended

maladaptation. For example, GMOs and pesticides may be causal factors of Colony Collapse Disorder among pollinator bees, who are critical components of global agriculture (Cox-Foster et al., 2009; Southwick & Southwick, 1992).

7.4 Limitations and Future Research

The study findings are limited in several ways. First, the data I used to develop measures of climate change exposure and sensitivity spanned 2000-2009, because of data availability. This is a potentially short timeframe for capturing the attention span of managers for the biophysical impacts of the climate change. A longer history would have enabled assessment of trends from the more distant past that have carried forward to influence recent ski resort strategies. In the future, more time periods of data will become available to develop this longer history.

Second, since the climate data were averaged across the sampling history to develop measures of climate change exposure and sensitivity, the measure of vulnerability does not account for variances in these measures. Variance could be a key factor of climate change impacts on biophysical and socioeconomic systems. Higher variances imply great probability that weather extremes can create disruptive events to biophysical and socioeconomic systems. They also can create more uncertainty for decision-makers responsible for planning and implementing climate change adaptations (IPCC, 2001). Since operationalizing climate change vulnerability is difficult given, potentially, the great range of parameters that can be available for the task (Adger, 2006), the method chosen for this study is only a first step for management sciences. Future

research could explore new or more sophisticated ways of operationalizing the construct that include different parameters, such as variance-based climate change measures.

Third, the sample based on the use of the SACC environmental performance database might not be representative of the U.S. ski resort industry in the aggregate. The sample included only western U.S. ski resorts and comprised approximately 15% of the ski resorts operating in the United States in 2009, the final yearly time period in the study. It did include many of the largest and most well-known U.S. ski resorts, but it excluded many small ski resorts. As a result, the sample is likely skewed towards larger and more developed ski resorts. This bias has likely magnified the effects of interest in the study, since larger ski resorts with higher levels of capitalization are more likely to want to protect their investments from climate change vulnerability. In addition, larger ski resorts are also likely to have more firm-level climate change adaptive capacity, visibility with civil society stakeholder groups associated with normative environmental pressure, and regulator resource dependence.

Western U.S. ski resorts are also much more likely to operate on Forest Service land than resorts in other parts of the country (Rivera et al., 2006), potentially further magnifying the effect of regulator resource dependence and public land designation. In addition, the sampling restriction likely increases the bias toward proximity to national parks, since 27 of the nation's 59 national parks are located in the geographic region associated with the sample, while only 15 parks are proximal to other ski regions in the U.S.[42] Thus, the sample region probably has higher summer recreation potential that the population, on the average.

[42] Source: http://en.wikipedia.org/wiki/List_of_areas_in_the_United_States_National_Park_System. Access date April 10, 2011.

In addition, western U.S. ski resorts do not encompass the geo-climatic and socio-political diversity of the entire population. They are subject to weather generated from the Pacific Ocean and Arctic regions, which consistently generates the highest frequency and intensity of winter storms in the ski regions of the U.S. Other ski regions, in the mid-western and eastern parts, of the U.S. are exposed to Pacific weather via the jet stream after storms pass over the Coastal and Rocky Mountains, and western plains. Eastern ski resorts are also exposed to weather from the Atlantic Ocean and, on occasion, the Gulf of Mexico. These weather patterns generally do not yield as much snow as those involving direct exposure to the Pacific. On the other, the western U.S. does contain significant climatic heterogeneity. Coastal mountain ranges in California, Oregon and Washington consistently receive the most snow in the U.S., while some interior ranges in the Rocky Mountains are consistently dry. More intermediate western U.S. mountain ranges tend to receive amounts somewhere in between, since pacific storms become drier as they move from west to east (McClung & Shaerer, 2000). As a result, scope of the climate variability in the western U.S. may not be biased from the population of U.S. ski resorts.

The geology of the U.S. mountain ranges also varies from west to east. East of the continental divide, mountains are much older, lower, and generally have a significantly higher percentage of dense hardwood forests. Western ski resorts are more likely to have higher elevation conifer forests that facilitate natural glade skiing. These geological differences represent regional-level effects on natural capital stocks that are not captured in the proposed sample. As a result, western U.S. ski resorts are likely to have better skiing terrain than eastern ones, as well as more valuable wildlife habitat. This could create countervailing biases on the effects on interest. On the one hand, western U.S.

resorts have more sensitive ecosystems to perturb. On the other hand, better skiing terrain can reduce sensitivity to climate change by making it easier to ski with less snow.

It is difficult to ascertain whether there is socio-political bias in the sample. The state environmentalism represented in the sample range from very high (for example, California and Oregon) to very low (for example, Utah and Wyoming). Other states (for example, Colorado and Washington) have intermediate levels of state environmentalism. The same conditions exist in states excluded from the sample. For example, Vermont has very high levels of state environmentalism, Wisconsin has intermediate values and North Carolina has relatively low values. It is possible that this bias is skewed downward, since the sample does contain the states with the lowest levels of state environmentalism in the U.S., specifically Utah and Wyoming. Thus, this implies that *Biophysical Environmental Performance* is lower, ceteris paribus, in the sample than in the population.

The sample is biased in terms of Sustainable Slopes Program membership. According to Table 2, 86 percent of resorts in the sample are members of the program, while, in 2009, only 42% of U.S. ski resorts were members. Given that it is unclear whether the program impacts environmental performance, this bias may not affect the effects on interest. The sample may also be over-represented by horizontally integrated ski resort companies. In 2009, approximately 20% of ski resorts in the U.S were part of consortiums[43], while 43% of the resorts in the sample across the years were. Given that horizontal integration appeared to positively influence *Biophysical Environmental Performance*, it is possible that sampled firms tend to perform better in this regard than the population, on average.

[43] Source: http://www.skiareacitizens.com/index.php?nav=ownership. Access date: April 10, 2011.

While the sample may be biased, it might create some advantages. First, it ensures that most firms in the study operated under special use permits administered by the U.S. Forest Service. In this region, 90% of ski resorts operate under the jurisdiction of the Forest Service (Rivera et al., 2006). Thus, it is an appropriate sample for assessing the impact of *Regulator Resource Dependence* on corporate environmental performance. Further, western ski resorts, in particular, represent the most popular ski region in the U.S. In 2008, the region contained 163 of the country's 473 ski resorts (34%), while capturing approximately 32 million of its nearly 60 million skier-days. In addition, in 2008 foreign visitors (from outside of Canada) visited western ski areas 74% of the time they skied in the U.S. (NSAA, 2008).

The number of ski resorts rated by the SACC is growing, and will soon include firms from Canada as well as the U.S. Future studies might take advantage of the growing sample to address some of these sampling bias issues. Alternatively, future studies could examine some of the relationships posited in this study in different industries with broader data availability. Such studies could make important contributions to the area of corporate climate change adaptation and the theory of natural resource dependence, since different industries face different regulatory and technological constraints (Porter & van der Linde, 1995).

Fourth, the sample size of 76 firms is small enough so that outliers could unduly influence the effects of interest. To assess whether this was the case, I calculated Cook's D statistics for each of the observations in the sample for regressions of *Biophysical* and *Socioeconomic Environmental Performance* containing full models. Given that influence statistics cannot be calculated for regressions with adjusted standard errors, I based the

