ESSAYS ON THE ECONOMICS OF ENVIRONMENTAL MANAGEMENT AND GREEN REPUTATION

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ABSTRACT

ESSAYS ON THE ECONOMICS OF ENVIRONMENTAL MANAGEMENT STRATEGIES AND GREEN REPUTATION

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Many governments, firms, institutions and individuals have become increasingly cognizant of their impact on the environment, most notably with respect to global climate change. This coupled with a threat of future regulation and a desire for a ‘green’ image, among other reasons, has led firms and institutions to begin critically evaluating and managing their own “carbon footprint”. Effective programs to manage greenhouse gas emissions (GHG) benefit from understanding the preferences of the constituents the program intends to serve.

This study uses a survey at Michigan State University to examine the preferences of constituents (students, faculty and staff) for attributes of alternative greenhouse gas (GHG) reduction strategies. The first essay examines how much respondents were willing to pay for GHG reduction program attributes and the welfare implications of several alternative policies. The second essay examines how the attributes of alternative GHG management plans influence the university’s ‘green’ reputation.

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Ad maiorem Dei gloriam

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CHAPTER 1: GENERAL INTRODUCTION

Many governments, firms, institutions and individuals have become increasingly cognizant of their impact on the environment, most notably with respect to global climate change. This coupled with a threat of future regulation and a desire for a 'green' image, among other reasons, has led firms and institutions to begin critically evaluating and managing their own "carbon footprint". Strategies for managing or reducing one's carbon footprint differ across individuals, firms, and institutions. Nonetheless, many share similar governance structures and mechanisms for implementing carbon footprint management programs, and effective environmental management programs benefit from understanding the preferences of the constituents the program intends to serve.

This study has two objectives that are undertaken in successive essays. First, to estimate how much Michigan State University stakeholders are willing to pay for greenhouse gas (GHG) reduction program attributes and to examine the welfare implications of several alternative policies. Second, to examine how the attributes of alternative GHG management plans influence the university's 'green' reputation.

To accomplish the first objective Chapter 2 presents estimates from a stated preference choice experiment of constituents' for attributes of alternative GHG reduction strategies. The attributes considered by stakeholders include: the fuel portfolio mix, effort for conserving energy use, carbon emissions reduction, timeframe for emissions reduction to be achieved and cost. The data used in the analysis come from a web survey of a stratified random sample of Michigan State University students, faculty and staff. Random effects probit models are used to estimate the preferences and derive willingness to pay estimates for each of the campus stakeholder groups. The willingness to pay results also enables an examination of welfare implications for different combinations of the policy attributes that coincide with alternative GHG program strategies. The results show that each of the constituent groups have a positive WTP for carbon emissions reductions and prefer investments in reductions in the shorter- rather than longer-term. The results also suggest between the segments in the amount that they are willing to pay for increased reductions, with students and faculty willing to pay approximately 60% more than the staff.

Chapter 3 examines how the attributes of alternative GHG management programs influence the institutions' 'green' reputation. In contrast to Chapter 2, a stated-preference conjoint style technique is employed, where respondents rated GHG management programs by their contribution to the university's green reputation. The study examines 'external' influences on environmental reputation which come from energy management attributes that include: the mix of fuels, the institution's energy conservation effort (education initiatives and energy efficient technology upgrades), alternative carbon emissions targets, the investment time-frame, and the cost. It also examines 'internal' influences concerning the institution's green reputation, which include altruism (respondents' concern for the welfare of others) and environmentalism (respondents' concern for the environment). The results show that constituents do benefit from their institution's green reputation and that energy management techniques can contribute to or detract from the institution's green reputation. The results also show the importance of integrating both internal and external influences to create more informative models and better-informed decision-making.

CHAPTER 2: VALUING ENERGY POLICY ATTRIBUTES FOR ENVIRONMENTAL MANAGEMENT: CHOICE EXPERIMENT EVIDENCE FROM A RESEARCH INSTITUTION

1. INTRODUCTION

Public awareness regarding global climate change has increased in recent years, and with it has come rising concern for greenhouse gas (GHG) emissions. Countries around the world are developing policies and regulations such as the Kyoto protocol and European Union Emissions Trading Scheme aimed at curbing greenhouse gas emissions. The threat of future regulation along with a desire for a ‘green’ image, among other reasons, have led firms and individuals to begin critically evaluating and managing their own “carbon footprint”. A firm or individual’s carbon footprint can be separated into the direct (primary) footprint and the indirect (secondary) footprint. The direct footprint is a measure of energy from fossil fuels used in the production of a good or service, while the indirect footprint measures fossil fuel energy used during the life-cycle of a product or service (Tukker and Jansen, 2006). The direct carbon footprint is often used in policy analyses because it is more straightforward and transparent. While strategies for managing or reducing one’s carbon footprint differ across individuals, firms, and institutions, voluntary yet legally binding programs for individual firms and small government entities provide economic incentives for them to reduce their carbon footprint.

In this paper, we present results of a study into constituents’ preferences for attributes of alternative carbon management strategies at Michigan State University (MSU). Using a choice experiment survey, members of the MSU campus community were asked about alternative greenhouse gas reduction strategies for the institution. Study participants revealed their preferences for alternative strategy attributes. The strategies consist of different bundles of attributes of greenhouse gas reduction strategies that include: alternative mixes of fuels, varying levels of energy conservation effort, alternative carbon emissions targets, and cost. The results also allow for examination of welfare implications for different combinations of GHG reduction program attributes that make up potential investment plans. Our results show that the three groups of constituents share some preferences for attribute types, such as the desirability for lower carbon emitting fuels and shorter investment timeframes. Conversely, we find significant heterogeneity between segments of our study population in terms of their willingness to pay (WTP) for increased levels of some attributes of the carbon reduction strategies. Perhaps in line with expectations that faculty earn more than staff, faculty respondents appear willing to pay almost twice as much as staff for additional carbon emissions reduction.

2. REVIEW OF THE LITERATURE

Researchers have used stated preference techniques to understand underlying preferences for carbon emissions. Typically this branch of valuation research has focused on consumer WTP for either climate change mitigation programs or attributes of renewable energy policy, both of which often incorporate the examination of some carbon equivalent for greenhouse gas emissions. Climate change mitigation research has examined WTP for its effect on ecosystems (Fleischer and Sternberg, 2006; Turpie, 2003; Ready et al., 2006; Layton and Brown, 2000), and animal populations (Tseng and Chen, 2008; Pendleton and Mendelsohn, 1998). Lee and Cameron (2008) considered the attributes of a carbon reduction policy by examining preferences for programs that keep climate conditions at their current levels. The authors found that individuals are more supportive of programs that use an energy tax as well as those that have cost shares distributed internationally.

Several studies that have examined renewable energy policy focus on the external effects such as on the environment (Alvarez and Hanley, 2002), as well as non-environmental effects such as jobs (Bergman et al., 2006; Johnson and Desvousges, 1997), and energy security (Hartmann et al., 1991; Layton and Moeltner, 2005). Several other studies examined the payment scheme for green energy programs. For example, Kotchen and Moore (2007) used market data on green electricity programs to compare two different contribution mechanisms, and Wiser (2007) used contingent valuation methods to compare collective and voluntary payment schemes for renewable energy generation.

The type of energy production technology has been a carbon policy attribute often examined in previous research. A variety of studies considered a specific technology such as wind (Ek, 2005; Alvarez-Farizo and Hanley, 2002), or underground coal gasification (Shackley et al., 2006), and still yet others used renewable energy generation in general terms (Bergman et al., 2006; Bollino, 2009). Several studies have extended this literature by considering multiple technologies concurrently. Roe et al. (2001) used an experimental design that includes a mix of fuels, but they do not estimate the WTP for each energy source individually. Instead, they estimated the tradeoff for replacing fossil fuels with renewable fuels and nuclear power. On the other hand, Borchers et al (2007) compared respondents' WTP for generic or undistinguished renewable energy with that of specific technologies such as wind, solar, farm methane, and biomass. They found a positive WTP for both generic 'green' energy as well as several individual types of renewable technologies. The only specific technology respondents preferred to generic 'green' energy was solar power.

The majority of carbon emissions research appears to examine individual or household preferences, while limited work has considered firms or institutions. The recent trend in corporate environmental management (see Besley and Ghatak, 2007) has seen businesses, non-profits, and the public sector pay increasingly more attention to their carbon footprint. Therefore, institutions and firms can benefit from feedback about their own members' preferences for environmentally friendly activities, such as carbon footprint reduction strategies. Some studies have examined voluntary purchases of green power by firms and institutions. First, Wiser et al. (2001) surveyed 464 firms, and found that altruism and employee morale were important motivating factors for the firms' renewable energy purchase. However, Haar and Stanciu (2002) critiqued this finding by noting deficiencies in the survey techniques of Wiser et al., data analysis, and the difficulty of mapping individual preferences into an aggregate organizational preference function. Goett et al. (2000) used conjoint style experiments to analyze commercial and industrial customers WTP for service attributes, which included renewable energy sources. They found that consumers were willing to pay price premiums for renewable technologies, for example as much as 2 cents per kWh for a change to 100% hydroelectric power.

This paper builds upon and extends the previous literature. First, we examine the preferences for carbon management policies among various types of constituents of a large institution. Specifically, students, faculty, and staff of a large university that generates its own electricity and steam. These three population segments parallel both the constituencies of large private and non-profit firms as well as that of small municipalities. Furthermore, similarities can be seen in the types of mechanism available to the university as those available to firms, institutions, and small municipalities for managing their carbon footprint. Second, we examine attributes of carbon management programs generally available to firms and institutional decision makers that have not been considered in previous research. Specifically, attributes of an energy program include employee training, use of energy efficient technologies, and flexible investment time frames. Finally, we extend the work of Borchers et al. (2007) and Roe et al. (2001) by examining respondents' WTP for energy supplied by various production technologies. We evaluate preferences and WTP for 6 different technologies individually as part of an overall fuel portfolio for the institution.

