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Classification Of Ethanol Consumers and Willingness to Pay for Reductions in Greenhouse Gas Emissions Through Purchases of E85

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To the Graduate Council:

I am submitting herewith a thesis written by Adrienne Elizabeth Marra entitled "Classification Of Ethanol Consumers and Willingness to Pay for Reductions in Greenhouse Gas Emissions Through Purchases of E85." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Burton C. English, Major Professor

We have read this thesis and recommend its acceptance:

Kimberly L. Jensen, Christopher D. Clark

Accepted for the Council:
Dixie L. Thompson

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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CLASSIFICATION OF ETHANOL CONSUMERS AND WILLINGNESS TO PAY FOR REDUCTIONS IN GREENHOUSE GAS EMISSIONS THROUGH PURCHASES OF E85

A Thesis

Presented for the

Master of Science Degree

The University of Tennessee, Knoxville

Adrienne Elizabeth Marra

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DEDICATION

This thesis paper is dedicated to my parents, Leslie Marra and Dan Marra as well as my brothers Joey Marra and Michael Marra.

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ABSTRACT

In recent years, the issues of energy dependency and renewable energy options have gained recognition with not only policy-makers but also mainstream consumers. Understanding consumer beliefs and preferences related to these issues is therefore relevant as innovative renewable energy markets have the potential to change conventional consumer purchasing decisions. This paper investigates the beliefs and behaviors of U.S. consumers related to E85 ethanol from corn and cellulosic feedstocks. Four distinct market segments are created so that the ethanol market can be investigated more in-depth. Overall familiarity with ethanol as an alternative fuel is high; however, individual segments vary on beliefs related to corn and cellulosic ethanol, purchasing Flex-Fuel Vehicles, general concern for the environment, and many other factors. In order to successfully market ethanol to a diverse market, the preferences, beliefs and behaviors of these four distinct segments should be taken into account. While environmental concern has waxed and waned over time, issues like as climate change have come to the forefront of both domestic and international discussion and policy. The role of greenhouse gas emissions in contributing to climate change has been acknowledged. As a major source of emissions, transportation fuels are an obvious source of potential reductions in greenhouse gas emissions. This study segments consumers into four distinct market segments and uses a contingent choice method to determine willingness to pay for reductions in greenhouse gas emissions through purchases of E85 ethanol blends. Overall, willingness to pay is estimated at about 0.18 cents per gallon for each percentage in emissions reductions when compared with gasoline containing no ethanol (E0). Willingness to pay for emissions reductions varies in significance and degree across the four market segments. The diversity between the four segments implies that marketing plans should take into account the heterogeneity of consumers and make efforts to account for their varied needs and preferences.

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Part 1: Introduction

According to the National Energy Policy Development Group, this country currently "faces the most serious energy shortage since the oil embargoes of the 1970s", which has been preceded by a fundamental imbalance between supply and demand" (2001). While discrepancies between supply and demand are not uncommon in many markets, the size and global impact of the fossil fuel market makes this issue of particular interest. In the summer of 2008, the United States realized the impacts of volatile oil prices when the price of crude oil reached over $140.00 a barrel. Taheripour and Tyner suggest that the price of crude oil and the price of gasoline are highly correlated, and that this correlation, though not as strong, extends into the agricultural sector (2008). In a world where the bottom line influences business as well as policy decisions, many would argue that the price of fossil fuels is of the highest importance. But what if the price is not a true representation of the costs? In light of the recent oil spill in the Gulf of Mexico, the "hidden costs" of oil are beginning to unveil themselves to a judgmental and unforgiving public. Can the market be expected to allocate a resource efficiently when social, environmental, and economic externalities are not taken into account? While gas prices are not currently at all-time high, consumers are realizing that the true costs of fossil fuels are not always reflected on the receipt they tear casually from their neighborhood fuel pump.

In 2008, the United States used 1.5 billion tons (oil equivalent) of fossil fuels (Energy Statistics 2009). That's only 332.7 million tons less than China whose population is around four times as large as the United States'. It has become painfully obvious that we have built a society that cannot survive without large energy inputs. Cities sprawl, highways connect them, and everyone needs to get from point A to point B in their own vehicle. As a result of growing energy demand and environmental concerns, fuel mixes like E85 ethanol (85 percent ethanol, 15 percent gasoline) have gained attention as an alternative for transportation fuels. According to

one source, the future of global biofuels production will depend on many factors including future oil prices, availability of low-cost feedstocks, government support, cost-reducing technologies, and competition from other fossil fuel alternatives (Coyle 2007). While these are necessary components of a successful biofuels market, consumer support should also be mentioned as vital piece of this market. Consumers are ultimately responsible for fuel purchasing decisions, and allowed to act independently will choose the fuel that provides the most utility. The heterogeneous nature of preferences and needs among consumers allows them to be segmented into relatively homogeneous groups that can be examined and targeted accordingly in order to facilitate marketing of E85 ethanol as an alternative fuel.

The first part of this paper will segment consumers from an ethanol survey and suggest ethanol marketing strategies based on each of the specific profiles. The second part of this paper will use the same segments to estimate willingness to pay for greenhouse gas emissions through E85 purchases. Finally, a summary will review the results of both papers and offer suggestions for further research.

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Part 2: Classification of Ethanol Consumers with Implications for Marketing: A Cluster Approach

Abstract

In recent years, the issues of energy dependency and renewable energy options have gained recognition with not only policy-makers but also mainstream consumers. Understanding consumer beliefs and preferences related to these issues is therefore relevant as innovative renewable energy markets have the potential to change conventional consumer purchasing decisions. This paper investigates the beliefs and behaviors of U.S. consumers related to E85 ethanol from corn and cellulosic feedstocks. Four distinct market segments are created so that the ethanol market can be investigated more in-depth. Overall familiarity with ethanol as an alternative fuel is high; however, individual segments vary on beliefs related to corn and cellulosic ethanol, purchasing Flex-Fuel Vehicles, general concern for the environment, and many other factors. In order to successfully market ethanol to a diverse market, the preferences, beliefs and behaviors of these four distinct segments should be taken into account.

Introduction

As a result of human activities greenhouse gas (GHG) emissions such as carbon dioxide, methane gas, and nitrous oxide have increased (IPCC 2007). The threats of global climate change, geopolitical instability, and fuel security have provided reason and incentive to develop energy from renewable and sustainable sources. Consequently, the case for renewable forms of energy has moved from the area of niche markets to one of economic incentive and necessity as renewable technologies become environmentally and economically viable alternatives to energy from fossil fuels (Herzog et al. 2001). As the global market demands more energy, it will be necessary to provide an energy product that is efficient and sustainable. Research indicates that

there is substantial economic potential for the reduction of GHG emissions in the coming years (IPPC 2007).

One means of reducing GHG emissions in the short run would be to substitute fossil fuels with a renewable fuel such as ethanol. Transportation is a necessary and vital component of many societies, and most modern transportation vehicles utilize some form of petroleum product. For use as a transportation fuel, ethanol is currently blended into E10 and E85 fuel. The number in the name of the fuel represents the percentage of ethanol present in the gasoline/ethanol blend. E10 is not new to the fuel market and is compatible with all gasoline powered engines; however, E85 can be used in Flex-Fuel vehicles (FFVs) as a substitute for traditional E0 or E10 gasoline. In 2008, approximately 9.2 billion gallons of ethanol were produced in the United States, and demand was approximately 9.5 billion gallons (EERE 2008). The Energy Independence and Security Act of 2007 includes a Renewable Fuel Standard mandating 36 billion gallons of renewable fuels in the fuel supply by 2022. While fifteen billion gallons of this may come from corn ethanol, the remaining 21 billion must come from cellulosic feedstocks and biomass-based diesel. Ethanol, as an alternative fuel, has the potential to provide a secure and sustainable fuel source as well as reduce GHG emissions. However, it is important to note that the majority of vehicles on the road today use a 10% ethanol blend. With this in mind, a concept known as the blend wall has the potential to limit ethanol production to 10% of total gasoline consumption. Currently, the United States consumes around 140 billion gallons of gasoline annually, so the blending wall lies at 14 billion gallons of ethanol (Taheripour and Tyner 2008). The authors in this publication go on to suggest increasing the current E10 blend to either E15 or E20 as a possible solution to the blend wall issue (2008). While problems arise with even this solution, a way around the blend wall is necessary to sustain future increases in ethanol production.