Cook's D predictions on OLS regression models. After calculating these predictions, I then determined which observations were influential, using the conventional Cook's D cut-off formula of 4 ÷ Sample Size (which equals approximately 0.0655 in this case). The list of influential observations for regressions of *Biophysical* and *Socioeconomic Environmental Performance* are shown in Tables 19 and 21 in Appendix Two, respectively. Finally, to determine if the influential observations biased the results of interest, I implemented PCSE regressions for full models of *Biophysical* and *Socioeconomic Environmental Performance* omitting influential observations. These results are shown in Tables 20 and 22, respectively, for *Biophysical* and *Socioeconomic Environmental Performance.* Model 43 in Table 20 omits all influential observations for the PCSE regression of the full model of *Biophysical Environmental Performance*. A comparison of the effects of interest in this model with those in Model 5 indicates one significant change in an effect of interest: *Regulator Resource Dependence* becomes significantly negatively related to *Biophysical Environmental Performance* ($\beta = -0.34$, $p<.05$). Thus, it appears that influential observations may be suppressing the hypothesized relationship between these two constructs. Model 44 runs the same regression and omits only highly influential observations. Here the negative relationship between *Regulator Resource Dependence* and *Biophysical Environmental Performance* is also apparent ($\beta = -0.30$, $p<.10$). However, the positive relationship between *State Environmentalism* and *Biophysical Environmental Performance* disappears ($\beta = 0.03$, n.s.). Model 45 in Table 22 omits all influential observations for the PCSE of the full model of *Socioeconomic Environmental Performance*. A comparison of the effects of interest in this model with those in Model 16 does not indicate any significant changes in

the effects of interest. Model 46 omits only highly influential observations for the PCSE of the full model of *Socioeconomic Environmental Performance*. Again, a comparison of the effects of interest in this model with those in Model 16 does not indicate any significant changes in the effects of interest. Given that omitting influential observations can change effects of interest in regressions of *Biophysical Environmental Performance*, it is necessary to consider whether doing so is warranted. Generally speaking, researchers can justify excluding influential outliers from their sample if they can ascertain that there is measurement error associated with the observation or if extreme values are irrelevant to the effects of interest (Cook & Weisberg, 1982). In the first case, I reviewed the data and found no evidence of measurement error. In the second case, I do not have a reason to consider extreme values irrelevant to the study. Thus, I do not have clear reasons for excluding influential observations from the study and changing my conclusions.

Fifth, indicators that reflect *Corporate Climate Change Adaptive Capacity*, including *Ownership Structure*, *State Environmentalism* and *Regulator Resource Dependence*, may be related to the corporate environmental performance for reasons outside of firms' climate change adaptations. For example, Frooman (1999) described how *State Environmentalism* constrained the ability of Starkist Tuna's global suppliers to use dolphin-killing nets, even though they were governed under regulations that allowed their use. Similarly, Rivera and de Leon (2004) observed that public ownership was negatively related to environmental performance in the U.S ski resort industry generally, although they did not control for climate change vulnerability. And, finally, Levy and Kolk (2002) observed that oil companies used *Regulator Resource Dependence* to slow the momentum behind movements to establish carbon emissions governance in the U.S.

In this case, threat from firms' regulatory environment, rather than biophysical environment, induced firms to use their power collectively. To reduce the measurement error in this study and in others that have operationalized *Corporate Climate Change Adaptive Capacity* in similar ways (e.g. Belliveau et al., 2006; Hoffman et al., 2009), one would have had to develop proxies that uniquely account for *Corporate Climate Change Adaptive Capacity*. Such a task might be difficult, since corporate adaptive capacity to both climate change and other non-climate related external threats are likely rooted in very similar strategic, dynamic and organizational capabilities, and forms of external institutional support (Adger, 2003; Berkhout et al., 2006). In the future, a study with a larger number of cross-sectional units in the data set might feasibly develop an index that accounts for the common variance of climate change vulnerability and adaptive capacity measures. Such a measure would extract the common contributions of adaptive capacity measures and geophysical climate change measures to an index, or parsimonious set of principle components. This might enable researchers to better account for the variance of corporate climate change adaptive capacity measures that are arguably more unique to corporate climate change adaptations. On the other hand, it would limit the interpretability of coefficients associated with the measures.

Sixth, measures used to operationalize *State Environmentalism* might be rough proxies of the construct. While the different measures of the construct yielded similar effects on the dependent variable, indicating degree of convergent validity, *State Environmentalism* is truly a function of the power of states' collection of stakeholders that advocate for corporate environmental protection. Measuring their volume and the voting patterns of the elected federal officials does not comprehensively measure this

power. In the future, it might be possible to develop a more robust measure of *State Environmentalism* via content analysis of media reports and/or government documents. This type of analysis might clearly show power-related influences from environmental NGOs on governments' and firms' behavior.

Seventh, the measure used to operationalize *Regulator Resource Dependence* focuses on ski resorts' economic relationships with Forest Service districts to the exclusion of other stakeholders with governance capacity. Municipal, county and/or state governments and/or local communities can have governance roles over ski resorts, while they depend upon the resorts for economic development and tax revenues. While the Forest Service is the ultimate authority responsible for approving and administering ski resort special use permits, ski resorts still must obtain local business permits and comply with local regulations, which potentially could impact the pace and form of their development. Community-level activism, in particular, can motivate government agents to constrain corporate strategies that have local environmental impacts (Gunningham, Kagan & Thornton, 2004). This is consistent with the tendency toward community-level NIMBY (not-in-my-backyard) behavior (Shrivastava, 1995). The U.S. ski resort industry, in particular, has at times experienced significant community opposition, which has helped to halt many ski resort developments (Clifford, 2002). Community dependence on the local environment can also affect the relationships modeled in this study. If the local community depends upon scarce ecosystem services that a firm intends to perturb, it might challenge the firm over control of those resources, impeding the firm's ability to adapt to climate change. For example, local communities have successfully prevented ski

resorts from deploying snow-making in areas where there are water shortages (Clifford, 2002).

Future research might take advantage of the growing availability of geographic data from the United States Geological Survey (USGS) measuring the spatial distribution of the earth's ecological resources. This data, coupled with updated census data, could be used assess how the stocks of natural capital within user-defined areas correlated with population and population changes over time in these areas. The data are collected via remote sensing instruments, such as satellites and airplanes[44,45]. Currently, remote sensing instruments collect relevant data about forest cover, soil compositions, and hydrological resources.

Finally, the study and the theory underpinning its conceptual model apply specifically to firms that have significant natural resource dependence and biophysical climate change vulnerability. Firms that are not substantially and directly dependent upon their biophysical environments for critical ecosystem services are unlikely to be biophysically vulnerable to climate change in the manner described in this study. As a result, they are unlikely to deploy corporate climate change adaptations that leverage their biophysical environments and impact environmental performance in this domain. By extension, the generalizability of this research is constrained to firms operating in industries that have significant natural resource dependence, including firms in most renewable natural resource based industries.

In the future, inductive research could assess whether the effects of *indirect* natural resource dependence are distinct from general interorganizational

[44] Source: http://remotesensing.usgs.gov/index.php. Access date March 1, 2001.
[45] Source: http://landcovertrends.usgs.gov. Access date: March 1, 2011.

interdependence and power relations. To explain, firms that experience natural resource dependence problems, possibly associated with climate change vulnerability, are often suppliers. In particular, firms operating in renewable natural resource industries generally supply raw materials or energy to firms in all sectors. If these firms experience uncertainty in their ability to access critical ecosystem services derived directly from their biophysical environments, it follows that this uncertainty would affect their interdependence with other organizations and stakeholders. However, the question remains whether these changing dynamics embody some unique aspects of organizations and stakeholders' indirect exposure to natural resource dependence through the focal firms. If indirect natural resource dependence is somehow conceptually different than interdependence, then scholars could employ inductive research to attempt to explain these differences.

7.5 Next Steps

Currently, there are three related manuscripts planned. The first manuscript will be a conceptual paper outlining the theory of natural resource dependence and explaining the components of the theory that extend the existing theory of resource dependence. This manuscript will be based largely on Chapter 3 of the dissertation. The second manuscript will be an empirical paper based on the quantitative study in the dissertation. The main goal of the paper will be to illustrate tests of natural resource dependence theory in the context of corporate climate change adaptation in the U.S. ski resort industry. Finally, the third manuscript will be another conceptual paper that develops a model of corporate climate change vulnerability. The model will attempt to explicate different types of

antecedents coming from firms' biophysical or socioeconomic environments, different forms of vulnerability rooted in resources, capabilities and/or competencies that are derived from firms' biophysical or socioeconomic environments, and different forms of corporate impacts in firms' biophysical or socioeconomic environments.