3. RESEARCH SITE

The research site is Michigan State University, which sits on a 5,200 acre campus, of which 2,100 acres are developed. There are approximately 577 buildings spread throughout the campus that vary in age from new to over 100 years old. In 2009, the university's population was comprised of approximately 47,000 students, 5,000 faculty and 6,300 staff. The university's governance structure parallels that of private and non-profit firms. It is overseen by a board of trustees, and administrators control the university's day-to-day operations. The university also has the ability to charge various fees to its constituents, which provides a plausible mechanism for designing a study that can quantify respondent's preferences monetarily. In fact, the university's environmental stewardship initiatives and carbon reduction targets resulted in the levying a $57 energy fee per semester on all students in 2008 and included energy fees as part of enrollment fees in 2009, the year in which we conducted our survey.

The university's co-generation power plant produces all of the electricity and steam for the campus. For fiscal year 2006-2007, peak levels of electricity demand were 58.4 MW, while steam demand for heating and cooling reached 537,000 lbs/hr. In total, the university's emissions level for 2007 amounted to 601,579 tons of carbon equivalent emissions, and it is estimated that the power plant accounts for 96% of the university's carbon emissions (Boomer, 2008). The power plant gives the university direct control over its energy supply, and an ability to manage its carbon footprint through altering its sources of energy production. The co-generation power plant currently uses approximately 90% coal, 10% natural gas, and less than 1% biomass. The university uses steam created during electricity production to heat and cool most of the buildings on campus. In the winter, steam heats many campus buildings while in the summer, steam is used to run refrigeration units for air conditioning on campus. The heating ventilating and air conditioning (HVAC) system on campus requires that a baseline level of steam be produced year-round. However, the electricity demands in excess of the electricity generated to meet the steam baseline may be met with non-thermal technologies such as wind and solar. The high costs associated with changing the current steam-based heating and cooling infrastructure makes steam generation from the power plant necessary for the foreseeable future. Historically, the demand for electricity from the power plant has been greater than that generated to meet the steam needs for the HVAC system.

The university joined the Chicago Climate Exchange (CCX) in 2006 to, among other things, demonstrate its commitment to environmental sustainability and take credible actions to lower its carbon footprint. The CCX provides economic incentives for voluntary, yet legally binding reductions in greenhouse gas emissions (Chicago Climate Exchange, 2009). Each CCX member is required to reduce carbon emissions according to a reduction schedule based on emissions relative to an agreed upon baseline year (e.g. 2000). CCX members represent all sectors of the economy, including several major research universities. The university's CCX membership requires a carbon reduction target of 6% below 2000 levels by 2010. Beyond its CCX obligations, the university has pledged to further reduce carbon emissions to 15% or more below its 2000 baseline by 2015.

4. CONCEPTUAL FRAMEWORK

To examine respondents' preferences for attributes of carbon management policies we employ a choice experiment method with an underlying theoretical framework derived from both Lancaster's consumer theory of demand and random utility theory (RUT). First, Lancastrian demand theory posits that utility is derived from the characteristics or attributes of a good rather than in the consumption of the good itself (Lancaster, 1966). That is, a good consists of a bundle of attributes and its value is derived by the sum of the value of the good's attributes (Louviere et al., 2000). This framework can be extended to analyze a wide array of goods and services and in our case we use it to evaluate carbon management strategies by considering individuals' preferences in terms of strategy attributes.

Second, complementing the characteristic based approach; we use RUT to evaluate individuals' choices among competing management alternatives. Underlying RUT is the behavioral assumption that economic agents seek to maximize their utility given their choice set. The random utility specification takes uncertainty into account by modeling the utility of a representative individual as the sum of observable and unobservable components:

$$(1)\quad U_{ij} = V_{ij} + \varepsilon_{ij}$$

U_{ij} is the latent, unobservable utility for the *i*th individual and *j*th alternative, where V_{ij} is the observable portion of utility and ε_{ij} is the random component of utility capturing the uncertainty. The statistical model is driven by the probability that choice *j* is made over alternative *k*, which we denote as Y=1 (Greene, 2000).

$$(2)\quad \Pr(Y = 1) = \Pr\left(V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}\right) \qquad \forall j \neq k$$

or equivalently:

$$(3)\quad \Pr(Y = 1) = \Pr\left(V_{ij} - V_{ik} > \varepsilon_{ik} - \varepsilon_{ij}\right) \qquad \forall j \neq k$$

We assume the deterministic portion of utility has the form

$$(4)\ V_{ij} = \alpha X_j + \beta(I_i - p_j)$$

such that α is a vector of estimatable parameters for a vector of attributes *X* corresponding to choice alternative *j*. Similarly, I_i is the income of respondent i and p_j is the cost of alternative *j*, where β is the corresponding parameter. Therefore, we can rewrite the probability of choosing alternative *j* over *k* by combining equations 3 and 4 as:

$$(5)\ \Pr(Y=1) = \Pr\left[\alpha(\Delta X) - \beta(\Delta p) > \varepsilon_{ik} - \varepsilon_{ij}\right] \qquad \forall j \neq k$$

To obtain estimates for the parameters on the deterministic portion of utility we assume that the error term is normally distributed, and the differenced error term i.e. $\Delta\varepsilon = \varepsilon_{ik} - \varepsilon_{ij}$ is also normally distributed. For choice sets with two alternatives, this yields the probit form for the probability of choosing alternative *j* over alternative *k*,

$$(6)\ \Pr(Y=1) = \Pr\left[\alpha(\Delta X) - \beta(\Delta p) > \Delta\varepsilon\right] = \Phi\left[\alpha(\Delta X) - \beta(\Delta p)\right]$$

where Φ is the cumulative distribution function for the standard normal distribution.

The stated choice experiment questions of the survey were designed to give each potential respondent 3 separate pairs of program alternatives that they were asked to choose between. Due to the multiple responses possible for each individual it is likely that individual specific effects carry across responses (i.e., unobserved characteristics unique to each individual can induce correlation among responses). Therefore, the random effects probit estimation technique is used (Wooldridge, 2002).

The random utility framework outlined above can be extended to incorporate the unobservable individual specific effect likely present in the panel data. So the model can be written as follows:

$$(7)\quad \Delta U_{ij} = \alpha\left(\Delta X_j\right) + \beta\left(\Delta p_j\right) + \mu_i + \varepsilon_{ij}$$

The coefficients of the model (7) can be used to estimate the *ceteris paribus* tradeoffs between attributes or attribute levels that respondents would be willing to make. In particular, the price coefficient can be used to estimate a WTP metric or implicit price for each of the attributes or attribute levels, which is calculated as $-\left(\frac{\alpha}{\beta}\right)$, where α is an attribute coefficient and β is the coefficient on the price.

5. STUDY DESIGN

The data used in this analysis was obtained from a choice experiment survey during the spring semester of 2009 that was designed to elicit university constituents' preferences for alternative carbon management strategies. The survey guided respondents through a series of information treatments that asked questions about carbon management and energy conservation knowledge, explained the attributes, and then elicited carbon emission reduction strategy preferences. Special attention was paid to making the choice experiment credible and capable of being understood by the sample population, while also answering the necessary policy questions at hand. Respondents were also reminded a number of times that their input would be used to shape the university's carbon management strategy.

5.1 Survey Instrument Development

The survey instrument was developed in multiple phases using an iterative process (Kaplowitz et al., 2004). A key part of this process was to identify and refine the set of attributes to be used in the choice experiment. The pertinent attributes were identified through interviews with administrators, physical plant staff, as well as with focus groups of students and staff. Informative interviews were held with university administrators and engineers to identify potential policy-relevant attributes of the university's current and future possible carbon management strategy. The interviews revealed that any relevant carbon management strategy for the university needed to explicitly include the power plant. Subsequently, technical experts were used to identify possible energy generation attributes and attribute levels. Focus groups with students and staff helped gauge their knowledge and understanding of energy use and carbon management strategies on campus and of alternative energy generation and conservation approaches. Following the focus groups, a survey instrument was developed and pretested in the field. This allowed for the collection of additional feedback, which along with further technical input, helped identify and refine the study's attributes and other aspects of the survey instrument.

5.2 Choice Experiment Attributes

In the end, five key attributes for the university's carbon management scheme were selected for the study: the mix of fuel types, the level of university energy conservation effort, carbon emissions reduction target, the year that the emissions reduction will be achieved, and the cost of an additional per semester fee per person. Table 1, describes the attributes and the attribute levels.

Table 1: Carbon Management Strategy Attributes and Attribute Levels

Attribute	Attribute Level
Fuel Portfolio Mix	
Coal	0% to 100%
Natural Gas	0% to 100%
Biomass	0% to 30%
Wind	0% to 10%
Solar	0% to 10%
Nuclear	0% or 50%
Energy Conservation Effort	Minimal, Moderate, Extensive
Carbon Emissions Reduction	15%, 17%, 19%, 21%, 23%
Year Reduction Achieved	2015, 2020, 2025
Additional Semester Fee Per Person	$25, $50, $100, $150

Survey respondents were informed that the university's current fuel mix varies according to relative input prices and consists of approximately 90% coal, 10% natural gas and less than 1% biomass. They were also informed that the university's fuel portfolio is variable in the long term and that the portfolio may include coal, natural gas, biomass, wind, solar and nuclear. The information treatments before the choice experiment explained each fuel's current and potential expense and emissions level relative to the other fuel types. Respondents were also told for fuels not in current use, the time-frame required before they would be available and usable.

The attribute levels for the fuel portfolio mix, carbon emissions reduction, year reduction achieved and additional semester fee are fairly straight forward. Further details on the fuel portfolio mix concerning the study's experimental design are provided in Section 5.3 Energy conservation effort, at the university and explained in the survey, are comprised of two approaches—an energy education campaign and the level of conservation technology adoption. Increasing levels of these two conservation approaches were used to describe three levels--

minimal, moderate, and extensive--of energy conservation effort available to the university. The minimal conservation effort entails a general, campus-wide education campaign and upgrading of outdated appliances and fixtures. In the moderate level, there is targeted energy conservation training and certification for new students and additional conservation certification for all new buildings. Finally, the extensive conservation level involves the conservation training for all segments of the population and the use of technology so that all buildings on campus are certified as energy efficient. Thus, the choice experiment includes an attribute for the overall level of energy conservation effort for the campus.