With the impact of human energy consumption on global climate surfacing as an important issue, consumers have taken notice and environmental awareness has become increasingly relevant in purchasing decisions (Rowlands, Scott, and Parker 2003; Roberts 1996; Minton and Rose 1997; Wiser 1998). Increased availability of green electricity programs has given consumers a choice. Consumers must now make decisions related to both the amount and type of energy they will purchase. The economic potential for renewable energy products has motivated suppliers to develop new energy products for an emerging green market. Wong et al. (1996) focused on three forces driving the adoption of green technology in industry: firm-related motives (cost reduction, marketing a green image), threat of regulation, and green consumerism. Pressure from competitors, government, and the public all influence the firm's decisions related to what type of product to produce and how much to supply to the market. Since consumers are ultimately responsible for purchasing decisions, considering the demand side of the equation is just as important. There is increasing agreement in the marketing literature that the green market is significant and that firms can profit by developing green products (Ottman 1993; Eriksson 2002). However, green products are no different from conventional products in that they must satisfy a consumer need, and be preferred in the market to substitutes in order to merit additional investment. It is therefore important for firms producing green products to understand the benefits and challenges associated with marketing their products and to establish effective marketing strategies for promoting and selling them.

The role of the consumer in economics is fundamental. Wendell R. Smith's pioneering article emphasized this role, and discussed the strategy of market segmentation (1956). In the years since this article was written, market segmentation has quickly become a commonly utilized marketing tool (Claycamp and Massy 1978; Wind 1978). Classification of consumers

into groups or market segments is often used in order to gain better understanding of consumers' needs and motivations in order to facilitate the marketing of a product (Smith 1956; Baker and Burnham 2001). A common way of segmenting markets is through clustering. Clustering is a basic human activity that involves grouping similar objects together based on a set of characteristics (Everitt 1993). It is the art of finding groups in data, and is very much reliant on the meaningful interpretation of the researcher or classifier (Kaufman and Rousseeuw 2005). Simply stated, mathematical methods of cluster analysis involve the gathering of similar objects (data) into distinct clusters that are internally homogeneous and externally heterogeneous.

Objective

The objective of this research is to identify potential ethanol consumers through distinct market segments. This will be achieved through cluster analysis. Once the segments are identified, specific marketing strategies will be suggested.

Literature Review

Market Segmentation

According to Smith (1956), market segmentation is the mechanism by which a large heterogeneous market is viewed as multiple smaller homogeneous markets as an acknowledgement of disparate product preferences among consumers. In the same manuscript, Smith recognized that divergent demand among consumers was an important market characteristic that could be accounted for through adjustment of product lines and marketing strategies (1956). Emphasis was then placed on the firm's ability to merchandise to a heterogeneous market by promoting the ability of a product to satisfy the needs and wants of various distinct groups of consumers. Specific advertising and promotion followed segmentation

and was aimed at informing market segments about a product that will target consumer needs (1956). Segmentation is based on developments in the demand side of the market and embodies a balanced and more precise coordination of a product and marketing efforts. In this scenario, many demand schedules are taken into account where only one demand schedule would previously been used to evaluate an entire market. While product differentiation gives the marketer a horizontal share of a market; the strategy of market segmentation produces greater depth of market position in defined segments (Smith 1956).

Wind (1978), notes that market segmentation is one of the most dominant and fundamental concepts of both marketing literature and practice. As well as being one of the primary means of operationalizing the marketing concept, segmentation provides guidance for a firm's marketing strategy and resource allocation among markets and products. In the presence of heterogeneous markets, a firm utilizing a market segmentation strategy can most often increase expected profitability, which provides significant theoretical rationale for the market segmentation process. In the discussion on methods of segmentation, Wind mentions cluster analysis as a means of data exploration, data reduction, and hypothesis generation. When examining the results of a segmentation analysis, Wind encourages researchers to ensure that results are meaningful and instrumental in the design, execution, and evaluation of a marketing strategy (1978). Many segmentation studies offer a valuable, multi-faceted profile of potential target markets, which can potentially lead to the propagation of multiple marketing ideas and strategies (Wind 1978).

Cluster Analysis

Cluster analysis has become a useful means for both marketing and academic researchers to develop empirical groupings of people, products, or occasions to serve as a basis for further analysis (Punj and Stewart 1983). Baker and Burnham (2001) used Ward's minimum variance cluster method and the SAS CLUSTER procedure to identify market segments based on consumer preferences for brand, price, and GMO content of cereal. Three clusters were identified based on the pseudo F-statistic, pseudo t^2- values, and the researchers' interpretation of the cluster solutions. Attitudinal, demographic, and psychographic variables were included in the cluster analysis because of their influence on consumer behavior (Baker and Burnham 2001). Implications for policy makers and marketers based on the results of segmentation were also included.

Henriques and Sadorsky (1999) used the K-means cluster procedure in the SPSSPC+ Quick Cluster routine to classify 400 firms into four environmental profiles related to environmental commitment and managerial perception of stakeholder importance. Based on the four firm profiles, the authors suggested that firms wishing to make environmental issues a priority should make an effort to hire management who react positively to stakeholders who exhibit the values the company wishes to portray.

Vassilikopoulou et al. (2005) used a k-means cluster analysis to segment consumers based on attitudes towards corporate social responsibility. Consumer attitudes were measured using a twenty-seven question survey. Responses to questions were measured on a 5-point Likert scale ranging from 'strongly agree' to 'strongly disagree'. A three cluster solution was chosen as the optimal result based on the number of discriminating between cluster variables and

distinct profile development. Cluster profiles were provided in the study and were based on the cross tabulation between the scores of the twenty-seven statements and the cluster-membership variable. Target marketing strategies for the three segments were also included.

Van de Velde et al. (2009) used 363 responses from a consumer survey to examine the importance of fuel characteristics as they relate to belief about biofuels in Belgium. The first section of the survey asked respondents to state the importance of twelve different fuel characteristics with respect to purchasing a new vehicle. Responses were measured on a five-point Likert Scale ranging from 'not at all important' to 'very important'. The second section of the survey pertained to awareness and familiarity with alternative fuels. The third section of the survey profiled respondents using four items to measure perceived consumer effectiveness (PCE) and whether or not the government had provided sufficient information regarding biofuels. Finally, respondents provided information about their current vehicle, potential future vehicle purchases, and general demographics. A two-step cluster analysis was used to segment the respondents. First, Ward's minimum Variance cluster method was used to initially cluster the respondents. Based on the authors' inspection of the agglomeration schedule and dendrogram from this analysis, a four-cluster solution was determined to be optimal. A K-means cluster analysis was then used to refine the solution using initial cluster centers found through Ward's method. The four clusters were named according to defining characteristics and profiled in terms of demographics, lifestyle, vehicle characteristics, and perceived importance of fuel characteristics. Implications and suggestions for target marketing were offered, and the authors recognized that failure to account for the consumer perspective may negatively affect the adoption of renewable energy technologies.

The Ethanol Promotion and Information Council (EPIC) has commissioned five surveys over the last five years[1]. The objectives of these surveys were to track changes in awareness of and purchase intent for ethanol –blended gasoline, to determine factors influencing consumer's attitudes towards ethanol-blended gasoline, and to gain a better understanding of Flex-Fuel Vehicle and E85 users. A new goal mentioned in the November 2008 survey is to explore awareness of and interest in cellulosic ethanol. In the November 2008 survey, 73 percent of respondents believe that domestically produced biofuels are the best solution to the U.S. energy situation, while only 7 percent suggest importing more foreign oil. Familiarity with E85 rose slightly from 31 percent in April 2008 to 33 percent in November 2008, up from 20 percent in November 2006. In this survey, familiarity with cellulosic ethanol received a low rating with a mean score of 1.5 (On a scale ranging from 1= not at all familiar to 5=extremely familiar). Among those familiar with cellulosic ethanol, the chief characteristic mentioned was that it was made from non-food plant sources. Despite its low familiarity rating, 56 percent of respondents indicated that they would likely purchase cellulosic ethanol blended gasoline.