7.51 Beyond the Dissertation

Beyond the research undertaken in the dissertation, I intend to pursue some of the future research directions that were suggested as possibilities for addressing the dissertation's limitations. The first is a similar study in a different industry, to see how different regulatory and technological conditions impact firms' adaptive capacity and vulnerability, the nature of corporate climate change adaptations, and the external impacts of those adaptations. Commercial forestry and agriculture are potentially fruitful research contexts for the proposed study, given the prevalence of firms that have demonstrated biophysical vulnerability to climate change in those industries. The second is a study that uses USGS remote-sensing data to develop measures of community resource dependence on relevant sources of natural capital, and assess its impacts on the ability of firms to adapt to climate change. Finally, I intend to conduct a qualitative-inductive study of indirect natural resource dependence, to assess how firms' natural resource dependence affects other organizations and stakeholders in their socioeconomic environments. As mentioned above, the goal of this work would be to explore whether indirect natural resource dependence is simply a case of organizational interdependence, or whether it consists of heretofore unexplained theoretical mechanisms that affect firms' behavior.

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APPENDIX ONE

Ski Area Citizen's Coalition Environmental Performance Ratings[46]

1. Maintaining Ski Terrain Within the Existing Footprint (30 points)

2. Preserving Undisturbed Lands from Development (31 points)

2a. Maintaining Development or Parking Lot Construction within Currently Disturbed Lands

2b. Avoiding Road Construction on Undisturbed Land

2c. Maintaining Parking Lot Construction on Previously Disturbed Lands

3. Protecting or Maintaining Threatened, Endangered, Sensitive, or Candidate Species and Their Habitat (22 points)

4. Preserving Environmentally Sensitive Areas (30 points)

4a. Protecting/Preserving Wetlands

4b. Protecting/Preserving Old Growth

4c. Protecting/Preserving Unique Geological Formations

4d. Protecting/Preserving Roadless Areas

5. Conserving Water and Energy by Avoiding New Snowmaking (20 points)

6. Protecting Water Quality (12 points)

7. Environmental Policy Positions and Advocacy (15 points)

8. Renewable Energy (17 points)

9. Water and Energy Efficiency (18 points)

10. Transportation (7 points)

11. Waste Stream Management (9 points)

12. Purchasing (8 points)

[46] Source: http://www.skiareacitizens.com/index.php?nav=how_we_grade. Access date: November 1, 2010.

13. Environmental Reporting and Accountability (4 points)

14. Community Sustainability (2 points).

Criteria Details

1. Maintaining Ski Terrain Within the Existing Footprint (30 points)

The ski area is not proposing, undertaking, nor has undertaken terrain expansion on currently undisturbed land, on a progressive basis with 100% of points docked for proposals made or still in place, approved, or implemented in the last year (based on the calendar year), 80% between one and two years ago, 60% between two and three years ago, 40% between three and four years ago, 20% between four and five years ago, and 0% before five years. Similarly, the ski area has not sought National Forest management prescriptions or local zoning for additional terrain expansion outside currently disturbed areas. Zoning expansions are worth 25% of acreage values. Points based on acreage of expansion or zoning request:

No expansion: 30 points

Up to 50 acres: 25 points

51 - 100 acres: 20 points

101 - 150 acres: 15 points

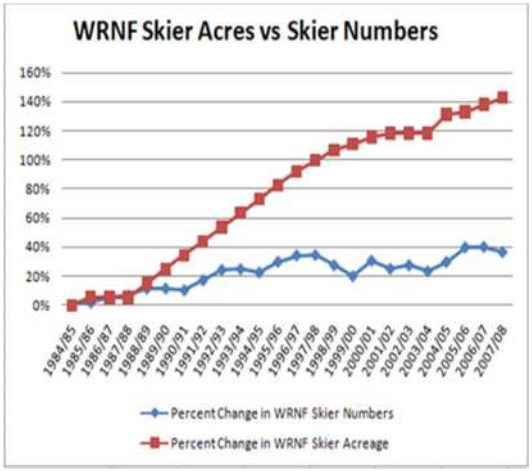
151 - 200 acres: 10 points

201 – 300 acres: 5 points

301+ acres: 0 points

Ski area upgrades and improvements that take place within already impacted ski area boundaries, as opposed to expansions into undisturbed terrain, have less damaging impacts on wildlife and the environment.

Every ten to fifteen years, the Forest Service is required to revise its management plan for each forest, basically zoning sections of forest for future developed skiing, logging, wildlife habitat protection, or other uses. Ski area expansion proponent's claim they only seek to have additional sections of forest zoned for developed skiing. However, once a region of forest is zoned for ski area expansions it is practically guaranteed that those sections of forest will eventually be developed for downhill skiing were the ski area to request permission for expansion. Tellingly, no amount of scientific evidence or public opposition has ever empowered the White River NF in Colorado – home to 63% of Colorado's skier visits – to deny an expansion request. Meanwhile, many states and/or municipalities require zoning for privately owned lands. Some ski areas on non-federal land must obtain proper zoning for ski area expansion terrain from local and/or state governments.



Ski area upgrades and improvements that take place within already impacted ski area boundaries, as opposed to expansions into undisturbed terrain, have less damaging impacts on wildlife and the environment. In a Dec. 30, 1999 letter to the White River National Forest for instance, the Colorado Department of Natural Resources noted that:

"…greater density at existing ski areas would have far less impacts on wildlife than a new ski area, or expansion into undeveloped terrain… A

principal rule in wildlife protection is that impacts should be concentrated rather than dispersed."

Upgrades and improvements on already impacted terrain, such as upgrading a lift from a two person chair to a high speed quad, is encouraged and therefore does not incur loss of points.

2. <u>Preserving Undisturbed Lands from Development (31 points)</u>

2a. Maintaining Real Estate Development Within Currently Disturbed Lands. The ski area is not proposing, undertaking, nor has undertaken residential development, commercial ventures, or other construction (excluding employee housing) on undisturbed lands, by year <u>on the progressive basis outlined under criterion #1.</u> Construction denudes an area of vegetation, exposes excessive soil for sediment run-off in streams and requires associated sewer lines, power lines, etc. Parking lot construction denudes an area of vegetation, exposes excessive soil for sediment run-off in streams and creates oil and anti-freeze concentrations that can affect water quality. Similarly, the ski area has not sought zoning for such development. Remodeling, expanding existing facilities, or construction on previously disturbed lands are granted full credit. Zoning requests are worth 25% of point values.

- No development outside currently disturbed lands: 20 points
- Up to 10 acres: 15 points
- 11-25 acres: 10 points
- 26-50 acres: 5 points
- 51+ acres: 0 points

2b. The ski area is not proposing, undertaking, nor has undertaken road construction on previously undisturbed lands, by year on the progressive basis outlined under criterion #1. Road construction denudes an area of vegetation, exposes excessive soil for sediment run-off in streams and creates oil and anti-freeze concentrations that can affect water quality. 8 points based on mileage of request.

- No road construction: 8 points
- Up to .5 mile: 4 points
- .5-.9 mile: 2 points
- 1 mile+: 0 points

2c. The ski area is not proposing, undertaking, nor has undertaken parking lot construction on previously undisturbed lands, by year on the progressive basis outlined under criterion #1. Parking lot construction denudes an area of vegetation, exposes excessive soil for sediment run-off in streams and creates oil and anti-freeze concentrations that can affect water quality. 3 points based acreage of request.

- No parking lot construction: 3 points
- Up to 2 acres: 2 points
- 2-5 acres: 1 point
- 5+ acres: 0 points

3. <u>Protecting or Maintaining T&E Species and Their Habitat (22 points)</u>

Habitat for federal and/or state threatened, endangered, sensitive or candidate animal species. Specie impact determinations by the Fish and Wildlife Service, or analogous determinations by the Forest Service or state wildlife agency, by year on the progressive basis outlined under criterion #1, as follows:

“Protecting or Maintaining Sensitive, Candidate, Threatened or Endangered Species and Their Habitat (The following determinations are found in government agency analysis documents.)