5.3 Experimental Design for the Choice Experiment

In the choice-experiment, each respondent was presented with three sets of two potential carbon management strategies. Due to the political environment in which the survey was conducted, respondents were not given the option to select a "neither strategy" response. Respondents were asked to select their preferred strategy between each pair (see Figure 1 for an example of the choice pairs). An experimental design was used to vary attributes across respondents to allow for the statistical analysis of the effect of each attribute level on the probability that an alternative strategy set is preferred. Our experimental design accounts for actual university design constraints in the possible mixes of fuel types in the fuel type attribute.

Two constraints were placed on the mix and levels of fuels used in the study's fuel type attribute. First, we considered the engineering constraints of the University's infrastructure and the amount of energy that can come from each of the different types of fuel (e.g., need for steam generation, inability of climate to support 100% solar or wind power). Second, the fuel type mix must sum to 100%. These constraints are denoted in the attribute ranges next to each fuel type in

Table 1. By allowing the different types of fuel to take on a range of values instead of a discrete number of bundles of fuel mixes we are able to identify the effect of each fuel type individually along with that of the other attributes. However, including this type of attribute in a choice experiment requires a more sophisticated experimental design than the typical main-effects design for the discrete attribute levels.

The subsequent experimental design for the choice experiment incorporates both the use of an algorithm to generate the levels for the fuel type mix and a conventional main-effects design for the non-fuel attributes. First, an algorithm was created to draw levels for the different fuel types subject to both the infrastructure and adding-up constraints. All of the fuel types could have been

Figure 1. Example of a choice set

Which of these strategies do you prefer?

Characteristics	Strategy	
	A	**B**
Fuel Type	Coal 70% Biomass 20% Wind 10%	Coal 60% Biomass 30% Solar 10%
Energy Conservation Effort	Minimal -campus wide education campaign -upgrade outdated appliances/fixtures	Extensive -training all faculty/staff/students -efficiency cert. for all buildings
Carbon Emissions Reduction	23%	15%
Year Reduction Achieved	2020	2020
Additional Semester Fee Per Person	$100	$50

Compare the characteristics of Strategy A and Strategy B. Choose the strategy that you prefer for MSU.

☐ **Strategy A** or ☐ **Strategy B**

drawn as continuous variables except for nuclear. The nuclear option consists of building a small-scale nuclear plant on the outskirts of campus, which would provide for 50% of the University's energy consumption. In designing the algorithm for fuel mix, we minimize the amount of correlation among attributes that is induced by the adding-up constraint on fuel-mix. A table of the correlation coefficients for the fuel type variables can be found in Appendix A. A fractional factorial design was generated for the non-fuel type variables such that the main effects were identifiable and orthogonal. The full experimental design then put together the fuel type and non-fuel attributes.

5.4 Survey Implementation

For an accurate representation of the university population, the registrar provided the researchers with a random sample of student, faculty and staff email and mailing addresses drawn from official university records. The members of the sample populations were invited to participate in the web-based survey during spring of 2009. The invitations informed recipients about the study and provided them with a link to the survey as well as a unique username and password. The study populations all have email and internet access, as students, faculty and staff at the university are expected to conduct business using the internet. Therefore, use of a web-based survey was appropriate. Members of the sample that failed to complete the survey were contacted up to two more times. After adjusting for undeliverables, the overall response rate was about 24% (15% for students, 34% for faculty, and 49% for staff). A total of 4,079 individuals responded yielding 12,086 usable choice experiment responses.

6. DATA ANALYSIS AND RESULTS

Since the data were drawn from stratified random samples of the campus constituency groups - students, faculty and staff- we first test whether it may be appropriate to pool the data by comparing the pooled data to each individual segment. Using a log likelihood ratio test (Wooldridge, 2002), we tested each possible combination of faculty, students and staff, against the pooled data, and the results are reported in Table 2. The results show that for each possible combination of the population segments we can reject the null hypothesis that pooling the segments together is the same as treating them individually at the 99% confidence level. Thus, we report separate models for students, faculty, and staff.

Table 2. Log Likelihood for the Random Effects Probit Estimation for Pooled and Respondent Group Data

	RE Probit	LR Statisitic	p-value	Degrees of Freedom
Pooled (Faculty, Students and Staff)	-6883.7245			
Student	-2840.5676			
Faculty	-1188.4835			
Staff	-2782.593	144.16	0.0000	22
Faculty & Staff	-4008.4714			
Faculty	-1188.4835			
Staff	-2782.593	74.79	0.0000	11
Faculty & Students	-4047.4788			
Faculty	-1188.4835			
Student	-2840.5676	36.86	0.0001	11
Student & Staff	-5658.5025			
Student	-2840.5676			
Staff	-2782.593	70.68	0.0000	11

6.1 Estimation Results of Within Group Preferences

The results of the random effects probit estimation can be found in Table 3. They show that *ceteris paribus* all segments of the population prefer energy for the campus to be produced from lower carbon intensive technologies and that respondents prefer to have carbon reductions happen sooner rather than later. Not surprisingly, all constituencies prefer carbon reduction strategies to be low cost.

Table 3. Estimation results from the random effects probit model

	Student		Faculty		Staff	
	Coefficient	P-value	Coefficient	P-value	Coefficient	P-value
Fuel Type						
Natural Gas	0.0124	0.000	0.0128	0.000	0.0111	0.000
Biomass	0.0187	0.000	0.0187	0.000	0.0209	0.000
Wind	0.0440	0.000	0.0400	0.000	0.0449	0.000
Solar	0.0438	0.000	0.0388	0.000	0.0338	0.000
Nuclear	0.0055	0.000	0.0003	0.825	-0.0022	0.020
Energy Conservation Effort						
Minimal (baseline)						
Moderate	0.0947	0.004	0.0336	0.514	0.0340	0.298
Extensive	0.0546	0.127	-0.0049	0.931	-0.0516	0.151
Carbon Emissions Reduction	0.0773	0.000	0.0557	0.000	0.0492	0.000
Year Reduction Achieved	-0.0382	0.000	-0.0458	0.000	-0.0329	0.000
Fee ($ in 100's)	-0.6275	0.000	-0.4468	0.000	-0.6325	0.000
Sigma U	0.0739	0.180	0.1547	0.1371	0.0029	0.0240
Rho	0.0054	0.0263	0.0234	0.0405	0.0000	0.0001
Log Likilihood	-2840.57		-1188.48		-2782.59	
Number of respondents	1,722		684		1,673	
Number of choices	5,140		2,017		4,929	

Fuel Type. As previously discussed, the fuel portfolios for all of the choices were constrained to add up to 100%, which requires the fuel type attributes in the model be evaluated relative to a baseline fuel. Since the *status quo* fuel mix is coal intensive, we use 100% coal as the baseline fuel in our analysis. The results show that, *ceteris paribus*, all three segments of the university population most prefer the zero-carbon emitting options of wind and solar power.

Given the long term planning horizon that power plant managers consider, we were asked to include nuclear power as an option. The estimation results show that nuclear power is a statistically insignificant attribute for faculty at any reasonable statistical level in comparison to an all coal portfolio. This means that faculty have the same preference for coal as they do for nuclear power. Conversely, the nuclear option was negative and statistically significant at the 5% confidence level for the staff segment, which means that the staff prefer coal to nuclear power. Students had a low, yet positive preference for nuclear energy relative to the use of coal. These estimation results, along with the qualitative focus group data concerning nuclear power, suggest that there may be a generational shift in preferences concerning nuclear power. Younger generations, represented by the student segment, seem more likely to accept nuclear power as a potential greenhouse gas-neutral energy solution, while acknowledging obstacles like the transportation and storage of nuclear waste. The staff clearly prefer less nuclear and the faculty appear to be indifferent between nuclear and the baseline coal dominated portfolio. Apprehension toward nuclear may be due to remaining sentiment from the accident at the Three Mile Island Nuclear Plant in 1979 and memories of the Chernobyl disaster in 1986. This is supported by hedonic studies of nuclear power plants in the literature, such as Clark and Allison (1999), which find a decline in home values due to visual reminders and proximity to nuclear pants.

Energy Conservation Effort. Firms and others can also reduce greenhouse gas emissions by using energy conservation. On one hand, reduced energy demand can be achieved though education initiatives designed to change individuals' energy consumption habits and behaviors. On the other hand, energy demand can be reduced through the installation and use of energy efficient technologies that provide the same services with lower energy input. Using "minimal conservation" as our baseline, the estimation results indicate that faculty and staff do not prefer moderate or extensive conservation to minimal conservation as a greenhouse gas reduction strategy. However, students have a significant positive preference for moderate conservation effort as opposed to minimal conservation. Perhaps students believe, rightly or wrongly, that conservation may result in significant reductions in greenhouse gas emissions. At the same time, faculty and staff may believe that increased conservation may or may not work and they may be conflicted between possible disruptions to their work schedule as a result of the education initiative and the technology upgrades.

Reduction Target and Timeframe. The heart of any carbon management strategy revolves around two separate yet related attributes; the level of emissions reduction to be achieved, and the time frame in which the reduction will be achieved. Our results show that all of the university's population segments have a statistically significant positive preference for increased emissions reduction and for emissions reductions to happen sooner rather than later. These finding are further supported by another question in the survey which asked whether a target of 15% reductions by 2015 is too little, just right or too much. As Table 4 illustrates, less than 10% of students, faculty and staff think that the university's target of 15% by 2015 is too much abatement. At the same time, over one-third of the population reported that an abatement larger than the 15% target might be warranted.