The October 2007 and November 2006 surveys both include a cluster analysis of survey respondents. In October 2007, four clusters were identified based on responses to questions related to consumer attitudes, purchase likelihood, and psychographics. The four clusters were named 'Environmental Activists' (17 percent of respondents), 'Patriotics' (30 percent of respondents), 'Value Seekers' (24 percent of respondents), and 'Indifferents' (30 percent of respondents). Clusters are profiled using index scores for the attitudinal, purchase likelihood, and psychographic variables. Demographic information for the clusters is also provided. In the November 2006 survey, respondents were clustered based on psychographic and attitudinal

[1] Survey dates: November 2006, May 2007, October 2007, April 2008, and November 2008

variables. A factor analysis followed by the K-Means cluster procedure was used to identify three clusters named 'Outgoing/Influencers' (28 percent of respondents), 'Patriotic/Environmentally Responsive' (28 percent of respondents), and 'Price Conscious/ Value Seekers' (44 percent of respondents). Means for the attitudinal and psychographic clustering variables, information about ethanol purchase likelihood, and demographics for the three clusters are provided.

Previous research has looked at preferences for biofuels characteristics and made suggestions for marketing strategies based on segmentation of respondents according to their perceived importance of these characteristics (Van de Velde et al. 2009); however, no cluster analysis has been uncovered that looks in-depth at market segments of the ethanol market with relation to topics such as familiarity with specific cellulosic feedstocks and Flex Fuel Vehicle use and purchase intent.

Data and Methods

Survey Methods

Data for this analysis will come from the Ethanol Conjoint Survey conducted online in January and February 2009. Knowledge Networks (KN) provided the survey sample and online survey administration services. The sample was taken from Knowledge Networks' online research panel which is designed to be representative of the U.S. population. Panel members are recruited by telephone using random digit dialing (RDD). Address-based sampling methods are also used to account for RDD's declining effectiveness (due to cell phones, etc.) Free internet access and a laptop computer are provided to panel members on an as-needed basis in exchange for agreeing to complete at least one survey each week. Panel members who complete longer

surveys, i.e. longer than 15 minutes, receive incentive points that are redeemable for cash. Each panel member completes an initial profile survey that collects essential demographic information. This profile is updated annually.

Panel members selected for this survey were sent an email informing them that there was a new survey available to take and a link was provided to the survey. Automatic email reminders were sent to non-responders after three days. Panel membership for this survey was compared to the most recent demographic distribution data from the Current Population Survey and was adjusted to correct for known deviations in panel recruitment from an equal probability sample of the U.S. population, as well as non-response and non-coverage bias in panel membership.

The survey was fielded to 2,851 panel members age 18 and older, and a total of 1,909 responses were collected. The survey instrument began with two screening questions. If the household did not currently own or lease at least one automobile or the household automobile driven the most often did not have a gasoline or gasoline/electric engine, the respondent was screened out of the survey. 1,727 out of 1,909 respondents passed the screening and provided useable responses to the survey. Out of these usable responses, 1,668 were used for the cluster analysis based on the completeness of responses to the clustering questions.

A survey weight was designed to account for non-response to the survey and was calculated by comparing respondent demographics with benchmark demographics from the Current Population Survey (i.e., gender, age, ethnicity, education, census region, metropolitan area, and access to the internet). An iterative proportional fitting procedure was used to calculate the weights (Knowledge Networks 2009). The distribution of the calculated weights was

examined to identify and trim outliers at the extreme upper and lower tails of the weight distribution. Results were weighted with the calculated weights.

The survey instrument contained eight "information screens" that provided respondents with some basic information on ethanol blends and feedstocks. The first screen explained gasoline and ethanol, and provided information related to the amount of crude oil consumed in the U.S. that comes from foreign sources. The second screen described E10, E85, and FFVs, and warned that only E85 could be used in FFVs. The third screen explained the differences in octane levels of gasoline and E85. The fourth screen explained that ethanol has lower energy content relative to gasoline, and that this translates into increased frequency of refueling. The fifth screen explained that the use of ethanol reduces the amount of GHG and other pollutants released into the atmosphere. Lastly, three screens provided information on the three different feedstocks: switchgrass, wood wastes, and corn.

Questions in the survey address issues such as familiarity and experience with ethanol and FFVs, vehicle ownership, driving patterns, future automobile purchases, respondent attitudes towards a variety of topics including fuel security, personal actions, the food vs. fuel debate, and the environment, membership in environmental organizations, and sources of environmental information. The survey also contained a contingent choice exercise in which respondents were asked to choose between different variations of E85 and either an E10 or E0 blend, depending on the survey. Respondents were asked to assume that their automobile was compatible with E85 when responding to the contingent choice questions. The contingent choice exercise contained fourteen different choice tasks. Three of the alternatives were an E85 blend with differing levels of attributes and the fourth alternative was either E10 with corn as the ethanol feedstock or E0.

Cluster Methods

Survey respondents were clustered based on their responses to fifteen questions measured on a Likert-scale ranging from 'strongly disagree' to 'strongly agree'. These questions pertained to attitudes and behaviors related to fuel security, the food vs. fuel debate, environmental concern, perceived consumer effectiveness (PCE)[2], and faith in the efficacy of others (FIO)[3]. A complete list of cluster variables can be found in Table 2.1[4].

A popular two-stage cluster method in which a hierarchical cluster method is followed by a non-hierarchical method (Sharma and Kumar 1998; Punj and Stewart 1983; Kuo, Ho, and Hu 2002) was chosen for this analysis. Ward's Minimum Variance method was the hierarchical method used to determine the optimal number of clusters. Ward's Minimum Variance method minimizes the within-cluster sum of squares (Ward 1963). At each stage of the analysis, joining of every possible pair of clusters is considered, and the two clusters whose union results in the minimum increase in 'information loss' are combined (Everitt 1993). The number of clusters was determined based on inspection of the dendrograms and the author's interpretation of the relevance of three, four, and five cluster solutions. Based on these observations, a four-cluster solution emerged as optimal. Cluster centroids were saved from the Ward's analysis to be used as starting seeds for the k-means analysis. It is widely recognized in the literature that the performance of the k-means method depends largely on the initial seeds used to begin the

[2] Perceived consumer effectives measures the extent to which an individual consumer feels that his or her behavior has an impact on a given situation (Berger and Corbin 1992). Berger and Corbin (1992) suggest that PCE is extremely influential as a representative of the environmental attitude/consumer behavior relationship.

[3] Faith in others represents a circumstance in which rather than changing a personal action, an individual could choose to support policies, research, or groups to solve a particular problem. Bergin and Corbin (1992) suggest that an individual's level of FIO will influence the extent to which the individual supports other's actions in pursuing a solution to a problem.

[4] All tables and figures located in the appendix

clustering process (Pena, Lozano, and Larranaga 1999; Kuo, Ho, and Hu 2002; Steinley 2003). Steinley cautions about the starting seeds used in the k-means procedure (2003): "Because there could be numerous local optima in a data set, the choice of starting values for the k-means algorithm is all the more crucial." The author goes on to say that researchers have often chosen to use starting seeds from a hierarchical method like Ward's Minimum Variance to obtain the starting seeds for the k-means method (Milligan 1980; Waller et al. 1998). The results from the Ward's method analysis were refined using the k-means non-hierarchical method. The k-means method is a simple, non-parametric clustering method that minimizes within-cluster variability and maximizes between cluster variability. The starting seeds used for the k-means method are the centroids taken from the Ward's method. Frequency tables were constructed for the four clusters, and bivariate analyses such as cross-tabulations and analyses of variance were conducted in order to investigate associations between clusters and demographics and other survey questions. The analyses of variance were calculated based on an approach suggested by Kennedy (1998). In this case, dummy variables are created for three of the four clusters. A variable of interest is then regressed on the three cluster dummy variables. In this method, the coefficients for the dummy variables are the means for the variable for each cluster. The analysis of variance F-test is the same as testing whether or not the dummy variable coefficients (means) are significantly different from each other (Kennedy 1998). It was necessary to use this method so that the post-stratification weight could be applied to the data.