- 'Beneficial' or 'No effect': 22 points,
- 'May affect/impact individuals of a population' -one species: 21 points,
- 'May affect/impact individuals of a population' -two species: 19 points,
- 'May affect/impact individuals of a population' -three species: 17 points,
- 'May affect/impact individuals of a population' -four species: 15 points,
- 'May affect/impact individuals of a population' -five species: 13 points,
- 'May affect/impact individuals of a population' -six species: 11 points,
- 'May affect/impact individuals of a population' -seven species: 9 points,
- 'May affect/impact individuals of a population' -eight species: 7 points,
- 'May affect/impact individuals of a population' -nine species: 5 point,
- 'May affect/impact individuals of a population' -ten species: 3 points,
- 'May affect/impact individuals of a population' -eleven species: 2 points,
- 'May affect/impact individuals of a population' -twelve species: 1 point,
- 'Likely to adversely affect population viability,' or 'Jeopardy' determination or
- 'May affect/impact individuals of a population' -13 species+: 0 points

4. <u>Preserving Environmentally Sensitive Areas (30 points)</u>

Ski runs are essentially permanent clear cuts; development paves over land making it completely unavailable for most species. Studies indicate that logging ski runs enhances the extirpation of declining interior forest species, such as the golden crowned kinglet and the three-toed woodpecker. Logging for additional ski runs in

undisturbed forests, building roads, grading slopes with bulldozers or blasting to moderate slope inconsistencies, or covering over wetlands entails significant long-term environmental impacts. They sever the habitat and migration corridors of forest interior species such as lynx, and often result in the loss of old growth forest and wetlands. Creating new ski runs generally entails significantly greater impacts than ski runs cut in areas previously logged or altered.

The Ski Area Environmental Scorecard does not compensate the destruction of wildlife habitat or wetlands for the implementation of mitigation measures. Sacrificing known quality wildlife habitat or a functioning wetland for development in return for questionably viable habitat through mitigation is unacceptable to the Ski Area Citizens Coalition. References to historic failures of mitigation measures include:

"Many mitigation projects have, in fact, failed due to one or more of the following reasons: poor siting and project design; inadequate monitoring programs; lack of adequate maintenance or remedial activities; and in some cases, failure of permittees to comply with the conditions of their permits."

"Based on over a decade of survey results, the cumulative record of past mitigation projects remains undeniably poor overall, with disappointingly few examples of success."

The "sober reality [is] that under present mitigation policies and practices 'losses are likely to be uncompensated for and that what we call mitigation has a high chance of failure.'"

In cases where significant scientific controversy exists as to the extent of impacts resulting from actions proposed, approved, or undertaken by the ski area, protection of natural resources is granted the benefit of the doubt. The ski area is not proposing, undertaking, nor has undertaken an expansion, land alteration, or development in known environmentally sensitive areas, by year on the progressive basis outlined under criterion #1. Similarly, the ski area has not sought National Forest management prescriptions or local zoning for terrain alteration in environmentally sensitive areas. The ski area receives points for not disturbing:

4a. Protecting/Preserving Wetlands

- No disturbance: 9 points
- Up to .5 acres: 6 points
- .5+ to 1 acre: 3 points
- 1.01 - 1.99 acres: 1 point
- 2 or more acres: 0 points

4b. Protecting/Preserving Old Growth

- No old-growth disturbed: 9 points
- Up to .5 acres: 6 points
- .5+ to 1 acre: 3 points
- 1.01 - 1.99 acres: 1 point
- 2 or more acres: 0 points

4c. Protecting/Preserving Unique Geological Formations

- No geologic alteration: 3 points
- Up to .5 acre: 2 points

- .5 - 1 acre: 1 point
- 1+ acres: 0 points

4d. Protecting/Preserving Roadless Areas

- No disturbance: 9 points
- Up to 1 acre: 6 points
- 1+ – 10 acres: 3 points
- 10+ acres: 0 points

5. <u>Conserving Water and Energy by Avoiding New Snowmaking (20 points)</u>

Snowmaking frequently requires withdrawal of waters when streams and aquatic life need it the most – in the low flow times of the year (fall and early winter). Snowmaking also uses vast quantities of energy that, to some degree, exacerbate global warming. Given the varied laws and regulations on minimum instream flows and water withdrawals throughout the western U.S., and the lack of availability of water withdrawal data, the Ski Area Citizens' Coalition estimates the impacts of water withdrawals through proposed additions to existing snowmaking. New snowmaking utilizing reservoirs that recharge exclusively during high flow times (late spring and early summer) are not counted toward this criterion. 20 points based on acreage of new snowmaking proposed, approved, or implemented, by year on the progressive basis outlined under criterion #1:

- No new snowmaking (sans from reservoir that withdraw during spring): 20 points
- Up to 50 acres: 15 points
- 51 - 100 acres: 10 points
- 100+ - 200 acres: 5 points

- 200+ acres: 0 points

Since the 1978/1979-ski season, skier numbers have increased less than 2% over 21 seasons, or less than 1/10th of 1% per year. Yet many ski area snowmaking expansions, as with acreage expansions, are being undertaken in an effort to attract the limited pool of skier dollars nationwide. Doing so fuels a cycle whereby other ski areas feel pressure to expand snowmaking or acreage in order to retain their market share and/or lure the limited number of skiers from other resorts. Ninety percent of ski areas in the western United States are on public lands administered by the Forest Service. It is not sound public policy for the Forest Service to continue to approve snowmaking expansions, which feed this cycle encouraging ski area expansions without regard for public recreation needs.

Artificial snowmaking requires vast amounts of energy. It often depletes streams when fish and other wildlife need it the most – in the fall and winter when flows are at their lowest. Depleting streams to minimum required stream flows, if they exist at all, could destroy a stream's ability to support fish populations, which in turn adversely impacts larger wildlife such as bald eagles, grizzly bear, and osprey.

6. <u>Protecting Water Quality (12 points)</u>

The ski area will receive points if it is not engaged in activities that have resulted in water quality violations, by year on the progressive basis outlined under criterion #1.

- No violations: 12 points
- One violation: 6 points
- Multiple violation/repeat offender: 0 points

Construction activities create large areas of exposed soil in the mountain environment, which create the potential for large sediment movements during spring run-off and rain events, in addition on-site storage of gas, oil, anti-freeze, solvents, etc. can leak and can contaminate surface and ground water. These activities as well as others can lead to water quality violations as cited by a state water board, the EPA or Army Corp of Engineers. Mountain streams can often be tainted with heavy metals pollution from historic mining operations. Snowmaking utilizing water of lower quality than the ambient downstream receiving waters including that from treated sewer systems, can have a negative affect on the watershed, its aquatic habitats and downstream users. Polluted snow melting into drainages undisturbed from mining can spread heavy metals pollution to clean creeks. In other cases, drawing water from clean streams that serve as a dilution source for other joining streams with mining pollution can worsen water pollution problems downstream.

7. <u>Environmental Policy Positions and Advocacy (15 points)</u>

Ski areas can earn points by their environmental policy positions as follows:

7a. Not opposing any environmentally progressive local, state, or federal policies or legislation involving forest and land management issues that impact mountain ecosystems and environments: 5 points

7b. Actively supporting environmentally progressive local, state, or federal policies or legislation involving forest and land management issues that impact mountain ecosystems and environments: 5 points

7c. Addressing climate change including, but not limited to a position statement or support letter for the Kyoto Agreement, the Mayor Climate Protection

Agreement, the US-CAP Program, or other specific policies aimed at reducing greenhouse gas emissions.

8. Renewable Energy (17 points)

Global warming brings the potential to harm the ski industry by reducing wintertime snowfall and warming mountain temperatures. The ski industry will be one, if not the first industry to be impacted by the effects of increased global temperatures.

8a. Using biodiesel fuel in any diesel equipment or vehicles. (Percentage total annual biodiesel use = .05*(B5 gallons)+.2*(B20 gallons) + (B100 gallons)/total consumption: 1-5% of total annual diesel use:4 points, 6-10%:5 points, 11-15%:6 points, 16-20%:7 points, 21% and above:8 points

8b. Generating clean, renewable energy on-site such as wind, solar, geothermal or low impact certified hydroelectric (one piece of equipment:1 point, two pieces of equipment:2 points, more than two pieces of equipment:3 points, one building facility:4 points, two facilities:5 points, more than two facilities:6 points)

8c. Purchasing wind, solar, geothermal or low impact certified hydroelectric energy credits to off-set electrical use for ski lifts and resort energy use (1-5% of annual electricity use:1 point, 6-50%:2 points and 51-100%:3 points)

9. Water and Energy Efficiency (18 points)

9a. Employing energy efficiency retrofits, to lighting, heating, insulation, power supply, etc. in restaurant, lodging, lift and other facilities; 1-5% of facilities:1 point, 6-20%:2 points, 21-40%:3 points, 41-60%:4 points, 61-80%:5 points, 81-100%:6 points.