Table 4. A target of a 15% emissions reduction by 2015

	Student	Faculty	Staff
too little	36.54	36.65	34.52
just right	60.65	58.46	59.36
too much	2.8	4.89	6.12

Fee. Finally, the estimation results for the per person per semester energy fee show that within each group the respondents preferred carbon reduction strategies to be low cost. This result is statistically significant at the 1% lever and is consistent with our *a priori* assumptions about the constituent groups.

The estimation results from the model in Table 3 allow us to evaluate within-group preferences for each of the strategy attributes. However, since each constituency group is estimated separately the underlying variances may differ, confounding comparisons of parameter estimates between groups. However, if parameter ratios are used, any common unidentified variance will cancel out, facilitating comparison across models. Therefore, we will use the implicit prices for each attribute to determine each group's WTP for the attributes and make further comparisons between groups.

6.2 Implicit Prices

Implicit price is defined as the rate at which a person is willing to make a trade-off between an attribute and cost. In the choice experiment, program costs are presented as an energy fee levied on all students, faculty and staff each semester. Using this fee as our payment vehicle allows us to calculate each group's WTP for the various attributes. Table 5 presents the mean implicit prices for the strategy attributes for each of the constituent groups. The standard errors are calculated using the delta method and appear in parentheses below each implicit price.

Table 5. Implicit Prices Per Person for Carbon Management Strategy Attributes

	Willingness to Pay		
	Students	Faculty	Staff
Fuel Type			
Natural Gas	$1.98	$2.86	$1.76
	(0.165)	(0.422)	(0.158)
Biomass	$2.99	$4.18	$3.30
	(0.247)	(0.610)	(0.255)
Wind	$7.02	$8.95	$7.10
	(0.528)	(1.308)	(0.534)
Solar	$6.98	$8.68	$5.35
	(0.537)	(1.315)	(0.496)
Nuclear	$0.88	$0.07	-$0.35
	(0.149)	(0.328)	(0.152)
Energy Conservation Effort			
Minimal (baseline)			
Moderate	$15.09	$7.51	$5.37
	(5.730)	(12.597)	(5.672)
Extensive	$8.69	-$1.10	-$8.15
	(5.147)	(11.395)	(5.187)
Carbon Emissions Reduction	$12.31	$12.47	$7.77
	(0.833)	(1.874)	(0.731)
Year Reduction Achieved	-$6.09	-$10.25	-$5.20
	(0.615)	(1.526)	(0.603)

* Standard errors were calculated using the delta method.

Fuel Type. Examining the implicit prices for the fuel mix shows that the faculty revealed a higher WTP for each fuel type as compared to students and staff. The results in general, demonstrate that respondents prefer less carbon intensive technologies such as wind and solar power, yet they do not have a statistically significant WTP for carbon free nuclear power. Wind energy appears to be slightly more preferable than solar for each constituent group. For example, students seem willing to pay $6.98 of a fee each semester for an additional percentage increase of wind power in the institution's overall fuel portfolio.

Energy Conservation Effort. The implicit prices for the energy conservation effort levels yield results that are largely statistically insignificant. These WTP metrics suggests that respondents in all three constituency group do not have a strong preference for the different levels of energy conservation effort. Due to this, we limit the discussion of preferences for energy conservation effort, and do not include it in the alternative investment policy scenarios.

Reduction Target and Timeframe. The results reveal differences between the constituent groups in terms of their support for the amount of emissions reduction and the time frame reductions would be achieved. Students and faculty appear willing to pay $12 per semester for an increase in emissions reductions beyond the 15% university target as compared to $8 for staff members. All three groups prefer to see emissions reductions made in the near-term rather than in the distant future. The implicit prices show that students and staff have a WTP of -$6.09 and -$5.20 for extending the emissions target one year into the future. While the faculty group is WTP -$10.25 for extending the emissions target. Each constituency groups has a statistically significant negative WTP for postponing the emissions reduction, which shows common preference for emissions reductions in the near-term, but with some differences in WTP for how much and how fast reductions are achieved.

6.3 Alternative Investment Plans

One strength of choice based modeling is the ability to use the estimated coefficients from the econometric model and the subsequent WTP measures to assess the economic value of alternative policy scenarios. To examine the alternative policy scenarios we calculate the economic surplus of each bundled carbon reduction strategy in relation to a base scenario. We omit energy conservation effort from our scenario analysis, due to the statistical insignificance among the constituent groups and for simplicity. We calculate the economic surplus of each scenario in relation to the baseline (Bennett and Blamey, 2001):

$$\text{Economic Surplus} = -\left(\frac{1}{\beta_{Fee}}\right)\left(V_i - V_k\right)$$

V_i represents the indirect utility for the policy scenarios, where *i* denotes the baseline scenario and *k* indexes the an alternative policy scenario. We use as our base scenario an all coal fuel mix, with a 15% emissions reduction targeted to be reached by the year 2015. This base scenario is feasible through energy reduction and the purchase of carbon offsets, among other techniques. In Table 6 we consider four scenarios that are characterized by different levels of the fuel mix, reductions in carbon emissions and time frames relative to our baseline. The four policy scenarios considered were:

- Nuclear power reactor [A]: 25 MW of electricity, small self contained device buried in the ground in outskirts of campus
- Wind [B]: 5 MW of electricity, 2 to 3 large turbines each at a height of 80m
- Wind and Solar [C]: 2.5 MW of electricity from 1 to 2 large wind turbines with hub height of 80m, and 2.5 MW of solar panels installed on campus buildings
- Fuel switching [D]: Using 30% less coal by building a small biomass facility to use energy crops in current boilers and use of more natural gas

Table 6. Willingness to Pay for selected carbon management strategies in ($)

Scenarios		A	B	C	D
	Baseline	Nuclear	Wind	Wind and Solar	Fuel Switching
Attributes					
Fuel Portfolio Change	100% Coal	50% Nuclear	10% Wind	5% Wind 5% Solar	15% Biomass 15% Natural Gas
Carbon Footprint Reduction	15%	23%	21%	23%	19%
Time Frame	2015	2025	2020	2025	2020
Welfare Change					
Students	-	$81.58	$113.61	$107.58	$93.34
Faculty	-	$0.76	$113.07	$85.41	$104.23
Staff	-	-$7.34	$91.62	$72.41	$80.98

The welfare measures in Table 6 can be interpreted as how much the average member of each constituent group would be WTP per semester for each scenario instead of the baseline. For example, staff members welfare change would be $91.62 for hypothetical scenario B, which includes 10% of the fuel portfolio coming from wind power and a 21% reduction in the university carbon footprint to be achieved 11 years from the survey date. Our scenarios suggest that option B, only increasing the share of wind power generation on campus yields, the highest welfare gains for all of the constituent groups. Option C, switching fuels from coal to natural gas and biomass is the second best scenario for the employee groups (faculty and staff), while students prefer the renewable energy in either B or C. It is also easily verified that the nuclear option is the least preferable option for campus constituents, yielding low welfare effects for faculty and negative effects for staff. The negative WTP effect by the staff group suggests that they would have to be paid $7.34 for the nuclear option over the baseline.

7. Discussion and Conclusions

In response to the changing global climate, social and political pressure, and the threat of future regulation, firms and individuals have begun to critically evaluate their carbon footprint and contemplate changes. The heterogeneity of firms and institutions can present challenges in generalizing results across sectors and industries. Nonetheless, there are several aspects of carbon management policy that can apply to many firms, institutions, and municipalities. Our results examine several key attributes of carbon footprint reduction strategies and shed light on the preferences for them by students, faculty and staff at a large, research intensive university. In particular we examine the fuel mix that energy is generated from, a notion of energy conservation effort on the part of the firm or institution, the amount of carbon emissions being reduced and an investment time frame. Use of a choice experiment approach allows us to analyze constituents' WTP for either different levels or marginal changes of each attribute. We use the WTP metrics to examine welfare implications for four alternative investment strategies.

Our results show that each of the constituent groups have a positive WTP for carbon emissions reductions and prefer investments in reductions in the shorter- rather than longer-term. We did find differences between the segments in the amount that they are willing to pay for increased reductions, with students and faculty willing to pay approximately 60% more than the staff. We also found, that the constituent groups do not hold a strong preference for the level of energy conservation, even though technology upgrades and education campaigns would most likely have the most influence their daily lives.

A unique component of our analysis was our treatment of the university's fuel portfolio within the choice experiment. We created an algorithm for the fuel portfolio to draw percentages of each fuel (coal, natural gas, biomass, wind, solar and nuclear) while simultaneously meeting engineering feasibility constraint and the full portfolio adding to 100%. The study results show that given the institutional and engineering constraints of the university, stakeholders across the board have the highest WTP for marginal increases in use of lower carbon fuels, especially carbon free wind and solar power. We also found relatively low WTP for nuclear power as a source of electricity in comparison to the other carbon free technologies among students and a negative WTP relative to coal for nuclear power for the staff.

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Appendix A.

Table 7. Correlation Matrix for generated data

	coal	natural gas	biomass	wind	solar	Nuclear
coal	1.000	-0.417	-0.220	-0.099	-0.105	-0.534
natural gas		1.000	-0.374	-0.183	-0.164	-0.283
biomass			1.000	0.003	-0.001	-0.002
wind				1.000	-0.010	0.017
solar					1.000	0.005
nuclear						1.000

CHAPTER 3: INFLUENCE OF ENERGY ALTERNATIVES AND CARBON EMISSIONS ON AN INSTITUTION'S GREEN REPUTATION

1. INTRODUCTION

Firms, institutions, and government entities, like individuals, have begun to identify themselves along with their products as "environmentally friendly." For example, colleges, universities, and businesses increasingly highlight the construction and use of 'gold' and 'platinum' LEED Certified buildings.[1] Similarly, corporations publicize their voluntary reduction of waste streams as part of their corporate 'greening' initiatives (e.g. Xerox: Maslennikova, 2000; Manufacturing industry: Clelland et al., 2000). Such moves toward 'green' behaviors and branding fit generally into the category of pro-environmental behavior, which when carried out by a firm or institution has also been labeled corporate environmentalism. Motivations for firms adopting voluntary, pro-environmental practices may include: reducing future liability, pre-empting mandatory regulation, cost savings, increasing rivals' costs, as well as differentiating one's business or products to increase demand or charge a price premium. Some of these motivations for corporate environmentalism are, no doubt, driven by business considerations such as cost, the attributes of a product or service, and socio-economic characteristics of consumers. Green branding has also served as a signal or measure of product or service differentiation to attract increasingly segmented consumer groups. For example, automobile manufacturers advertise hybrid vehicles by touting financial savings at the gas pump, low carbon emissions, and an environmentally friendly image. These advertisements do not typically mention the vehicles' total cost of purchase or the breakeven point in time when the cost savings for fuel equals the price premium

[1] See the U.S. Green Building Council <http://www.usgbc.org> for a complete list of LEED certified buildings.

paid for the hybrid version of the automobile. However, the environmentally friendly image is an important attribute for both the parent corporation as well as the consuming public.