Clusters were named based on inspection and interpretation of the mean responses to the clustering variables. Cluster one will be called 'Potential Activist', cluster two will be called 'Environmental', cluster three will be called 'Neutral', and cluster four will be called 'National Interest'.

Results

Cluster Profiles Based on Clustering Variables

The Potential Activist Cluster is the largest of the four and contains 560 respondents. While the members of the Potential Activist cluster feel strongly about many of the questions, they have neither the highest or lowest mean response relative to agreement or disagreement for all but two of the clustering questions. This cluster leans toward supporting national security efforts and domestic oil drilling. Issues surrounding climate change are of greater importance to this cluster than the National Interest and Neutral clusters, but not greater than the Environmental. The Potential Activists are also second behind the Environmentals when it comes to environmental issues both now and in the future; however, they are the least likely to feel that they have enough information to make well-informed decisions about environmental issues. This segment has varying levels of perceived consumer effectiveness (PCE). They tend to disagree that personal actions don't have any significant effect on the environment, but they are also the most likely out of the four clusters to agree that most people aren't willing to make sacrifices to protect the environment. Finally, the Potential Activists are second most likely behind the National Interests to agree that science and technology will solve environmental problems. See Figures 2.1 through 2.5 for cluster variable means and cluster profiles.

The Environmental Cluster is the second largest cluster with 459 respondents, and members of this cluster are most likely to agree that climate change is occurring, and that it will lead to environmental and health problems around the world. This cluster strongly disagrees that there is no urgent need to take measures to prevent climate change. The Environmentals are second most likely behind the National Interests cluster to agree that U.S. farmland should be

used to produce food and not fuel and that increased corn ethanol production will lead to higher food prices. This cluster believes that reducing dependence on foreign oil is important, but not that it is more important than protecting the environment. In accordance, the Environmentals are the least likely to support opening up more U.S. lands for oil drilling. Concerns for the loss of the world's forest are highest in this section as well as concern for the state of the environment both present and in the future. They have high PCE and believe more than any other cluster that their personal actions do have an effect on the quality of the environment; however, like cluster one, they are likely to agree that most people are not willing to make sacrifices to protect the environment. They are second behind the National Interest cluster in agreement to feeling that they have enough information to make well-informed decisions on environmental issues. Not surprisingly, the Environmentals feel most strongly that we have a responsibility to protect the environment for future generations.

The Neutral Cluster is the third largest with 410 respondents. The means for the cluster variables were overall neutral (all within .40 of 3.00). This being said, there are still comparisons that can be made with other segments. This cluster is the least concerned about the food versus fuel issue and improving national security by reducing dependence on foreign oil. They are second behind the Environmental cluster in disagreement that reducing dependence on foreign oil is more important than protecting the environment and that more land in the U.S. should be opened for oil drilling. They are second most likely behind the National Interest cluster to disagree that climate change is occurring, that it will lead to environmental and health problems around the world, and that there is an urgent need to prevent it. The Neutrals are also second behind the National Interest cluster in their lack of concern for the loss of the world's forests and for the state of the environment both now and in the future. After the Potential

Activist cluster, they are the second most likely to believe that they don't have enough information to make well-informed decisions on environmental issues. While they disagree more than any other cluster that people are not willing to make sacrifices to protect the environment, they are the least likely out of the four clusters to agree that we have a responsibility to protect the environment for future generations.

Cluster four, National Interest, is the smallest of the four with 210 respondents. This cluster agrees more strongly than any other cluster that U.S. farmland should be used for food not fuel, and that increasing corn ethanol production will lead to higher food prices. National security is of utmost importance to this cluster as they are most likely to agree that reducing our dependence on foreign oil is important and that it is more important than protecting the environment. Hence, they also feel most strongly about opening more U.S. lands for oil drilling. In terms of climate change, cluster four is the least likely of all the clusters to agree that climate change is occurring and that it will lead to health and environmental problems around the world. The National Interest cluster is also the most likely to disagree that there is an urgent need to take measure to prevent climate change, that they are concerned for the loss of the world's forests, and that they are concerned for the state of the environment both now and in the future. This segment feels most strongly about their ability to make well- informed decisions on environmental issues, but they are also most likely to agree that personal actions do not have any significant effect on the quality of the environment. The National Interest cluster is the most likely to agree that science and technology will develop solutions for environmental and pollution problems and the third most likely out of the four clusters to agree that there is a responsibility to protect the environment for future generations.

Association between Clusters and Demographics

Links between cluster membership, political affiliation, age, ethnicity, and highest level of education obtained were found to be significant ($p < .001$ for all). In terms of political affiliation, the National Interest cluster is 87.6 percent Republican. On the other end of the spectrum, the Environmental cluster is 72.4 percent Democrat. The Potential Activist and Neutral clusters are divided much like the total sample. Looking at age, the Neutrals are the 'youngest' cluster with 28.5 percent of respondents in the 18-29 age category. The National Interest cluster is the 'oldest' with only 12.5 percent in the 18-29 age category and 67 percent over the age of forty-five. The National Interest cluster contains 90.8 percent white and non-Hispanic, while white, non-Hispanic respondents account for only 73.5 percent of the total sample. The Neutral cluster contains almost twice as many black, non-Hispanic respondents as the total sample. Approximately 70 percent of both the Environmental and National Interest clusters report having at least some college education; however, only 51.4 percent of the Potential Activists and 48.4 percent of the Neutrals report the same. Marital status was also found to be significant ($p = 0.012$). Approximately 63 percent of the National Interest cluster is married. This is 10 percent higher than the total sample. Gender was found to be a significant indicator of cluster membership, and again the National Interest cluster stands out with 64.5 percent male respondents ($p = 0.001$). All three other clusters are divided similarly to the total sample. In terms of household income, the National Interest cluster has the highest mean income among the four clusters, and the Neutrals have the lowest ($p < 0.001$). Overall, the highest numbers of respondents in each cluster reside in suburban areas; however, respondents in the Environmental cluster are more likely than any other respondents to be found in metropolitan areas ($p = 0.025$). Finally, 38.6 percent of total survey respondents report living in the south

($p = 0.078$). The National Interest cluster stands out here again with only 11 percent or respondents living in the northeast.

Association between Clusters, Driving and Fueling Habits, and Vehicle Characteristics

To begin, frequency of refueling and length of time before purchasing another vehicle were not found to be significantly different among clusters ($p > .05$). However, the four clusters did differ significantly on how often each goes out of their way to purchase cheaper fuel ($p = .015$). Respondents in the Environmental cluster reported going out of their way to buy cheaper fuel most often with 52.3 percent stating that they frequently or always engage in this behavior. Conversely, approximately 59 percent of the Potential Activist, Neutral, and National Interest clusters never or rarely go out of their way to buy cheaper fuel. Not surprisingly, the Environmentals were the most likely to purchase either a Flex-Fuel Vehicle (FFV) or a gas electric hybrid for their next automobile (for both $p < .001$). The National Interest cluster is the least likely to make the decision to purchase a FFV or gas electric hybrid for their next vehicle with 37.6 percent reporting that it is not at all likely they will purchase a FFV and 46.1 percent at least somewhat disagreeing that the next vehicle they purchase will be a gas electric hybrid. Miles driven per day was also found to be significantly different among clusters ($p = .039$). Overall, the National Interest cluster logs the most miles per day followed by the Potential Activists, Neutrals, and the Environmentals. Use of public transportation and carpooling was found to be significantly different among clusters ($p < .001$). While incidence of both behaviors are overall low for the whole sample, the Environmental and National Interest clusters are overall more likely to use public transportation or carpools. See Tables 4, 5, and 6 for more detailed information. See Tables 2.3 and 2.4 for more information.

No link was found between cluster membership and the number of vehicles owned or leased (p = .25) or the octane rating of the fuel typically used for the vehicle (p = .83). Type of vehicle owned (p = .023), whether it is owned or leased (p = .044), and average vehicle gas mileage (p = .01) were all found to be significantly different among the four clusters. It is interesting to note that at least twice as many respondents in the Neutral cluster did not know the average mileage of their vehicle relative to the other three clusters.