9b. Replacement of old and/or energy inefficient snowmaking guns with

automated systems, systems that minimize the use of compressed air, utilizing newer 3 stage centrifugal compressors and mounting guns on towers. 1-5% of facilities:1 point, 6-20% of facilities:2 points, 21-40%:3 points, 41-60%:4 points, 61-80%:5 points, 81-100%:6 points (Full credit for ski areas that do not have snowmaking.)

9c. Retrofitting old facilities with low flow faucets, toilets, or undertaking other water minimization practices. 1-50% of facilities:1 point, 51-100%: 2 points.

9d. Installation of low flow faucets, waterless urinals or other water minimization practices in new facilities that are not required by law. 1-50% of facilities:1 point, 51-100%: 2 points.

9e. Adhering to a green building policy or commitment: 2 points.

10. Transportation (7 points)

Travel to and within ski resort areas creates traffic stresses and air quality problems. Increased vehicles equate to increased traffic problems, which means more pollution and difficulties for residents and visitors alike. By engaging in programs within the community and region to reduce the number of vehicle miles traveled, such as efforts to promote buses, shuttles, and trains for workers and recreationists and giving special discounts for carpooling, ski areas can help ameliorate these environmental problems.

10a. Providing incentives for carpooling for guests and/or use of mass transit, such as lift ticket discounts or free or reduced parking: 3 points.

10b. Providing incentives for carpooling for employees and/or use of mass transit: 2 points.

10c. Promoting or sponsoring commuter buses and shuttles from off-mountain

sites to the ski area. (Intra-mountain shuttles traveling between parking areas, base areas and lodging areas are not adequate for this criterion. 'Off-mountain sites' include down valley destination towns and park-and-ride areas: 2 points.

11. Waste Stream Management (9 points)

11a. Recycling customer use products (bottles, cans, aluminum, plastic, newspaper, trail maps, etc.): 1-33% of waste stream by weight or volume:1 point, 34-66%: 2 points, 67-100%:3 points.

11b. Recycling non-customer use products (cardboard, oil, etc.) (1-50% of waste stream:1 point, 51-100%:2 points.

11c. Reusing or using recycled building materials: 1-50%:1 point, 51-100%:2 points.

11d. Composting food waste or other products: 2 points.

12. Purchasing (8 points)

12a. Using non-disposable products for food service, or composting food waste and other products: 1-33% of facilities:1 point, 34-66%:2 points, 67-100%:3 points.

12b. Purchasing recycled office and food service paper products: 1-33% of use by weight, volume or cost (via purchase orders):1 point, 34-66%:2 points, 67-100%:3 points.

12c. Use of cleaner burning, fuel efficient 4-stroke snowmobiles: 50% and up of snowmobile fleet 4-stroke: 2 points, 1-49%:1 point, none:0 points.

13. Environmental Reporting and Accountability (4 points)

13a. Publication of an annual or semi-annual environmental performance report that is, or can be, publicly available: 2 points.

13b. Undertaking independent 3rd party auditing of environmental practices, including but not limited to certification under ISO 14001: 2 points.

14. Community Sustainability (2 points)

14a. Providing funding or other support to a local philanthropic foundation for environmental protection/conservation/sustainability purposes: 1 point.

14b. Undertaking clean-ups of contaminated sites, or ecological restoration projects unrelated to mitigation for construction or development projects, spills, or violations: 1 point.

TABLE 13. Results of OLS Regression of Biophysical Environmental Performance[a]

Variables	Model 23	Model 24	Model 25	Model 26	Model 27
Sustainable Slopes Program Membership	-0.14	-0.10	-0.16*	-0.17*	-0.16
Size	-0.21***	0.00***	0.00***	0.00***	0.00***
Age	0.02***	0.02***	0.01***	0.01***	0.01***
Public Land[b]	0.20**	0.20**	0.18**	0.18**	0.19**
Private Land[b]	0.44***	0.44***	0.22	0.28*	0.24
Group	-0.01	0.02	0.21**	0.19**	0.24***
Distance to Airport with Jet Service	0.00	0.00	0.00	0.00	0.00
Population within 75 Mile Radius[c]	-0.03	-0.01	-0.01	-0.02	-0.03
Number of Ski Areas within 75 Mile Radius	-0.01*	-0.01**	-0.01*	-0.01**	-0.01
Number of National Parks with 75 Mile Radius	-0.07***	-0.08***	-0.07***	-0.07***	-0.07***
Exposure		-0.04	-0.07***	-0.07***	-0.07***
Sensitivity		2.85***	4.01***	4.11***	4.08***
Vulnerability (Exposure x Sensitivity)		-2.32***	-3.04***	-3.13***	-3.10***
Public Company[d]			-0.74***	-0.73***	-0.69***
State Environmentalism				0.05*	0.05
Regulator Resource Dependence					-0.27
Intercept	0.19	0.06	0.12	0.32	0.38
Global F-test	13.48***	11.33***	20.16***	19.85***	19.70***
df	(10, 601)	(13, 598)	(14, 597)	(15, 596)	(16, 595)
R^2	0.17	0.18	0.25	0.25	0.25
ΔR^2		0.01	0.07	0.00	0.00
Standard Errors Adjustment	None	None	Robust	Robust	Robust

[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
[d] The reference group is Private or Non-Profit Organization
* p < .10
** p < .05
*** p < .01

TABLE 14. Results of Random Effects Regression of Biophysical Environmental Performance[a]

Variables	Model 28	Model 29	Model 30	Model 31	Model 32
Sustainable Slopes Program Membership	0.02	0.04	0.00	0.00	0.00
Size	-0.20***	-0.18***	-0.15***	-0.15***	-0.15***
Age	0.01	0.01	0.01	0.01	0.01
Public Land[b]	0.09	0.09	0.09	0.09	0.09
Private Land[b]	0.28	0.27	0.19	0.22	0.21
Group	0.00	0.01	0.14	0.14	0.15
Distance to Airport with Jet Service	0.00	0.00	0.00	0.00	0.00
Population within 75 Mile Radius[c]	0.00	0.01	0.01	0.00	0.00
Number of Ski Areas within 75 Mile Radius	-0.01	-0.02	-0.01	-0.01	-0.01
Number of National Parks within 75 Mile Radius	-0.09**	-0.10**	-0.09**	-0.09**	-0.09**
Exposure		-0.03	-0.06	-0.06	-0.06
Sensitivity		2.64	3.50**	3.53**	3.53**
Vulnerability (Exposure x Sensitivity)		-2.12	-2.67*	-2.71*	-2.70*
Public Company[d]			-0.50***	-0.49***	-0.48***
State Environmentalism				0.03	0.03
Regulator Resource Dependence					-0.12
Intercept	0.16	0.12	0.16	0.28	0.31
Wald χ^2	21.33**	63.53***	107.68***	113.61***	116.65***
R^2	0.16	0.18	0.23	0.23	0.23
ΔR^2		0.02	0.05	0.00	0.00
Shapiro-Wilk W test on Random Effect	0.97***	0.97***	0.97***	0.98***	0.97***
Random Effect Correlated with X? (see Table 14)	3 of 10	11 of 14	4 of 15	4 of 16	5 of 17

[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
[d] The reference group is Private or Non-Profit Organization
* $p < .10$
** $p < .05$
*** $p < .01$

TABLE 15. Correlations between Random Effect and Independent Variables in Random Effect Regressions of Biophysical Environmental Performance[a]