The economics literature concerning pro-environmental behavior often examines the private provision of public goods. Bergstrom et al. (1984) theoretically predict the importance of income in sorting individuals between those contributing to a public good and those free-riding. Several studies empirically examine the determinants of pro-environmental consumption of energy related products and services. Welsch and Kuhling (2009) highlight the importance of demographics, income, price premiums and consumption patterns for participating in a green electricity program or installing residential solar equipment. The stated preference literature has examined the price premium consumers are willing to pay to mitigate the effects of global warming (Layton and Brown 2000), for renewable energy technology (Bergman et al., 2006; Bollino, 2009; Roe et al., 2001), and for environmental attributes of energy policy (Alvarez and Hanley, 2002). For the purpose of this inquiry, "external" influences of pro-environmental behavior include such factors as cost, socio-economic characteristics of consumers, and attributes of a product or service.

In contrast to the scholarly literature on so-called external influences of pro-environmental behavior, research typically based in psychology offers another perspective, that of "internal" influences on the adoption of pro-environmental behavior. Such research suggests that pro-environmental behavior by individuals originates in their underlying values, beliefs and attitudes. For example, Fransson and Garling (1999) review the link between individuals' attitudes and psychological factors with their level of environmental concern along with the influence of individuals' environmental concern on their pro-environmental behavior. Social science scholars have called for research that considers both external (e.g., competition, cost) and internal (e.g., values, attitudes, beliefs) influences on adoption of pro-environmental behavior (e.g., Van Liere and Dunlap, 1980). Furthermore, Guagnano, et al. (1995) suggests that analyses that integrate the relationship between external and internal influences on behavioral change may yield more informative environmental policy analysis.

The relationship between external influences (i.e., energy production and consumption policy attributes), internal influences (i.e., environmentalism and altruism), and institutional pro-environmental behavior (i.e. promoting ‘green’ reputation) has received little attention. This paper undertakes such an examination in the context of constituencies’ preferences for energy management programs at their institution. Universities, like corporations, range comparably in size and are comprised of a variety of constituents: administration (upper management); faculty (lower management); staff (workers); and graduate and undergraduate students (customers/shareholders). While there has been extensive study in the contingent valuation literature on attributes of renewable energy policy (e.g., Alvarez and Hanley, 2002; Bergman et al., 2006; Johnson and Desvousges, 1997; Layton and Moeltner, 2005), the role that energy generation and management attributes play in shaping an institutions’ green reputation has yet to be empirically examined. Our analysis uses a stated-preference conjoint survey approach that asks students and employees at Michigan State Univeristy to rate the contribution to green reputation of various energy management scenarios. The study examines ‘external’ influences of the attributes of energy management plans (e.g., mix of fuels, energy conservation effort, carbon emissions targets, etc.) as well as the role of ‘internal’ influences (e.g., altruism and environmentalism) on an institution’s green reputation.

The reported research examines an institution’s green reputation and image from within the institution, along with exploring how the attributes of its decisions influence the institution’s green reputation. Our novel experimental design and energy management attributes are pertinent to the decision-making of many large firms and institutions. Our research also provides a foundation for analyzing how institutions can influence their own 'green' reputation by undertaking infrastructure and policy changes. The paper proceeds as follows: Section 2 provides background literature and reviews the study setting; Section 3 discusses the survey design and administration; Section 4 presents the conceptual framework underlying the analysis; Section 5 presents the research result; and the final section discusses the findings, their implications, and our conclusions.

2. BACKGROUND

2.1 Additional literature

Recently, the research on voluntary corporate environmentalism has extended beyond individual case studies (e.g. Lynes and Andrachuk, 2008; Jones et al., 2005; Warhurst and Mitchell, 2000) and some highly theoretical work (e.g., Besley and Ghatak, 2007) to empirical examinations of why firms or institutions undertake voluntary environmental initiatives. This recent literature tends to point at two demand-side influences that motivate firms or institutions to adopt more environmentally friendly practices. First, researchers assert that firms seek to market a product or service as 'green' to attract consumers that have high levels of concern for the environment (Zimmer et al., 1994; Mostafa, 2007). Second, researchers have explored the hypothesis that rather than marketing products/services as being 'green,' firms or institutions instead want to improve their overall public image by marketing themselves as 'green' or environmentally friendly (e.g., Fryxell et al., 2004; Heikkurinen, 2010). Fryxell et al., (2004) report that enhancing a firm's reputation is an important driver for Chinese firms seeking ISO 14001 environmental management certification. While another line of inquiry examines the role of a firm's environmental reputation on current employees and recruitment efforts (Behrend, 2009; Bauer, 1996). However, regardless of the rationale for seeking to improve green reputations, quantifying a firm's gain from improving its environmental reputation can be challenging. Some researchers have tried to measure impacts on environmental reputation by examining changes in stock exchange share prices/values corresponding to corporate environmental disclosures (e.g. Khanna et al., 1998), while some firms have turned to environmental audits (Van Leeuwen, 2004; De Moor and De Beelde, 2005). Another approach that researchers have tried is to estimate a model of corporate reputation based on data from mangers' assessments and market analysis (e.g., Brammer and Pavelin, 2006). All of these approaches appear to treat a firm's pro-environmental behavior as a function of external mechanisms and feedback to the firm.

Other social science literature on pro-environmental behavior has concentrated on internal mechanisms of individuals such as their environmental concern and altruism. Bamberg and Moser (2007) suggest a theoretical model that combines self-interest and pro-social motives to explain individuals' pro-environmental behavior. Fransson and Garling (1999) review some previous research to investigate whether environmental concern plays a vital role in understanding individuals' changes in behavior. These authors assert that socio-demographic factors such as age, education, rural/urban residence, and political inclination are key factors in predicting levels of environmental concern. That is, the socio-demographic characteristics of individuals, it is suggested, help determine individuals' environmental concern. A second internal mechanism, altruism, has also been noted as a possible determinant of activities such as green branding. In particular, research on electricity purchases finds that individuals with higher levels of environmental consciousness and altruism appear more likely to participate in green electricity programs (Kotchen and Moore, 2007). Moreover, Griskevicius et al. (2010) argue that buying green products is inherently altruistic because the purchase of green goods creates positive externalities that benefit the environment for everyone.

Two studies have begun to integrate the inquiry of both internal and external influences on firms' decision making. Wiser et al (2001) surveyed 464 firms about their purchase of green power, and they report empirical results suggesting that altruism and employee morale were important motivating factors in firms' renewable energy purchases. Clark et al. (2003) used elements from psychology on pro-environmental behavior and economic models of the private provision of a public good to identify key internal and external variables that may explain voluntary participation of households in a green electricity program. Their study indicates that internal factors such as individuals' altruism and environmental attitudes as well as external variables like household income and household size may be predictors of pro-environmental behavior. However, there is nothing in the literature that relates to institutions' green reputation and how institutional decisions to adopt pro-environmental behavior are influenced by, and in turn influence, their constituents' perception of the institution's "green" reputation.

2.2 Research Site

This study was conducted at Michigan State University, which sits on a 5,200-acre campus, of which 2,100 acres are in planned or existing development. There are approximately 577 buildings on the campus that vary in age from new to over 100 years old. The university's constituent population is comprised of approximately 46,000 students and 11,100 academic, support staff, and administrators. In 2007, the university's total greenhouse gas emissions level in carbon equivalent terms was 601,579 tons. It is estimated that 96% of the university's carbon emissions come from the university's co-generation power plant, which generates electricity and steam for the campus (Boomer, 2008). The university uses steam created during electricity production to heat buildings in the winter and run refrigeration units for air conditioning in the summer. The university's power plant gives it direct control over its energy supply and a unique ability to manage its carbon footprint.

In addition to its technical constraints, Michigan State University joined the Chicago Climate Exchange (CCX) in 2006 to, among other things, demonstrate its commitment to environmental sustainability and take actions in line with its commitment to being recognized as a "green" university. The CCX is voluntary, however once an institution joins, its commitment to the CCX's emissions reduction schedule (based on emissions relative to an agreed upon baseline year) is legally binding. CCX members represent all sectors of the economy, including several major research universities (Chicago Climate Exchange, 2009). The university's CCX membership requires a carbon reduction of 6% below year 2000 levels by 2010. Beyond those CCX obligations, the university has also pledged to further reduce carbon emissions to 15% or more below its 2000 baseline by 2015.

3. METHODS

With the university considering ways to meet or exceed its CCX obligation through changing its fuel and carbon management strategy, we sought to better understand students' and employees' perceptions of green reputation benefits associated with various energy and carbon management policies. To do so, we use a type of conjoint analysis. Conjoint analysis is a method, widely used in marketing, to understand the relationship between consumer's ratings of a product and the attributes of the product (Cattin and Wittink, 1982; Green and Srinivasan, 1990; Kalish and

Nelson, 1991). In our case, we elicit student and employee ratings of the effect that energy and carbon management plans have on an institutions' green reputation and use regression to relate these ratings to the attributes of the management plans.