Association between Clusters, Flex-Fuel Vehicles, and E85

Familiarity with FFV's prior to taking the survey and currently driving a FFV were both significant characteristics of cluster membership (for both p = .001). While only 1.9 percent of the total sample reported owning a FFV, the National Interests were most familiar with FFV's and were most likely to drive a FFV with 3.8 percent responding that they did drive a FFV. The National Interests were also most likely to agree that FFV's cost significantly more than other vehicles (p <.001), that E85 ethanol blends are not widely available in their area (p < .001), and that E85 is not likely to be available in their area in the near future (p <.001). The Neutrals were most likely to disagree or remain neutral on these three statements. This could possibly be the result of the fact that the Neutrals were most likely to be unsure about the nature of a FFV; with 30.3 percent responding that they did not know if their vehicle was a FFV. Frequency of purchasing E85 among those responding that they did drive a FFV was not found to be significant (p = .92). However, it is worth noting that among those who rarely or never purchase E85 for their FFV, the most popular reason for Potential Activists and National Interests is ethanol not being widely available in the area, and for Environmentals and Neutrals it is the disbelief that E85 as a fuel helps the environment. See Table 2.4 and Figure 2.7 for more information.

Association between Clusters, Ethanol Feedstock Knowledge, and Use of Ethanol Blended Fuel

Knowledge of corn, switchgrass, and wood wastes as ethanol feedstocks prior to taking the survey were all found to be significant ($p < .001$ for all three feedstocks). Prior to the survey, at least 89.2 percent of all four clusters except for the Neutrals had heard of using corn for ethanol production. The Neutrals also contained the fewest respondents (11.3 percent) who were familiar with switchgrass. Familiarity with wood wastes as an ethanol feedstock was similar to familiarity with switchgrass across the four clusters.

Frequency of buying an ethanol blend for the household vehicle driven the most often was found to be significant ($p < .001$). At least 27 percent of all four clusters reported never buying an ethanol blend, and the second most popular response was "Don't Know" for all clusters except the National Interest cluster. Out of the four clusters, the Neutrals were most likely to be uncertain about how often they purchase ethanol blends. Limited availability of ethanol blends and lack of recommendation from an automobile manufacturer were the two most popular reasons for never or rarely buying an ethanol blend. See Figure 2.9 for more information.

Association between Clusters and Knowledge of Environmental Issues

All questions related to knowledge of environmental issues were found to be significant in regard to cluster membership ($p < .001$ for all). The Environmental and National Interest clusters were the most familiar with GHG with 87.5 percent and 85.5 percent respectively being at least somewhat familiar. Conversely, 37.1 percent of the Potential Activist cluster and 54.1 percent of the Neutral cluster were not at all familiar with GHG. Overall, the majority of all four clusters were at least somewhat familiar with global climate change. Again, the Environmental

and National Interest clusters reported being the most familiar with this concept. This was expected, as these two clusters tend to feel more than the Potential Activist and Neutral clusters that they have enough information to make well- informed decisions related to the environment. In terms of familiarity with ethanol, a majority in all four clusters are at least somewhat familiar. Again, Environmentals and National Interests stand out with 82.6 percent of the Environmental and 90.4 percent of the National Interest clusters being at least somewhat familiar with ethanol prior to taking the survey ($p < .001$). See Figure 2.8 for more information.

As would be expected, the Environmental cluster had three times as many respondents reporting to be members of an environmental organization than the total sample. When asked about sources of environmental information, the most common answers for the total sample were television followed by newspaper and internet. The Potential Activists follow this trend and receive most information related to the environment form the television. The Environmentals and National Interest clusters receive more information overall from most of the sources. The Environmentals rely more heavily than any other cluster on the internet, family, and friends for their information while the National Interest cluster relies more heavily on radio. Neutrals follow the total sample fairly closely, but receives less information overall from all sources except television.

Discussion

No market segmentation study is complete without a discussion of segment profiles and how these diverse segments may be influenced in a given market. A firm utilizing a market segmentation strategy can most often expect increased profitability as they increase their product's ability to satisfy the needs and wants of various distinct groups of consumers (Wind

1978). In this case, the ethanol industry and feedstock producers can utilize these findings to reach a larger market and tailor marketing efforts with the goal of influencing a broader range of consumers.

As an overall strategy, efforts should be made to increase the availability or at least the perceived availability of E85. Likelihood of purchase is inherently reduced if a product is not perceived to be readily available. A majority of respondents report purchasing regular grade 87 octane fuel for their vehicles. Emphasizing the benefits of higher octane E85 may reduce some consumers' discontent with the lower energy content of the fuel. Overall, respondents have a neutral FIO and slightly positive PCE. A message focused on the impact of one consumer's driving habits related to switching to an ethanol blended fuel may help increase likelihood of purchase so as to contribute to a common goal (i.e. Using E85 instead of pure gasoline in one vehicle for one year will decrease x amount of GHG, x amount of imported oil, etc…). Following in the footsteps of the successful "got milk?" ad campaign, the ethanol industry and feedstock producers could initiate a similar strategy to increase awareness and provide information about ethanol as an alternative fuel (California Milk Processor Board 1993). Like the "got milk?" campaign, the message should be simple, yet effective.

The National Interest cluster is the smallest of the four clusters. It will arguably be the most difficult cluster in terms of marketing efforts as this group of respondents has very strong indifference pertaining to environmental issues, supports increased domestic oil production, and is the least likely to purchase a FFV. This segment is the oldest of the four clusters and feels that they are already well-informed enough to make decisions related to environmental issues. However, this segment will be purchasing their next vehicle sooner than any other cluster and has the highest mean income among the four segments. Providing aesthetically and functionally

appealing FFV options and promoting the ability of a FFV to run on pure gasoline may be an effective tool in capturing this segment of the market. Marketing efforts for this segment will have to be innovative, logical, and fact-driven as this segment will most likely not respond to appeals to emotion. Communicating the economic advantages of ethanol could be a possible avenue in which to appeal to this segment. As was mentioned earlier, research indicates that there is substantial economic potential for the reduction of GHG emissions in the coming years (IPPC 2007). In terms of cellulosic ethanol, emphasis should be placed on the ability of cellulosic feedstocks to grow on land not used for food production and reduce our dependence on foreign oil. Since this segment has the lowest PCE of the four clusters and one of the higher FIO scores, a hands-off approach may also be appealing to this group. Donations to or investment in research efforts aimed at increasing the energy independence of the U.S. may perhaps also be an effective premise by which the National Interests could be swayed to contribute to the support of the ethanol industry. A more conservative tone should be used in conveying information and ideas to this group.

The Neutral cluster is the third largest and has potential as a valuable target market. They are the youngest cluster, and obviously have not formed concrete opinions yet on many issues. They have the lowest mean income, and reported being uncertain of many survey questions. Educational messages will be fundamental for this cluster. From gas mileage to environmental issues, the Neutral cluster should be informed so that they can feel confident in making purchasing decisions and feel personally justified in their decisions as they have a comparatively high PCE compared with their neutrality on other questions. With the lowest mean income of the four, emphasis should also be placed on government incentives (and how to obtain them easily) and potential savings at the pump.

The Environmental cluster is a potentially profitable ethanol market segment; however, this group of consumers has strong opinions that must be taken into account in deciding on an effective marketing strategy. This group of consumers obviously feels very strongly about the effects of climate change and pollution and is most likely to purchase an FFV. That being said, an obvious strategy for marketing to this segment would be to emphasize the environmental benefits of ethanol, especially cellulosic ethanol. Another strategy would be to take advantage of this segment's high PCE and appeal to personal action in relation to ethanol purchases and their environmental benefits. This group is also the most likely to go out of their way to buy cheaper fuel. This may indicate that this segment is willing to take action despite an inconvenience if there is a perceived reward. This group has an overall low FIO, so focusing on personal actions may be a better strategy. The Environmental cluster also feels strongly about farmland being used to grow food and about the effects of corn as an ethanol feedstock on food prices. Emphasizing the non-food nature of cellulosic feedstocks and their ability to be grown on land not suitable for corn would be an effective strategy to employ in explaining the benefits of cellulosic ethanol. These consumers have most likely been aware of environmental problems and possible solutions in the past; therefore, creative and smart marketing tools should be used to avoid boring this segment with the usual environmentally conscious messages.