Variables	Correlations Model 28	Correlations Model 29	Correlations Model 30	Correlations Model 31	Correlations Model 32
Sustainable Slopes Program Membership	0.02	1.00	1.00	-0.14***	-0.14***
Size	-0.20***	-0.12***	-0.14***	-0.03	-0.03
Age	0.01	-0.66***	-0.03	0.20***	0.21***
Public Land[b]	0.09	0.42***	0.21***	0.12***	0.13***
Private Land[b]	0.28	0.16***	0.12***	-0.03	-0.03
Group	0.00	0.01	-0.03	-0.03	-0.02
Distance to Airport with Jet Service	0.00	-0.22***	-0.03	-0.02	-0.02
Population within 75 Mile Radius[c]	0.00	0.26***	-0.02	0.01	0.01
Number of Ski Areas within 75 Mile Radius	-0.01	0.05	0.01	-0.01	-0.01
Number of National Parks within 75 Mile Radius	-0.09**	-0.30***	-0.01	0.04	0.04
Exposure		-0.26***	0.04	0.04	0.04
Sensitivity		0.14***	0.03	0.01	0.01
Vulnerability (Exposure x Sensitivity)		0.24***	0.01	-0.02	-0.02
Public Company[d]			-0.02***	-0.15***	-0.14***
State Environmentalism				0.05	0.05
Regulator Resource Dependence					-0.11***

[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
[d] The reference group is Private or Non-Profit Organization
* p < .10
** p < .05
*** p < .01

TABLE 16. Results of OLS Regression of Socioeconomic Environmental Performance[a]

Variables	Model 33	Model 34	Model 35	Model 36	Model 37
Sustainable Slopes Program Membership	0.44***	0.43***	0.41**	0.39**	0.28*
Size	0.00	0.00	0.00	0.00	0.00
Age	0.01	0.01*	0.01*	0.01*	0.01**
Public Land[b]	0.06	-0.02	-0.03	-0.03	-0.09
Private Land[b]	0.42	0.33	0.27	0.39	0.58*
Group	0.37*	0.36*	0.42*	0.38	0.09
Distance to Airport with Jet Service	0.00	0.00	0.00	0.00	0.00
Population within 75 Mile Radius[c]	-0.21**	-0.26***	-0.26***	-0.29***	-0.22***
Number of Ski Areas within 75 Mile Radius	0.01	0.01	0.02*	0.01	-0.01
Number of National Parks with 75 Mile Radius	0.07*	0.10**	0.11**	0.09**	0.05
Exposure		0.20***	0.19***	0.18***	0.18***
Sensitivity		-8.30***	-7.95***	-7.74***	-7.54***
Vulnerability (Exposure x Sensitivity)		7.07***	6.86***	6.67***	6.48***
Public Company[d]			-0.22	-0.21	-0.46*
State Environmentalism				0.11	0.14**
Regulator Resource Dependence					1.71***
Intercept	1.72	2.21**	2.23*	2.66*	2.31***
Global F-test	2.58**	5.41***	4.93***	4.99***	8.19***
df	(10, 75)	(13, 75)	(14, 75)	(15, 75)	(16, 75)
R^2	0.12	0.19	0.19	0.19	0.29
ΔR^2		0.07	0.00	0.00	0.10
Standard Errors Adjustment	Cluster Robust	Cluster Robust	Cluster Robust	Cluster Robust	Cluster Robust

[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
[d] The reference group is Private or Non-Profit Organization
* $p < .10$
** $p < .05$
*** $p < .01$

TABLE 17. Results of Random Effects Regression of Socioeconomic Environmental Performance[a]

Variables	Model 38	Model 39	Model 40	Model 41	Model 42
Sustainable Slopes Program Membership	0.05	0.04	0.03	0.03	0.03
Size	0.00	0.00	0.00	0.00	0.00
Age	0.01	0.01*	0.01*	0.01**	0.02***
Public Land[b]	0.01	-0.02	-0.02	-0.03	-0.06
Private Land[b]	0.32	0.27	0.22	0.31	0.45
Group	0.26	0.26*	0.34**	0.33*	0.26
Distance to Airport with Jet Service	0.00	0.00	0.00	0.00	0.00
Population within 75 Mile Radius[c]	-0.19**	-0.24***	-0.24***	-0.26***	-0.24***
Number of Ski Areas within 75 Mile Radius	0.01	0.02*	0.02*	0.01	0.00
Number of National Parks within 75 Mile Radius	0.06	0.09*	0.10*	0.09*	0.07
Exposure		0.18***	0.17***	0.17***	0.17***
Sensitivity		-7.98***	-7.50***	-7.41***	-7.40***
Vulnerability (Exposure x Sensitivity)		6.87***	6.57***	6.48***	6.41***
Public Company[d]			-0.28	-0.27	-0.36*
State Environmentalism				0.07	0.09
Regulator Resource Dependence					1.04*
Intercept	1.85	2.29*	2.32**	2.60*	2.38**
Wald χ^2	18.48**	59.91***	59.59***	60.50***	89.90***
R^2	0.09	0.17	0.17	0.18	0.27
ΔR^2		0.08	0.00	0.01	0.09
Shapiro-Wilk W test on Random Effect	0.95***	0.97***	0.97***	0.97***	0.99***
Random Effect Correlated with X? (see Table 17)	2 of 10	2 of 14	2 of 15	2 of 16	3 of 17

[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
[d] The reference group is Private or Non-Profit Organization
* $p < .10$
** $p < .05$
*** $p < .01$

TABLE 18. Correlations between Random Effect and Independent Variables in Random Effect Regressions of Socioeconomic Environmental Performance[a]

Variables	Correlations Model 38	Correlations Model 39	Correlations Model 40	Correlations Model 41	Correlations Model 42
Sustainable Slopes Program Membership	0.20***	0.21***	0.20***	0.20***	0.18***
Size	-0.03	-0.03	-0.03	-0.03	-0.02
Age	-0.04	-0.04	-0.04	-0.05	-0.07*
Public Land[b]	0.03	0.01	0.01	0.01	-0.01
Private Land[b]	0.00	0.00	-0.01	-0.01	-0.01
Group	0.09**	0.08**	0.08**	0.07*	-0.02
Distance to Airport with Jet Service	0.04	0.04	0.04	0.04	0.03
Population within 75 Mile Radius[c]	-0.03	-0.04	-0.04	-0.04	-0.04
Number of Ski Areas within 75 Mile Radius	-0.03	-0.04	-0.03	-0.03	-0.04
Number of National Parks within 75 Mile Radius	0.02	0.02	0.02	0.02	0.02
Exposure		-0.03	-0.03	-0.02	-0.02
Sensitivity		-0.01	-0.01	0.00	-0.01
Vulnerability (Exposure x Sensitivity)		0.01	0.01	0.01	0.01
Public Company[d]			0.04	0.03	-0.03
State Environmentalism				0.07	0.07*
Regulator Resource Dependence					0.20***

[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
[d] The reference group is Private or Non-Profit Organization
* $p < .10$
** $p < .05$
*** $p < .01$

TABLE 19. Influential Observations for Regression of Biophysical Environmental Performance[a]

Observation Number	Cook's D	
64	0.007574	
111	0.013553	*
112	0.014398	*
155	0.007684	
162	0.007819	
163	0.012432	*
177	0.007198	
179	0.008062	
191	0.008567	
322	0.010690	*
323	0.011090	*
335	0.008551	
338	0.007175	
359	0.008432	
361	0.006985	
530	0.034600	*
531	0.007504	
575	0.008758	
576	0.008772	
581	0.007949	

[a] Cook's D cutoff is 0.0655 (4/612)

* Observation considered highly influential

TABLE 20. Results of PCSE Regressions of Biophysical Environmental Performance with Outliers Excluded from the Sample

Variables	Model 43	Model 44
Sustainable Slopes Program Membership	-0.17*	-0.14
Size	-0.16	-0.17***
Age	0.01***	0.01***
Public Land[a]	0.23***	0.20***
Private Land[a]	0.38***	0.29**
Group	0.28***	0.28***
Distance to Airport with Jet Service	0.02**	0.01*
Population within 75 Mile Radius[b]	-0.05	-0.04*
Number of Ski Areas within 75 Mile Radius	0.00***	-0.01
Number of National Parks within 75 Mile Radius	-0.06***	-0.06***
Exposure	-0.07***	-0.07***
Sensitivity	4.22***	4.31***
Vulnerability (Exposure x Sensitivity)	-3.34***	-3.38***
Ownership Structure[c]	-0.65***	-0.69***
State Environmentalism	0.06**	0.03
Regulator Resource Dependence	-0.34**	-0.30*
Intercept	0.53	0.37
Wald χ^2	277.37***	250.59***
R^2	0.32	0.29
Breusch-Pagen χ^2	0.60	0.59
Wooldridge F-test	0.73	2.33
(df)	(1, 69)	(1, 70)
N	592	606