We conducted a campus-wide survey of university constituents that guided respondents through a series of questions about their current behaviors, carbon management and energy conservation knowledge, and environmental attitudes and values. Each respondent was then presented with several pairs of energy and carbon management programs, asked to compare the characteristics of each potential program, and rate them using a Likert-style scale with respect to the program's contribution to the university's green reputation (See Figure 1 for an example). In our empirical conjoint model, the dependent variable is the Likert-scale rating comparing two alternative policy scenario's contribution to the institution's green reputation.

Since we are particularly interested the role of internal forces on individual's perceptions of how policies affect the university's green reputation, we condition the Likert-scale rating on two scales. We conducted factor analysis on a number of the attitudinal and motivational questions to reduce them to two interpretable variables (an altruism scale and an environmentalism scale) that become explanatory variables in our statistical model. Therefore, our conjoint approach enabled us to examine stakeholder views of energy program's green reputation effects as a function of the program attributes (forces external to the individual) and personal factors (forces internal to the individual).

3.1 Survey Design and Implementation

The survey instrument was developed in multiple phases using an iterative process (Kaplowitz et al., 2004). First, in person interviews were conducted with university administrators and technical experts to identify relevant attributes. This was followed by focus groups with students and staff in order to obtain qualitative information on their concerns, knowledge, and understanding of energy use and production at the institution. Following the focus groups, a draft survey instrument was developed and pre-tested in the field. The pre-testing allowed for the collection of additional information, which along with the input of technical experts, was used to refine the survey, the information treatments, the attributes and the attribute levels for the energy management scenarios.

For an accurate representation of the stakeholder population, the university registrar provided the researchers with a stratified random sample of student, faculty and staff email and mailing addresses. The sample population was invited by either an email or postcard to participate in the web-based survey during March 2009[2]. The invitation informed recipients about the study and provided them with a link to the survey as well as a unique username and password. Those failing to complete the survey were contacted up to two more times, either through email or a postcard, and invited again to take part in the survey. After adjusting for undeliverable mail and email addresses, the overall response rate was about 25% (RR1, AAPOR, 2009). The various subpopulations had significantly different response rates with faculty responding at 36% rate; staff at 49%; and students at 15%. A total of 4,092 individuals responded yielding 12,125 usable choice responses.

3.2 Energy Program Attributes

Five key attributes were chosen to describe energy management programs: the mix of fuels used to generate electricity and steam; the level of energy conservation efforts; the carbon emissions

[2] Invitation mode (i.e. mail or email) was part of an experiment on survey methods being reported elsewhere. Our analyses shows no substitutive difference in responses based on invitation mode.

reduction target; the time frame for achieving the emissions reduction target; and an additional semester fee per person to cover the cost. Table 1 presents the program attributes and the attribute levels used in the final survey.

Table 1. Carbon Management Program Attributes and Attribute Levels

Attribute	Attribute Description	Attribute Level
Fuel Type		
Coal	Using coal in co-generation power plant	0% to 100%
Natural Gas	Using natural gas in co-generation power plant	0% to 100%
Biomass	Building a biomass facility on campus and using biomass in the co-generation power plant	0% to 30%
Wind	Erecting utility scale wind turbines on or near campus	0% to 10%
Solar	Installing solar panels on several buildings on campus	0% to 10%
Nuclear	Installing a small, self contained nuclear underground at the university	0% or 50%
Energy Conservation Effort	The energy conservation effort consists of a combination of an education initiative and energy efficient technology adoption designed to lower energy demand	Minimal, Moderate, Extensive
Carbon Emissions Reduction	The amount that the University's carbon emissions would be reduced by undertaking a particular energy policy	15%, 17%, 19%, 21%, 23%
Year Emissions Reduction Achieved	The investment timeframe under which the emissions reductions would be fully achieved	2015, 2020, 2025
Additional Semester Fee Per Person	The additional fee paid by faculty, students and staff each semester	\$25, \$50, \$100, \$150

The variable for energy conservation effort, as explained to respondents, was made up of two components -- some level of energy conservation education campaign and some level of energy conservation technology adoption on campus. The two types of conservation components were combined to provide 'minimal', 'moderate', and 'extensive' levels of energy conservation efforts for possible adoption by the university (see Table 2).

Table 2. Energy Conservation Effort

	Education Initiatives	Technology Adoption
Minimal	Campus wide energy conservation education campaign	Upgrade outdated appliances/ fixtures
Moderate	Energy conservation training for all incoming students	Required energy efficiency certification for new buildings
Extensive	Energy conservation training for all faculty/staff/students	Required energy efficient certification for all buildings

3.3 Conjoint Experimental Design

To create energy management scenarios, we used an experimental design to vary attributes across respondents. This allows for the use of statistical techniques to identify the effect that each attribute has on the green reputation contribution. Due to the unique nature of the fuel type attribute (i.e., the need for steam generation, the scale requirement for small nuclear power, etc.), we imposed several constraints on the experimental design. We allowed for both coal and natural gas to be any level up to 100% of the fuel portfolio, while biomass ranges from 0% to 30% and, wind and solar ranges from 0% to 10% all at 10% increments. The limits for the latter arise because biomass, wind and solar do not generate needed steam for the university. The nuclear fuel attribute was limited to either not being in the fuel portfolio or being 50% of the portfolio due to the scale requirements needed to construct a nuclear facility. We also accounted for engineering feasibility and the restriction that the overall fuel mix must add to 100%.

Figure 1. Example of a choice set

Characteristics	Program	
	A	**B**
Fuel Type	Coal 70% Biomass 20% Wind 10%	Coal 60% Biomass 30% Solar 10%
Energy Conservation Effort	Minimal campus wide education campaign upgrade outdated appliances/fixtures	Extensive training all faculty/staff/students efficiency cert. for all buildings
Carbon Emissions Reduction	17%	23%
Year Reduction Achieved	2020	2020
Additional Semester Fee Per Person	$50	$100

Please compare Program A with Program B and select the box below that best describes their contribution to the university's green reputation.

Program A better   About the same   Program B better

☐ ☐ ☐ ☐ ☐ ☐ ☐

The ensuing experimental design used an algorithm-based approach to generate alternative levels for the fuel types and coupled it with a conventional main-effects design for the non-fuel attributes. In the algorithm design, we were faced with a trade-off between the distribution of fuel types and the correlation between fuel types (because they must add up to 100%). To avoid inducing collinearity among the fuel type, we constructed the fuel type distribution around technical feasibility provided by power plant engineers while minimizing the correlation within fuel types and between fuel and non-fuel attributes.

3.4 Factor analysis

The survey included two sets of attitudinal and motivational questions designed to elicit latent constructs regarding respondents. In particular, we are interested in individuals' degree of altruism and concern for the environment. Previous literature in the social sciences has noted the effectiveness of attitudinal and psychometric style questions for understanding unobservable latent characteristics of individuals (eg. Boxall and Adamowicz, 2002; Asah, 2008). Responses to these questions are used in the empirical model to help understand the green reputation ratings of the energy management scenarios. All of the attitudinal and motivational questions asked respondents to use a five point Likert-type scale to indicate their level of agreement or disagreement. The questions were pre-tested for clarity and to ensure consistency with the underlying constructs of interest. After the data were collected, we checked responses for internal consistency, and tested whether they could be combined into summated scales for each underlying construct.

The number of attitudinal and motivational questions used to build measures (i.e. scales) for each underlying latent characteristic was limited due to space constraints of the survey instrument. The final environmentalism scale was adopted from a subset of the full New Ecological Paradigm questions (Dunlap et al., 2000), and the scale used in our study has also been used by Kotchen and Moore (2007) and Clark et al (2003). The altruism scale was adopted from modified versions of Kotchen and Moore (2007) and Lusk et al. (2007).

We use principal components factor analysis in order to collapse the motivational and attitudinal data into indices representing their underlying constructs. The indices were created separately for student and employee samples. The factors were rotated using the Varimax rotation method (Kaiser, 1958) and the factor loadings and eigenvalues can be found in Table 3.

In practice, factors loadings that are above .4 are considered highly loaded and representative of the same underlying construct. Using this criterion, our factor loadings match up relatively well with the previous literature. Items A through E load on factor 1 for both students and employees. Since those items were chosen from the New Ecological Paradigm, we label this factor as the 'Environmental Index'. Items F through I all load on factor 2, with the close exception of question I for students. This factor is labeled as the

'Altruism Index' and can best be described as attitudes and motivations towards higher degrees of altruism. For simplicity and ease of interpretation in the empirical model the altruism and environmentalism indices were transformed so that larger values of the altruism index correspond to higher likelihoods of altruistic behavior and a larger values of the environmental index correspond with higher concern for the environment.

Table 3. Rotated Factor Loadings					
		Students		Employees	
		Factor 1 Environmental Index	Factor 2 Altruism Index	Factor 1 Environmental Index	Factor 2 Altruism Index
A	Plants and animals have as much right as humans to exist.	-0.4049	0.3132	-0.4835	0.2219
B	The so-called 'ecological crisis' facing humankind has been greatly exaggerated.	0.7485	-0.2243	0.7866	-0.2647
C	Human ingenuity will insure that we do not make the earth unlivable.	0.6054	0.3166	0.5738	0.0785
D	The earth is like a "spaceship" with very limited room and resources.	-0.4558	0.3019	-0.6110	0.1808
E	The balance of nature is strong enough to cope with the impacts of modern industrial nations.	0.7617	-0.0748	0.7685	-0.1078
F	I am willing to sacrifice for the good of those around me.	-0.0682	0.7654	-0.1446	0.7566
G	Paying taxes is important because they fund programs such as schools and roads from which everyone benefits.	-0.2156	0.5809	-0.3126	0.5810
H	I take actions to improve the well-being of people I don't know.	-0.0455	0.7567	-0.0480	0.7990
I	My responsibility is to provide only for my family and myself.	0.4102	-0.3889	0.2977	-0.5903
	Eigenvalues	2.71	1.375	3.19	1.231

4. DATA ANALYSIS

4.1 Descriptive statistics

Descriptive statistics for respondents' demographic characteristics and responses to energy conservation items are presented in Table 4. The descriptive statistics coincide with many of our *a priori* assumptions concerning the population. The high average student age seems to reflect changing student demographics in the general population and the number of graduate students responding to the survey. Not surprisingly, students were more aware of the current energy fee that is imposed on students than faculty and staff, while faculty and staff were more aware of the power plant's role on campus than students. The descriptive statistics also show that faculty members have a much higher mean income than staff, and that students are the lowest income group[3].