The Potential Activist cluster is the largest of the four and one of the most promising. This group has strong opinions on many topics, but appears to need more information in order to make these opinions stronger and put them into effective action. The Potential Activists have the second highest PCE and would therefore be served well by simple, factual information that could easily be transferred into personal action (i.e. Ethanol as a fuel delivers these environmental, security, etc. benefits…here's how you can support this effort.) This group appears to be

passionate about what they believe, but needs some additional information before they can become true advocates of a product or idea like ethanol as an alternative fuel. Potential Activists get the majority of their environmental information from the television and newspapers. Traditional advertising would be useful here, but this group also needs inspiration and motivation to invoke their sense of enthusiasm.

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Appendix

Table 2.1 Variables and Descriptions

Variable	Abbreviation	Description
Q1.	#autos	How many automobiles are currently owned or leased by members of your household?
Q7.	autotype	What type of automobile do you own?
Q9.	own	Is this automobile owned or leased?
Q12.	famethanol	How familiar were you with ethanol prior to taking this survey?
Q13.	ethpurchase	How often do you buy an ethanol blend for the household vehicle you drive the most often?
Q15.	famFFV	Prior to taking this survey, how familiar were you with Flex-Fuel Vehicles?
Q16.	ownFFV	Is the household vehicle you drive the most often a Flex-Fuel Vehicle?
Q17.	E85purchase	How often do you purchase E85 (85% ethanol, 15% gasoline) for this automobile?
Q19.	milesdrive	On a typical day, how many miles do you drive this automobile?
Q20.	publictrans	On average, how often do you use public transportation?
Q21.	carpool	On average, how often do you carpool?
Q22.	mpg	Which of the following best describes the average gas mileage of the household automobile that you drive the most often?
Q23.	octane	Which of the following best describes the octane rating of the fuel that you typically purchase for the household automobile that you drive the most often?
Q24.	freqrefuel	On average, how often do you refuel the household automobile that you most frequently drive?
Q25.	cheapfuel	How often do you go out of your way to buy cheaper fuel?
Q26_1.	famghg	How familiar are you with greenhouse gases?
Q26_2.	famclimate	How familiar are you with global climate change?
Q27.	famcorn	Prior to this survey, had you heard of using corn to make ethanol?
Q28.	famgrass	Prior to this survey, had you heard of using switchgrass to make ethanol?
Q29.	famwood	Prior to this survey, had you heard of using wood wastes to make ethanol?
Q31.	nextpurchase	How long do you think it will be before you lease or purchase your next automobile?
Q32.	purchaseFFV	If similarly priced to other automobiles, how likely is it that the next automobile you purchase will be a Flex-Fuel Vehicle (E85 compatible)?
Q33_a.	ethrefuel	How often I have to refuel my car is very important to my choice of ethanol blends.
Q33_1.	FFVcost	Flex-Fuel Vehicles cost significantly more than other vehicles.

Table 2.1 Variables and Descriptions

Variable	Abbreviation	Description
Q33_2.	ethavailable	Higher-level ethanol blends such as E85 are not widely available in my area.
Q33_3.	futavailable	E85 is not likely to be readily available in my area in the near future.
Q33_4.	hybridyes	The next automobile I purchase or lease is likely to be a gasoline/electric hybrid.
Q34_1.	FVFlanduse	U.S. farmland should be devoted to producing food and not fuel.
Q34_2.	FVFfoodprice	Increasing ethanol production from corn will lead to higher food prices.
Q34_3.	natsecurity	Reducing our dependence on foreign oil is important to improving our national security.
Q34_4.	secVSenviron	Reducing our dependence on foreign oil is more important than protecting the environment.
Q34_5.	drill	More land in the U.S. should be opened up for oil drilling.
Q35_1.	climate	Global climate change is occurring.
Q35_2.	health	Climate change will lead to environmental and health problems in many parts of the world.
Q35_3.	urgent	There is no urgent need to take measures to prevent climate change.
Q35_4.	forest	I am extremely worried about loss of the world's forests.
Q35_5.	future	I am extremely worried about the state of the world's environment and what it will mean for my future.
Q36_1.	pce1	I don't have enough knowledge to make well-informed decisions on environmental issues.
Q36_2.	pce2	My personal actions don't have any significant effect on the quality of the environment.
Q36_3.	fio1	Science and technology will come up with ways to solve environmental damage and pollution.
Q36_4.	fio2	Most people are not willing to make sacrifices to protect the environment.
Q36_5.	responsible	We have a responsibility to future generations to protect the environment.
Q37	member	Are you a member of an environmental organization?
Q38	info	Where do you generally get information about environmental issues?
Q41.	metro	Which best describes the area where you live?
Political Affiliation	political	Republican; Democrat; Other
Age	age	18-29; 30-44; 45-59; 60+
Education	education	Less than high school; high school graduate; some college; Bachelor's Degree or more
Ethnicity	ethnicity	White, non-hispanic; black, non-hispanic; other, non-hispanic; hispanic; 2+ races, non-hispanic
Marital Status	marital status	Married; widowed; divorced; separated; never married; living with partner
Gender	gender	Male; female
Household Income	income	$0 to $24,999; $25,000 to $49,999; $50,000 to $99,000; $100,000 +
Region	region	Northeast; Midwest; South; West

Table 2.2 Variable significance in determining cluster membership

Variable	F-value	Chi^2 value	p-value[a]
#autos	1.37	na	0.252
Autotype	na	66.70	0.023**
Own	na	9.48	0.044**
Famethanol	47.55	na	<0.001***
Ethpurchase	2.70	na	0.044**
FamFFV	23.90	na	<0.001***
OwnFFV	34.00	na	<0.001***
E85purchase	0.17	na	0.915
Milesdrive	5.33	na	<0.001***
Publictrans	11.21	na	<0.001***
Carpool	1.81	na	<0.001***
Mpg	na	53.25	0.010**
Octane	na	6.59	0.827
Freqrefuel	0.92	na	0.429
Cheapfuel	3.50	na	0.015**
Famghg	73.61	na	<0.001***
Famclimate	95.41	na	<0.001***
Famcorn	na	112.9	<0.001***
Famgrass	na	92.4	<0.001***
Famwood	na	91.3	<0.001***
Nextpurchase	1.48	na	0.218
PurchaseFFV	1.85	na	<0.001***
Ethrefuel	6.91	na	<0.001***
FFVcost	14.17	na	<0.001***
Ethavailable	14.93	na	<0.001***
Futavailable	8.11	na	<0.001***
Hybridyes	26.36	na	<0.001***
FVFlanduse	52.12	na	<0.001***
FVFfoodprice	82.32	na	<0.001***
Natsecurity	119.71	na	<0.001***
SecVSenviron	196.32	na	<0.001***
Drill	239.86	na	<0.001***
Climate	417.96	na	<0.001***
Health	421.45	na	<0.001***
Urgent	352.76	na	<0.001***
Forest	277.39	na	<0.001***
Future	427.24	na	<0.001***
Pce1	101.25	na	<0.001***
Pce2	109.67	na	<0.001***

Table 2.2 Variable significance in determining cluster membership

Variable	F-value	Chi^2 value	p-value[a]
Fio1	17.80	na	<0.001***
Fio2	32.93	na	<0.001***
Responsible	234.33	na	<0.001***
Member	na	58.75	<0.001***
Metro	na	30.1	0.025**
Political	na	255.92	<0.001***
Age	na	79.99	<0.001***
Education	na	94.61	<0.001***
Ethnicity	na	85.96	<0.001***
Marital status	na	45.28	0.012**
Gender	na	24.19	0.001***
Income	6.95	na	<0.001***
Region	na	23.66	0.078*