[a] The reference group is Mixed Public and Private Land
[b] Logarithm
[c] The reference group is Private or Non-Profit Organization
* $p < .10$
** $p < .05$
*** $p < .01$

TABLE 21. Influential Observations for Regression of Socioeconomic Environmental Performance[a]

Observation Number	Cook's D	
28	0.007780	
37	0.007097	
90	0.009836	
129	0.006797	
153	0.021918	*
154	0.008646	
164	0.010505	*
224	0.011853	*
271	0.011005	*
290	0.013733	*
291	0.009834	
292	0.010578	*
293	0.010820	*
458	0.021013	*
459	0.010213	*
464	0.007066	
466	0.009033	
467	0.008823	
522	0.018870	*
523	0.026942	*
542	0.008719	
607	0.008119	

[a] Cook's D cutoff is 0.0655 (4/612)

* Observation considered highly influential

TABLE 22. Results of PCSE Regressions of Socioeconomic Environmental Performance with Outliers Excluded from the Sample

Variables	Model 45	Model 46
Sustainable Slopes Program Membership	0.24*	0.28**
Size	0.00	0.00
Age	0.02***	0.02***
Public Land[a]	-0.05	-0.10
Private Land[a]	0.57**	0.55*
Group	0.13	0.15
Distance to Airport with Jet Service	0.00	0.00
Population within 75 Mile Radius[b]	-0.27***	-0.31***
Number of Ski Areas within 75 Mile Radius	0.00	0.00
Number of National Parks within 75 Mile Radius	0.07*	0.07**
Exposure	0.21***	0.22***
Sensitivity	-9.58***	-10.09***
Vulnerability (Exposure x Sensitivity)	8.15***	8.72***
Ownership Structure[c]	-0.25	-0.33
State Environmentalism	0.02	0.06
Regulator Resource Dependence	1.20***	1.29***
Intercept	2.28**	2.86**
Wald χ^2	249.02***	330.04***
R^2	0.15	0.16
Breusch-Pagen χ^2	23.09***	30.76***
Wooldridge F-test	42.13***	55.65***
(df)	(1, 70)	(1, 70)
N	590	601

[a] The reference group is Mixed Public and Private Land

[b] Logarithm

[c] The reference group is Private or Non-Profit Organization

* $p < .10$

** $p < .05$

*** $p < .01$

APPENDIX THREE

Statistical Test of Biophysical Environmental Performance as Mediator of the Negative Relationship between Corporate Climate Change Vulnerability and Adaptive Capacity and Socioeconomic Environmental Performance

A3.1 Mediational Model

As mentioned in Chapter 4, the predictions that *Corporate Climate Change Vulnerability* and *Adaptive Capacity* are positively associated with *Socioeconomic Environmental Performance* are based on a *theory that Biophysical Environmental Performance* is mediating this relationship. To statistically test for the presence of mediation in this case, it is first necessary to formally integrate these predictions into the conceptual model. To this end, I reclassify Hypothesis 3 as:

Hypothesis 3a: Corporate Climate Change Vulnerability is positively associated with firms' Socioeconomic Environmental Performance;

and then add this supplemental hypothesis:

Hypothesis 3b: Biophysical Environmental Performance mediates the relationship between the Corporate Climate Change Vulnerability and Socioeconomic Environmental Performance.

In addition, I reclassify Hypothesis 4 as:

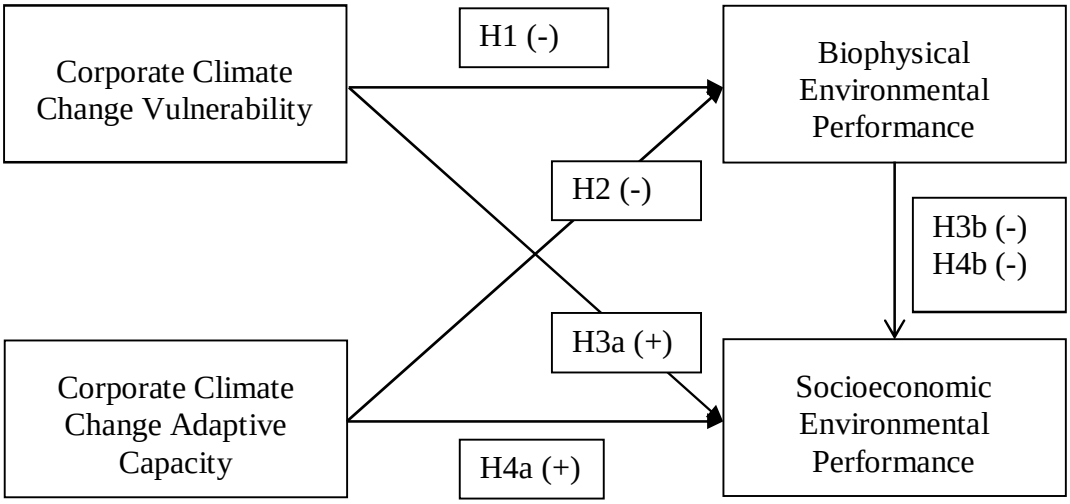
Hypothesis 4a: Corporate Climate Change Adaptive Capacity is positively associated with firms' Socioeconomic Environmental Performance;

and then add this supplemental hypothesis:

Hypothesis 4b: Biophysical Environmental Performance mediates the relationship between the Corporate Climate Change Adaptive Capacity and Socioeconomic Environmental Performance.

Figure 8 illustrates the revised conceptual model.

FIGURE 8. Conceptual Model Framework Including Mediation



To test this model, I employ the mostly widely used method for assessing mediation, which is the causal steps approach most famously described by Baron and Kenny (1986) (MacKinnon, Fairchile & Fritz, 2007). The procedure is outlined as follows:

1. Researchers first must test for the predicted statistical relationship between the proposed mediator (criterion) and independent variable (predictor), for both hypotheses. These tests are identical to the tests for H1 (H_a: $\beta_3<0$) and H2 (H_a: $\beta_4<0$, H_a: $\beta_5>0$, H_a: $\beta_6<0$), respectively, conducted in the model shown in equation (1) on pages 115 and 116. By implication, support for H1 provides support for this test with

respect to H3b, while support for H2 provides support for these tests with respect to H4b.

2. For each of the alternative hypotheses receiving support in step 1, researchers can proceed to the second step, which requires testing for the predicted statistical relationship between the dependent variable (criterion) and independent variable (predictor), with the proposed mediator excluded from the model. These tests are identical to the tests for H3a (H_a: $\beta_3>0$) and H4a (H_a: $\beta_4>0$, H_a: $\beta_5<0$, H_a: $\beta_6>0$), respectively, conducted by the model shown in equation (2) on pages 116 and 117. As a result, support for H3a provides support for this test with respect to H3b, while support for H4a provides support for these tests with respect to H4b.
3. For each of the alternative hypotheses receiving support in step 2, researchers can proceed to the third step, which requires testing for the predicted statistical relationship between the dependent variable (criterion) and proposed mediator (predictor), after controlling for the independent variables (predictors). For both hypotheses, this requires estimating a new regression model shown by equation (3) below, which adds the proposed mediator variable to the model specified in equation (2). For both H3b and H4b, the test of interest is (H_a: $\beta_7<0$), from the following regression model estimating *Socioeconomic Environmental Performance* using PCSE regression:

$$Y_{it} = \beta_0 + \beta_1 X1_{it} + \beta_2 X2_i + \beta_3 X1_i X2_i + \beta_4 X3_{it} + \beta_5 X4_{it} + \beta_6 X5_{it} + \beta_7 X6_{it} + \beta_n C_{it} + U_{it} \quad (3)$$

where:

Y_{it} = predicted socioeconomic environmental performance for ski resort i year t,

$X1_i$ = climate change exposure, ski resort i[47],

$X2_i$ = climate change sensitivity, ski resort i[48],

$X3_{it}$ = ownership structure, ski resort i year t,

$X4_{it}$ = state environmentalism, ski resort i year t,

$X5_{it}$ = regulator resource dependence, ski resort i year t,

$X6_{it}$ = biophysical environmental performance, ski resort i year t,

C_i = vector of control variables for ski resort i year t,

β_0 = the intercept (estimated grand mean) of Y_{it},

β_1 = the direct effect of $X1_i$ on Y_{it},

β_2 = the direct effect of $X2_i$ on Y_{it},

β_3 = the joint effect of $X1_i$ and $X2_i$ on Y_{it},

β_4 = the direct effect of $X3_{it}$ on Y_{it},

β_5 = the direct effect of $X4_{it}$ on Y_{it},

β_6 = the direct effect of $X5_{it}$ on Y_{it},

β_7 = the direct effect of $X6_{it}$ on Y_{it},

β_n = the direct effects of the C_{it} on Y_{it},

U_{it} = the unique error contributed by ski resort i year t to β_0, after implementing the PCSE procedure.