Table 4. Descriptive Statistics of Individual Characteristics

	Students	Faculty and Staff (employees)	
% Male	44.43%	43.48%	
# of respondents	1,722	2,366	
Average Age (in years)	23.91 (6.29)	46.93 (11.26)	
Political Ideology			
1= strongly conservative to 5= strongly liberal	3.34 (1.02)	3.33 (1.06)	
Average Income ($)	$16,442	$84,986	$45,508
Standard Deviation	$23,609	$42,085	$28,272
Aware of the current energy fee imposed on students	65.10%	25.77%	
Aware of the need for the power plant for producing steam and electricity	46.14%	71.36%	
Turn off lights in unoccupied room*	4.26 (.9844)	4.33 (.8234)	
Turn off computers, printers, etc. overnight *	3.43 (1.486)	4.08 (1.3)	

*Ranges from 1 = never to 5 = always
Parenthesis indicate standard deviations

[3] We use a standard recoding procedure, where the income of the constituent groups was measured at the midpoint of income ranges reported by each respondent. The income choices had a range of $15,000 for the levels from $0 up to the $60,000 threshold, then increased to $20,000 ranges from $60,000 up to the $100,000 threshold and end with a range of $100,000 to $150,000 and more that $150,000.

Figure 2. “The university’s target of a 15% emissions reduction by 2015 is:”

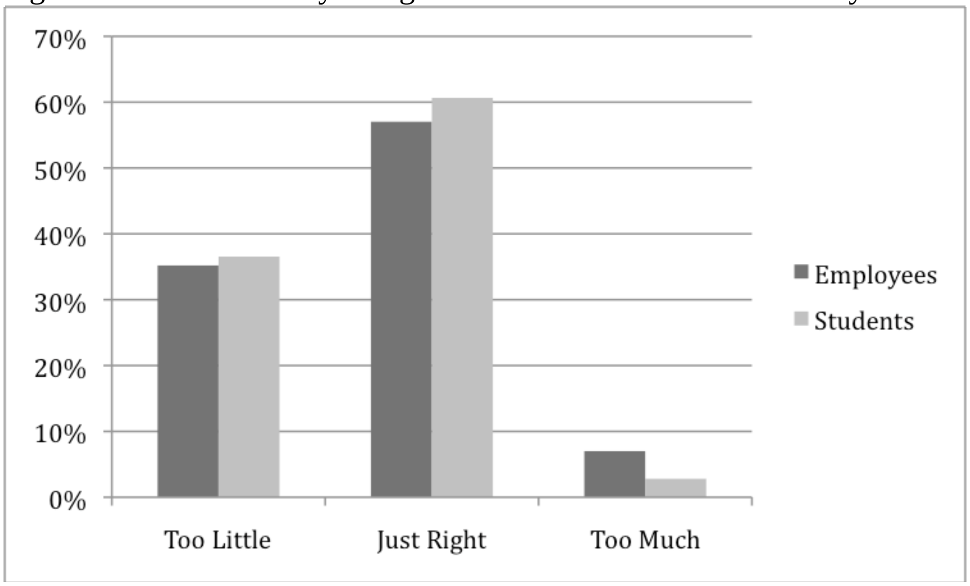
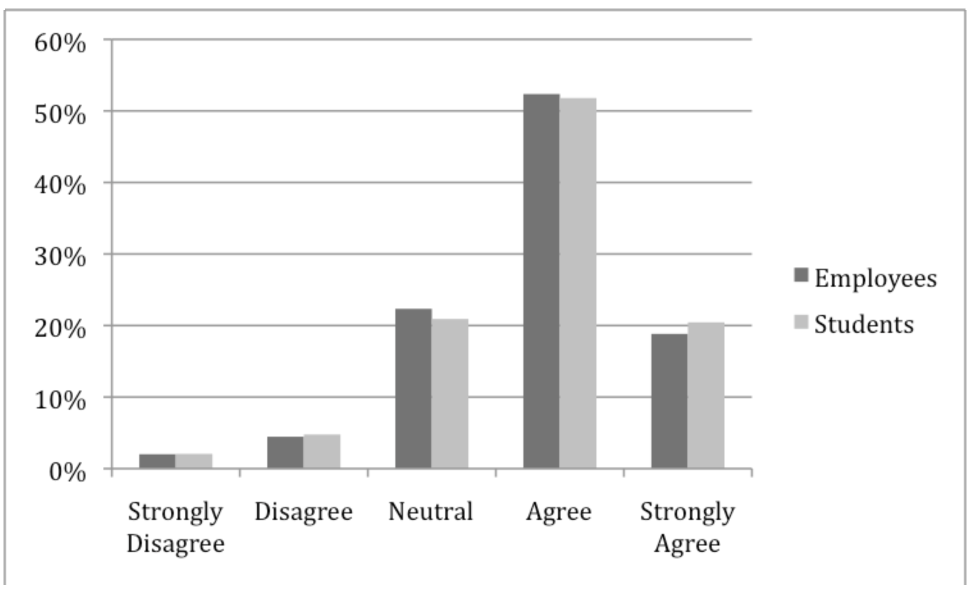


Figure 3. “I think that the university’s green reputation benefits me:”



As Figure 2 illustrates, the majority of students and employees (faculty and staff) think that the university’s emissions target of 15% reduction by 2015, which is greater than its CCX commitment, is either too little or just the right amount. Not only do the vast majority of students and employees support decreasing the campus' carbon footprint, but the constituents also believe that they gain a benefit from the university's green reputation. Figure 3 shows that 71% of employees and 72% of students agree or strongly agree that they benefit from the university's green reputation. These results support the merit of examining the relationship between how constituents benefit from decisions to maintain or improve an institution's green reputation.

4.2 Empirical Model

Empirically, we use the regression model $Y_i = \beta \Delta X_j + \gamma Z_i \Delta X_j + \mu_i + \varepsilon_{ij}$. The observable independent variables X_j are the energy management scenario characteristics of the two competing alternatives for the jth alternative. In order to take into account the tradeoffs made by respondents with respect to each choice pair, we use the difference between the attribute levels (i.e. Choice A – Choice B), which is represented in the regression model as ΔX_j. Using the differenced attributes allows us to identify and estimate β, the effect of the attributes on the green reputation ratings. The actual numerical values were differenced for the fuel type, carbon emissions reduction, time-frame, and fee, while a dummy variable procedure was differenced for the discrete energy conservation effort variable. The dependent variable Y_i is the Likert-scale comparison of the two competing alternatives that indicates which of the scenarios, according to the respondent, contributes more to the institution's green reputation. The data for the dependent variable was coded to match the structure of the independent variables. The model also considers interaction terms with the differenced energy management attributes ΔX_j in order to examine heterogeneity within constituent groups. We use respondents' demographic characteristics as well as altruism and environmentalism indices, which are represented by Z_i, allowing us to identify and estimate the parameter γ. Finally, because of the panel nature of our data we include an individual specific error component μ_i and a random error term ε_{ij}. The multiple error terms are used due to the multiple responses from each individual and because it is likely that individual specific effects carry across responses (i.e. unobserved characteristics unique to each individual can induce correlation among responses). Therefore, the random effects estimation technique is used (Wooldridge, 2002) in an ordinary least squares (OLS) linear random effects regression model.

As discussed above, the data were drawn from stratified random samples of the campus constituent groups. Therefore, using a Chow test we tested whether any of these three groups had different underlying preferences or if it might be appropriate to pool any of the groups (Chow, 1960). The results show that we cannot reject the hypothesis that faculty and staff have the same underlying preferences at the 5% significance level. At the same time, the analysis revealed that students had preferences that differed significantly from those of faculty and staff segments. Thus, faculty and staff are combined as ‘university employees’ but students remain a separate segment.

4.3 Model Estimation Results

We first consider separate regression model results for the student group and the employee constituent group. The results for the student segment are presented in Table 5 and the employee segment results are in Table 6. Model 1 for each group consists of only the energy management scenario attributes in the conjoint analysis. The results from Model 1 show that all of the coefficients for both groups are significant at the 1% level and have the expected sign. Interpreting the positive coefficients for all of the fuel types for both groups is taken in the context of the baseline category for the fuel variable, coal. These results indicate that energy produced by coal has the lowest green reputation benefit to university constituents, and that green reputation benefits increase as the use of carbon intensive fuel decreases. We find, using a Wald test, that for students wind and solar provide green reputation benefits that are statistically indistinguishable from each other, while for the employee group wind energy provides a higher green reputation benefit than solar energy. Nuclear power's impact on the institution's green reputation is found to be slightly more favorable to coal for both students and employees. It is likely that wind and solar power have the highest reputation effects because they are carbon free energy production technologies and that they also may provide a visible symbol of the university's environmental commitment. While nuclear power is also a carbon free technology, there are a variety of negative characteristics associated with nuclear power such as perceptions of higher risks and the issue of nuclear waste. The estimation results also show that increasing the emissions reduction target has a positive influence on green reputation. The negative sign on the emission reduction timeframe attribute suggests that both students and employees view shorter timeframes for achieving emissions reduction as enhancing the institution's green reputation.