[a] *, **, *** represent significance levels of 0.10, 0.05, 0.10, respectively

Table 2.3 Association between clusters and household vehicle information

Variable	Response[a]	Potential Activist (*n*=560)	Environmental (*n*=459)	Neutral (*n*=410)	National Security (*n*=239)	Total Sample (*n*=1668)	Chi^2 - value	*p*- value[b]
Q1. How many automobiles are currently owned or leased by members of your household? (%)	1	33.5	34.7	39.3	28.8	34.8	1.37[c]	0.252
	2	41.2	39.8	38.9	44.0	40.6		
	3	17.1	16.4	13.1	15.7	15.6		
	4+	8.2	9.1	8.7	11.5	9.0		
Q7. What type of automobile do you own? (%)	Compact or economy	16.6	19.0	23.3	15.5	19.0	66.7	0.023**
	Mid-size sedan	29.9	29.2	21.9	25.8	27.0		
	Full-size or luxury sedan	8.1	9.7	10.7	13.3	9.9		
	Sports car	4.4	7.2	3.2	2.5	4.6		
	Sport utility vehicle	18.1	18.3	13.9	16.6	16.8		
	Small pick-up truck	6.6	5.1	5.1	4.6	5.6		
	Large pick-up truck	8.5	3.2	8.1	11.8	7.5		
	Mini-van	6.4	6.9	10.2	7.7	7.7		
	Van	0.9	0.7	2.8	1.2	1.4		
	Other	0.4	0.6	0.6	0.8	0.6		
Q9. Is this automobile owned or leased? (%)	Owned	95.9	98.2	95.8	99.1	96.9	9.48	0.044**
	Leased	4.1	1.8	4.1	1.7	3.1		
Q22. Which of the following best describes the average gas mileage of the household automobile that you drive the most often?	Less than 16 miles per gallon	4.7	4.4	7.3	6.9	5.6	53.25	0.010**
	16-19 miles per gallon	23.3	22.6	22.6	20.2	22.5		
	20-23 miles per gallon	25.6	23.7	24.0	33.6	25.7		
	24-27 miles per gallon	16.6	21.1	13.6	17.2	17.0		
	28-32 miles per gallon	14.4	15.0	12.6	15.1	14.2		
	33 or more miles per gallon	5.5	4.9	3.2	3.8	4.5		
	Don't Know	9.9	8.3	16.6	3.2	10.5		

Table 2.3 Association between clusters and household vehicle information

Variable	Response[a]	Potential Activist (*n*=560)	Environmental (*n*=459)	Neutral (*n*=410)	National Security (*n*=239)	Total Sample (*n*=1668)	Chi^2 - value	*p*- value[b]
Q23. Which of the following best describes the octane rating of the fuel that you typically purchase for the household automobile that you drive the most often?	Regular (85-87)	82.7	80.6	82.6	86.1	82.6	6.59	0.827
	Mid-Grade (88-90)	12.2	11.8	11.6	7.7	11.3		
	Premium (91-93)	5.1	7.5	5.7	6.1	6.0		
	E85 (100-105)	0.0	0.1	0.0	0.0	0.0		

[a] reported as percentages

[b] *, **, *** represent significance levels of 0.10, 0.05, 0.10, respectively

[c] represents *F* -value

Table 2.4 Association between clusters and cost/availability of Flex-Fuel Vehicles and ethanol

Variable[a]	Potential Activist (*n*=560)	Environmental (*n*=459)	Neutral (*n*=410)	National Security (*n*=239)	Total Sample (*n*=1727)	*F*-value	*p*- value[b]
Q33_a. How often I have to refuel my car is very important to my choice of ethanol blends.	3.28	3.24	3.05	2.91	3.16	6.91	<.001***
Q33_1. Flex-Fuel Vehicles cost significantly more than other vehicles.	3.56	3.59	3.17	3.61	3.47	14.17	<.001***
Q33_2. Higher-level ethanol blends such as E85 are not widely available in my area.	3.78	3.81	3.37	3.97	3.70	14.93	<.001***
Q33_3. E85 is not likely to be readily available in my area in the near future.	3.43	3.42	3.20	3.68	3.40	8.11	<.001***
Q33_4. The next automobile I purchase or lease is likely to be a gasoline/electric hybrid.	2.90	3.35	2.77	2.49	2.93	26.36	<.001***

[a] Measured on a 5-point Likert Scale: 1=strongly disagree, 5=strongly agree. Reported as means.

[b] *, **, *** represent significance levels of 0.10, 0.05, 0.10, respectively

Cluster Variable		Mean
Q34_1.	U.S. farmland should be devoted to producing food and not fuel.	3.22
Q34_2.	Increasing ethanol production from corn will lead to higher food prices.	3.75
Q34_3.	Reducing our dependence on foreign oil is important to improving our national security.	4.41
Q34_4.	Reducing our dependence on foreign oil is more important than protecting the environment.	3.07
Q34_5.	More land in the U.S. should be opened up for oil drilling.	3.93
Q35_1.	Global climate change is occurring.	4.11
Q35_2.	Climate change will lead to environmental and health problems in many parts of the world.	3.97
Q35_3.	There is no urgent need to take measures to prevent climate change.	2.48
Q35_4.	I am extremely worried about loss of the world's forests.	3.76
Q35_5.	I am extremely worried about the state of the world's environment and what it will mean for my future.	3.73
Q36_1.	I don't have enough knowledge to make well-informed decisions on environmental issues.	3.44
Q36_2.	My personal actions don't have any significant effect on the quality of the environment.	2.54
Q36_3.	Science and technology will come up with ways to solve environmental damage and pollution.	3.37
Q36_4.	Most people are not willing to make sacrifices to protect the environment.	3.75
Q36_5.	We have a responsibility to future generations to protect the environment.	4.40

Awareness of Environmental Issues		
	Familiarity with Greenhouse Gases	**…with Climate Change**
Not at all familiar	37%	24%
Somewhat familiar	55%	65%
Very familiar	8%	12%

Are you a member of an environmental organization?	
Yes	3%
No	97%

Familiar with ethanol as an alternative fuel?	
Not at all familiar	32%
Somewhat familiar	55%
Very familiar	13%

Demographics			
Gender		**Ethnicity**	
Male	46%	White	75%
Female	54%	Black	7%
		Other	4%
Age		Hispanic	14%
18-29	19%	2+ races	1%
30-44	25%		
45-59	25%	**Political Affiliation**	
60+	31%	Republican	46%
		Other	5%
Education		Democrat	49%
< High School	13%		
High School	35%	**Familiarity with ethanol feedstocks**	
Some college	29%	**Familiar with corn?**	
Bachelor's +	23%	Yes	89%
Income		No	11%
$0 to $24,999	20%		
$25,000 to $49,999	32%		
$50,000 to $99,999	35%	**Familiar with Switchgrass?**	
$100,000 or more	13%	Yes	21%
		No	79%
Region		**Familiar with wood wastes?**	
Northeast	15%	Yes	17%
Midwest	25%	No	83%
South	41%		
West	19%		

Figure 2.1 Potential Activist Profile

Cluster Variable	Mean
Q34_1. U.S. farmland should be devoted to producing food and not fuel.	3.32
Q34_2. Increasing ethanol production from corn will lead to higher food prices.	3.88
Q34_3. Reducing our dependence on foreign oil is important to improving our national security.	4.21
Q34_4. Reducing our dependence on foreign oil is more important than protecting the environment.	2.00
Q34_5. More land in the U.S. should be opened up for oil drilling.	2.37
Q35_1. Global climate change is occurring.	4.75
Q35_2. Climate change will lead to environmental and health problems in many parts of the world.	4.66
Q35_3. There is no urgent need to take measures to prevent climate change.	1.39
Q35_4. I am extremely worried about loss of the world's forests.	4.49
Q35_5. I am extremely worried about the state of the world's environment and what it will mean for my future.	4.50
Q36_1. I don't have enough knowledge to make well-informed decisions on environmental issues.	2.30
Q36_2. My personal actions don't have any significant effect on the quality of the environment.	1.67
Q36_3. Science and technology will come up with ways to solve environmental damage and pollution.	3.11
Q36_4. Most people are not willing to make sacrifices to protect the environment.	3.73
Q36_5. We have a responsibility to future generations to protect the environment.	4.79

Awareness of Environmental Issues

	Familiarity with Greenhouse Gases	…with Climate Change
Not at all familiar	13%	4%
Somewhat familiar	57%	56%
Very familiar	31%	40%

Are you a member of an environmental organization?

Yes	13%
No	87%

Familiar with ethanol as an alternative fuel?