Here, *Socioeconomic Environmental Performance* (criterion) is predicted to be negatively related to *Biophysical Environmental Performance* (predictor), after controlling for the independent variables. The basis of this prediction is the theory that firms with lower levels of *Biophysical Environmental Performance* e will

[47] See footnote 27.
[48] See footnote 27.

demonstrate higher levels of *Socioeconomic Environmental Performance* to protect their legitimacy.

4. Finally, for the alternative hypotheses receiving support in step 3, researchers can proceed to the final step, which requires testing for the predicted statistical relationships between the dependent variable (criterion) and independent variables of interest (predictors), after controlling for the proposed mediator variable. For H3b, the test of interest is H_a: $\beta_{3(\text{equation (3)})} < \beta_{3(\text{equation (2)})}$. Support for the alternative hypothesis would indicate that the relationship between *Socioeconomic Environmental Performance* and *Climate Change Vulnerability* becomes smaller, after controlling for *Biophysical Environmental Performance*. For H4b, the tests of interest are H_a: $\beta_{4(\text{equation (3)})} < \beta_{4(\text{equation(2)})}$, H_a: $\beta_{5(\text{equation(3)})} < \beta_{5(\text{equation (2)})}$, and H_a: $\beta_{6(\text{equation (3)})} < \beta_{6(\text{equation (2)})}$, respectively to test whether the effects of *Ownership Structure*, *State Environmentalism* , and/or *Regulator Resource Dependence* on *Socioeconomic Environmental Performance* become smaller, after controlling for *Biophysical Environmental Performance.* In each case where the alternative hypothesis receives support, I could conclude that mediation is present.

A.3.2 Results for Hypothesis 3b

The tests for Hypotheses 1 and 3a received support; therefore, I proceeded to the third step of Baron and Kenny's method, which required specifying Model 47 in Table 23 below. The Breusch-Pagen χ^2 (17.09, $p<.01$) indicates that the model had heteroscedastic error variances. In addition, the Wooldridge F-test (67.69, $p<.01$) indicates panel specific error dependence. Thus, both error corrections were applied to this model. The Wald χ^2

TABLE 23. PCSE Regression of Socioeconomic Environmental Performance with Biophysical Environmental Performance Correlate[a]

Variables	Model 47
Sustainable Slopes Program Membership	0.15
Size	0.00
Age	0.02***
Public Land[b]	-0.16
Private Land[b]	0.31
Group	0.08
Distance to Airport with Jet Service	0.00
Population within 75 Mile Radius[c]	-0.23***
Number of Ski Areas within 75 Mile Radius	0.00
Number of National Parks within 75 Mile Radius	0.05
Exposure	0.21***
Sensitivity	-9.76***
Vulnerability (Exposure x Sensitivity)	8.32***
Ownership Structure[d]	-0.36
State Environmentalism	0.05
Regulator Resource Dependence	1.18**
Biophysical Environmental Performance	0.05
Intercept	2.29*
Wald χ^2	615.93***
R^2	0.12
Breusch-Pagen χ^2	17.09***
Wooldridge F-test	67.69***
(df)	(1, 70)

[a] n=612 observations for 76 firms
[b] The reference group is Mixed Public and Private Land
[c] Logarithm
[d] The reference group is Private or Non-Profit Organization
* $p < .10$
** $p < .05$
*** $p < .01$

statistic (615.93, p<.01) indicates that the set of predictors do significantly explain variance in the dependent variable. The coefficient on *Biophysical Environmental Performance* is insignificant (b= -0.05, n.s.), indicating that the test in the third step of Baron and Kenny's procedure was not satisfied. Further, the coefficient on *Vulnerability* is only slightly changed (Model 17: b=8.32, p<.01 versus Model 16: b = 8.50, p<.01), indicating that the test in the fourth step of the procedure was also not strongly satisfied. Thus, Model 47 does not provide support for Hypothesis 3b.

A.3.3 Results for Hypothesis 4b

Because *Biophysical Environmental Performance* was not significantly related to *Socioeconomic Environmental Performance* in Models 47, I was not able to establish the necessary relationship in the third step of Baron and Kenny's (1986) procedure. Further, earlier tests of the relationships between different forms of *Corporate Climate Change Adaptive Capacity* and *Socioeconomic Environmental Performance* disqualified each possible occurrence of mediation. In step two of the procedure, *Ownership Structure* needed to demonstrate a positive relationship with *Socioeconomic Environmental Performance*, while excluding *Biophysical Environmental Performance* from the model. Instead, each of the models testing for this relationship found either insignificant results, or negative and significant relationships. *State Environmentalism* did demonstrate the proposed positive relationship with *Biophysical Environmental Performance* in step one of the procedure, but only very weakly. In step two, there was no evidence that this construct was negatively related to *Socioeconomic Environmental Performance*. Finally, *Regulator Resource Dependence* was not significantly related to *Biophysical Environmental Performance* in step one of the procedure, even though it was positively related to *Socioeconomic Environmental Performance* in step two of the procedure, as predicted. Finally, there is no evidence that the relationships between any of these forms of *Corporate Climate Change Adaptive Capacity* and *Socioeconomic Environmental Performance* become attenuated when *Biophysical Environmental Performance* is entered into the Models. As a result, I cannot conclude that *Biophysical Environmental Performance* mediates the positive relationships between any of the forms of *Corporate Climate Change Adaptive Capacity* measured in this study and *Socioeconomic Environmental Performance.*

A.3.4 Discussion of Mediation Procedure Results

The mediation tests in Model 47 did not support H3b, primarily since the mediator (*Biophysical Environmental Performance*) was not significantly related to the dependent variable (*Socioeconomic Environmental Performance*). One possible explanation for these results is the existence of Type II error. The four-step causal approach has been widely criticized as a method for uncovering mediation in regression analysis as lacking power to identify significant effects since it involves three separate regression procedures (MacKinnon, Fairchild & Fritz, 2007). As a result, it may not be appropriate to reject the null hypothesis in this case. Two other statistical techniques are available to uncover mediation, which avoid the power loss of the four-step causal approach: the Sobel test and Bootstrapping (see Hayes (2009 for a complete discussion). Unfortunately, these techniques currently require the use of path analysis via structural equation modeling (SEM), which is a procedure that requires relatively large sample-sizes to maintain sufficient power. Given that the number of firms in the current study's sample is low (76), and the data are longitudinal (implying that yearly parameters for each variable need to be estimated) and unbalanced (longitudinal analyses in SEM require balanced panels), SEM analyses of the current study's data would involve relatively high model complexity and low power (Bryk & Raudenbush, 1992). Further, the Sobel test in particular requires the assumption of multivariate normality, which is nearly always untenable in the assessment of mediation effects (MacKinnon et al., 2007). In the future, statistical packages will develop procedures that integrate panel data analysis techniques with the Bootstrapping algorithm for mediation, which can be applied to the current study to overcome the power limitations of the four-step causal approach.

The mediation test in Model 47 also did not support H4b. This test is consistent with the findings presented in the main results section (see section **6.6 Hypothesis 4**, pages 153-156).