4.4 Examining the Heterogeneity of Preferences

We extend the conventional model described above to take into account heterogeneity within constituent groups by incorporating interaction terms of both respondents' socio-demographic characteristics as well as measures of their environmentalism and altruism (defined above). The extended model's interaction effects take into account several key factors that are believed *ex ante* to influence respondents' attitudes and preferences towards a program's green reputation. We evaluate each of the successively expanded models and perform a Wald test to ensure the additional covariates improve model fit. For the student segment, we fail to reject the null hypothesis that the simple and expanded models are equal at the 10% significance level for Model 3 and Model 4, but not Model 2. For the employee models, we fail to reject the null hypothesis at the 5% level for all of the models. Therefore, the results show that including the interaction terms of respondent's demographic, attitudinal, and altruistic characteristics increases the explanatory power of the model. Our test results suggest that there are heterogeneous preferences within each of the stakeholder segments that can be further evaluated by incorporating socio-economic characteristics as well as our environmentalism and altruism indices.

We present the model results including several different interactions with respondent characteristics and psychometric (i.e., environmentalism/altruism) indices for students in Table 5. The results from Model 2 indicate that awareness of the current energy fee that is levied on students does not have a statistically significant effect on the university's green reputation. This result is consistent throughout all three of the expanded interaction models. In light of the factor loadings of the environment and altruism indices, Model 3 suggests that the higher a respondent's level of environmentalism, the more weight the respondent puts on larger and quicker emissions reductions targets and for the programs' enhancement of the institution's green reputation.

When evaluating increased concern for the environment at the mean of both emissions reduction and time frame, the results suggest that emissions reduction plays a larger role in perceived green reputation benefits than the reduction in time frame for such reduction to take place. Likewise, increasing altruistic motivations were found to increase weight on emissions reduction as well as a shorter time frame for reductions to be made. The effects of including the altruism and environmental concern indices in the model are similar across population segments.

To examine the influence of respondents' political affiliation on perceptions of the impact of management strategies on the institution's green reputation, we used a dummy variable for the respondents' political affiliation, where a one indicated that respondents thought of themselves as either 'conservative' or 'moderate' and a zero indicates instances where respondents considered themselves to be 'liberal'. The political affiliation variable was interacted with the fuel mix for both stakeholder segments. We found that 'conservative/moderates' were less likely to perceive green reputation benefits from increasing the use of carbon-free technologies in the fuel portfolio mix. This was generally consistent for students and employees. However, wind and biomass did not have a statistically significant difference for students with opposing political affiliations. That is, students of either political affiliation are equally likely to see wind and biomass as enhancing the institution's green reputation.

In considering preference heterogeneity among university employees we find that age does not seem to have a statistically significant affect in their choice of the structure of the fuel portfolio except with respect to nuclear energy. We find that nuclear energy contributes less to one's perception of enhancing the institution's green reputation for older employees than it does so for younger employees. The results also show that as respondents' income increase they are less sensitive to the program fee (price) attribute.

5. DISCUSSION AND IMPLICATIONS

Despite increased pressure in recent years on many firms and institutions to move toward more sustainable and environmentally friendly practices, little research has examined the effects of such shifts on institutions' green reputation from within the firm. This study seeks to help build this literature by examining how constituents' (students and employees) green reputation benefits are derived from various possible energy production, consumption, and conservation policies. Our approach successfully incorporates the use of a Likert-style scale to rate the impact of various energy and carbon management scenarios on an institution's green reputation. The management plans consist of attributes such as fuel mix, carbon emissions reduction target, and investment time frame. Another strength of our empirical approach is the incorporation of respondents' socio-economic characteristics and motivational factors in examining internal influences and heterogeneity within constituent groups.

The results show that constituents do benefit from their institution's green reputation and that energy management attribute choices can contribute to or detract from the institution's reputation. We find that constituents gain a higher green reputation benefit from approaches that incorporate renewable energy generation such as wind and solar power in the institution's fuel portfolio along with increased emissions reduction targets. Likewise, carbon footprint reduction time frames can significantly influence an institution's green reputation among stakeholders. Incorporating social, economic and latent motivational characteristics in the model to examine preference heterogeneity within the population revealed significant heterogeneity within constituent groups as measured by respondent's demographic characteristics and altruistic and environmental indices. For example, respondents with more altruistic motives were found to have higher green reputation benefits from increased carbon emissions and shorter investment time frames. While self-identified "conservative" employees and students showed lower green reputation benefits for changing from coal to wind or solar than more liberal employees and students.

Compared to the previous literature on pro-environmental behavior and corporate environmentalism, our results coincide with the literature suggesting the importance of integrating both internal and external influences to create a more informative model. Similar to Clark et al. (2003), we find that both internal and external influences have implications on preferences for energy management policy. In keeping with Wiser et al. (2001), which noted the importance of altruism and employee morale in firm environmentalism, our results demonstrate the importance of altruism in constituents' perception of a policy's green benefit. Our results also coincide with the social science literature on socio-economic characteristics and environmental concern. As previously noted, social scientists assert that younger, more educated individuals with liberal political ideologies are the most environmentally concerned (Fransson and Garling, 1999). Similarly, our results show that older employees and more politically conservative individuals gain a lower green reputation benefit from a shift to less carbon intensive fuel sources.

The results of our study have implications for both policy makers and decision makers within firms and institutions. First, they show that constituent groups do indeed care about their institution's green reputation, and thus an institution has the ability to influence its internal green reputation as well as potentially its external green reputation through its energy production, consumption and management policies. Therefore, institutions should broaden their consideration of the full scope of their pro-environmental policy's costs and benefits to include previously hidden benefits found within the firm, such as policies' impact on green reputation. Second, the heterogeneity both between constituent groups and within each constituent group suggests that there is not one energy management policy for positively influencing an institution's green reputation for all constituents. Therefore, institutions should take into account their constituency’s composition and preferences in order to make appropriate management decisions.

Table 5: Student Coefficients and Interaction Terms for Carbon Management Programs

	(1)		(2)		(3)		(4)	
Variable	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Constant	2.87	0.000	2.86	0.000	2.87	0.000	2.88	0.000
Natural Gas	0.014	0.000	0.015	0.000	0.015	0.000	0.017	0.000
Biomass	0.024	0.000	0.025	0.000	0.025	0.000	0.027	0.000
Wind	0.050	0.000	0.050	0.000	0.050	0.000	0.059	0.000
Solar	0.048	0.000	0.049	0.000	0.048	0.000	0.053	0.000
Nuclear	0.009	0.000	0.009	0.000	0.0088	0.000	0.0094	0.000
Mod. Effort	0.12	0.005	0.12	0.005	0.12	0.004	0.121	0.004
Ext. Effort	0.10	0.027	0.10	0.025	0.105	0.022	0.104	0.025
Emissions Reduction	0.077	0.000	0.078	0.000	0.078	0.000	0.078	0.000
Year Reduction Achieved	-0.032	0.000	-0.033	0.000	-0.032	0.000	-0.032	0.000
Fee	-0.003	0.000	-0.004	0.000	-0.0035	0.000	-0.0036	0.000
Income*Fee awareness			0.0001	0.897	0.0003	0.692	0.0004	0.627
Emissions Reduction * NEP					0.014	0.012	0.012	0.026
Year Reduction Achieved * NEP					-0.011	0.018	-0.012	0.014
Emissions Reduction * ALT					0.020	0.000	0.021	0.000
Year Reduction Achieved * ALT					-0.017	0.000	-0.017	0.000
Natural Gas * Politics							-0.0037	0.122
Biomass * Politics							-0.0054	0.135
Wind * Politics							-0.018	0.014
Solar * Politics							-0.0099	0.196
Nuclear * Politics							-0.0010	0.683
Groups	1693		1690		1644		1644	
Sigma u	1.805		1.803		1.787		1.788	
Sigma e	1.503		1.503		1.501		1.502	
Rho	0.590		0.590		0.586		0.586	
R-squared (overall)	0.093		0.094		0.101		0.101	

Table 6: Employees Coefficients and Interaction Terms for Carbon Management Programs

	(1)		(2)		(3)		(4)	
Variable	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value	Coefficient	P-Value
Constant	2.83	0.000	2.85	0.000	2.86	0.000	2.86	0.000
Natural Gas	0.015	0.000	0.015	0.000	0.014	0.003	0.019	0.000
Biomass	0.024	0.000	0.025	0.000	0.024	0.000	0.029	0.000
Wind	0.052	0.000	0.051	0.000	0.049	0.000	0.066	0.000
Solar	0.047	0.000	0.047	0.000	0.057	0.000	0.056	0.496
Nuclear	0.0027	0.011	0.0028	0.013	0.011	0.018	0.0011	0.011
Mod. Effort	0.088	0.015	0.095	0.010	0.098	0.009	0.095	0.002
Ext. Effort	0.125	0.002	0.127	0.002	0.130	0.002	0.129	0.000
Emissions Reduction	0.062	0.000	0.061	0.000	0.061	0.000	0.060	0.000
Year Reduction Achieved	-0.037	0.000	-0.037	0.000	-0.037	0.000	-0.036	0.000
Fee	-0.0032	0.000	-0.0038	0.000	-0.0038	0.000	-0.0039	0.153
Income*Fee			0.0000	0.230	0.0000	0.257	0.0000	0.000
Emissions Reduction * NEP			0.019	0.000	0.019	0.000	0.018	0.013
Year Reduction Achieved * NEP			-0.0109	0.008	-0.0108	0.009	-0.0102	0.004
Emissions Reduction * ALT			0.015	0.003	0.014	0.004	0.014	0.008
Year Reduction Achieved * ALT			-0.010	0.007	-0.010	0.010	-0.011	0.001
Natural Gas * Age					0.0000	0.667		
Biomass * Age					0.0000	0.929		
Wind * Age					0.0000	0.892		
Solar * Age					-0.0002	0.468		
Nuclear * Age					-0.0002	0.066		
Natural Gas * Politics							-0.0073	0.005
Biomass * Politics							-0.0091	0.000
Wind * Politics							-0.025	0.012
Solar * Politics							-0.017	0.164
Nuclear * Politics							0.0031	0.000
Groups	2314		2157		2130		2141	
Sigma u	1.827		1.816		1.816		1.813	
Sigma e	1.526		1.520		1.520		1.515	
Rho	0.589		0.588		0.588		0.588	
R-squared (overall)	0.090		0.096		0.097		0.099	

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