Not at all familiar	17%
Somewhat familiar	61%
Very familiar	22%

Demographics

Gender	
Male	48%
Female	53%

Age	
18-29	21%
30-44	32%
45-59	32%
60+	15%

Education	
< High School	6%
High School	23%
Some college	28%
Bachelor's +	43%

Income	
$0 to $24,999	17%
$25,000 to $49,999	25%
$50,000 to $99,999	40%
$100,000 or more	18%

Region	
Northeast	22%
Midwest	20%
South	33%
West	25%

Ethnicity	
White	72%
Black	6%
Other	7%
Hispanic	13%
2+ races	2%

Political Affiliation	
Republican	22%
Other	5%
Democrat	72%

Familiarity with ethanol feedstocks Familiar with corn?	
Yes	94%
No	6%

Familiar with Switchgrass?	
Yes	29%
No	71%

Familiar with wood wastes?	
Yes	28%
No	72%

Figure 2.2 Environmental Profile

Cluster Variable	Mean
Q34_1. U.S. farmland should be devoted to producing food and not fuel.	2.73
Q34_2. Increasing ethanol production from corn will lead to higher food prices.	2.96
Q34_3. Reducing our dependence on foreign oil is important to improving our national security.	3.24
Q34_4. Reducing our dependence on foreign oil is more important than protecting the environment.	2.84
Q34_5. More land in the U.S. should be opened up for oil drilling.	3.20
Q35_1. Global climate change is occurring.	3.16
Q35_2. Climate change will lead to environmental and health problems in many parts of the world.	3.09
Q35_3. There is no urgent need to take measures to prevent climate change.	2.85
Q35_4. I am extremely worried about loss of the world's forests.	3.00
Q35_5. I am extremely worried about the state of the world's environment and what it will mean for my future.	2.94
Q36_1. I don't have enough knowledge to make well-informed decisions on environmental issues.	3.04
Q36_2. My personal actions don't have any significant effect on the quality of the environment.	2.75
Q36_3. Science and technology will come up with ways to solve environmental damage and pollution.	3.00
Q36_4. Most people are not willing to make sacrifices to protect the environment.	3.15
Q36_5. We have a responsibility to future generations to protect the environment.	3.38

Awareness of Environmental Issues

	Familiarity with Greenhouse Gases	…with Climate Change
Not at all familiar	54%	45%
Somewhat familiar	42%	50%
Very familiar	4%	5%

Are you a member of an environmental organization?

Yes	4%
No	96%

Familiar with ethanol as an alternative fuel?

Not at all familiar	47%
Somewhat familiar	49%
Very familiar	4%

Demographics

Gender	
Male	46%
Female	54%
Age	
18-29	29%
30-44	29%
45-59	25%
60+	18%
Education	
< High School	15%
High School	37%
Some college	27%
Bachelor's +	22%
Income	
$0 to $24,999	23%
$25,000 to $49,999	34%
$50,000 to $99,999	31%
$100,000 or more	12%
Region	
Northeast	15%
Midwest	23%
South	39%
West	24%

Ethnicity	
White	66%
Black	16%
Other	5%
Hispanic	12%
2+ races	1%
Political Affiliation	
Republican	40%
Other	8%
Democrat	52%
Familiarity with ethanol feedstocks	
Familiar with corn?	
Yes	73%
No	27%
Familiar with Switchgrass?	
Yes	11%
No	89%
Familiar with wood wastes?	
Yes	14%
No	87%

Figure 2.3 Neutral Profile

Cluster Variable	Mean
Q34_1. U.S. farmland should be devoted to producing food and not fuel.	3.94
Q34_2. Increasing ethanol production from corn will lead to higher food prices.	4.27
Q34_3. Reducing our dependence on foreign oil is important to improving our national security.	4.57
Q34_4. Reducing our dependence on foreign oil is more important than protecting the environment.	4.16
Q34_5. More land in the U.S. should be opened up for oil drilling.	4.75
Q35_1. Global climate change is occurring.	2.36
Q35_2. Climate change will lead to environmental and health problems in many parts of the world.	2.15
Q35_3. There is no urgent need to take measures to prevent climate change.	3.99
Q35_4. I am extremely worried about loss of the world's forests.	2.50
Q35_5. I am extremely worried about the state of the world's environment and what it will mean for my future.	2.01
Q36_1. I don't have enough knowledge to make well-informed decisions on environmental issues.	2.06
Q36_2. My personal actions don't have any significant effect on the quality of the environment.	3.13
Q36_3. Science and technology will come up with ways to solve environmental damage and pollution.	3.49
Q36_4. Most people are not willing to make sacrifices to protect the environment.	3.54
Q36_5. We have a responsibility to future generations to protect the environment.	3.71

Awareness of Environmental Issues

	Familiarity with Greenhouse Gases	…with Climate Change
Not at all familiar	15%	11%
Somewhat familiar	58%	57%
Very familiar	28%	32%

Are you a member of an environmental organization?

Yes	1%
No	99%

Familiar with ethanol as an alternative fuel?

Not at all familiar	10%
Somewhat familiar	64%
Very familiar	3%

Demographics

Gender	
Male	65%
Female	36%

Age	
18-29	12%
30-44	20%
45-59	34%
60+	33%

Education	
< High School	8%
High School	22%
Some college	36%
Bachelor's +	34%

Income	
$0 to $24,999	14%
$25,000 to $49,999	27%
$50,000 to $99,999	38%
$100,000 or more	21%

Region	
Northeast	11%
Midwest	22%
South	43%
West	24%

Ethnicity	
White	91%
Black	3%
Other	3%
Hispanic	3%
2+ races	1%

Political Affiliation	
Republican	88%
Other	3%
Democrat	9%

Familiarity with ethanol feedstocks Familiar with corn?	
Yes	96%
No	4%

Familiar with Switchgrass?	
Yes	43%
No	57%

Familiar with wood wastes?	
Yes	44%
No	57%

Figure 2.4 National Interest Profile

Cluster Variable	Mean
Q34_1. U.S. farmland should be devoted to producing food and not fuel.	3.20
Q34_2. Increasing ethanol production from corn will lead to higher food prices.	3.63
Q34_3. Reducing our dependence on foreign oil is important to improving our national security.	4.06
Q34_4. Reducing our dependence on foreign oil is more important than protecting the environment.	2.87
Q34_5. More land in the U.S. should be opened up for oil drilling.	3.43
Q35_1. Global climate change is occurring.	3.79
Q35_2. Climate change will lead to environmental and health problems in many parts of the world.	3.67
Q35_3. There is no urgent need to take measures to prevent climate change.	2.50
Q35_4. I am extremely worried about loss of the world's forests.	3.57
Q35_5. I am extremely worried about the state of the world's environment and what it will mean for my future.	3.49
Q36_1. I don't have enough knowledge to make well-informed decisions on environmental issues.	2.86
Q36_2. My personal actions don't have any significant effect on the quality of the environment.	2.45
Q36_3. Science and technology will come up with ways to solve environmental damage and pollution.	3.22
Q36_4. Most people are not willing to make sacrifices to protect the environment.	3.55
Q36_5. We have a responsibility to future generations to protect the environment.	4.13

Awareness of Environmental Issues

	Familiarity with Greenhouse Gases	…with Climate Change
Not at all familiar	33%	23%
Somewhat familiar	52%	57%
Very familiar	15%	20%

Are you a member of an environmental organization?

Yes	6%
No	94%

Familiar with ethanol as an alternative fuel?

Not at all familiar	30%
Somewhat familiar	56%
Very familiar	14%

Demographics

Gender	
Male	49%
Female	51%

Age	
18-29	21%
30-44	27%
45-59	28%
60+	24%

Education	
< High School	11%
High School	31%
Some college	29%
Bachelor's +	29%

Income	
$0 to $24,999	19%
$25,000 to $49,999	30%
$50,000 to $99,999	35%
$100,000 or more	15%

Region	
Northeast	16%
Midwest	23%
South	39%
West	23%

Ethnicity	
White	74%
Black	9%
Other	5%
Hispanic	12%
2+ races	1%

Political Affiliation	
Republican	43%
Other	6%
Democrat	51%

Familiarity with ethanol feedstocks Familiar with corn?	
Yes	87%
No	13%

Familiar with Switchgrass?	
Yes	23%
No	77%

Familiar with wood wastes?	
Yes	22%
No	78%

Figure 2.5 Overall Profile

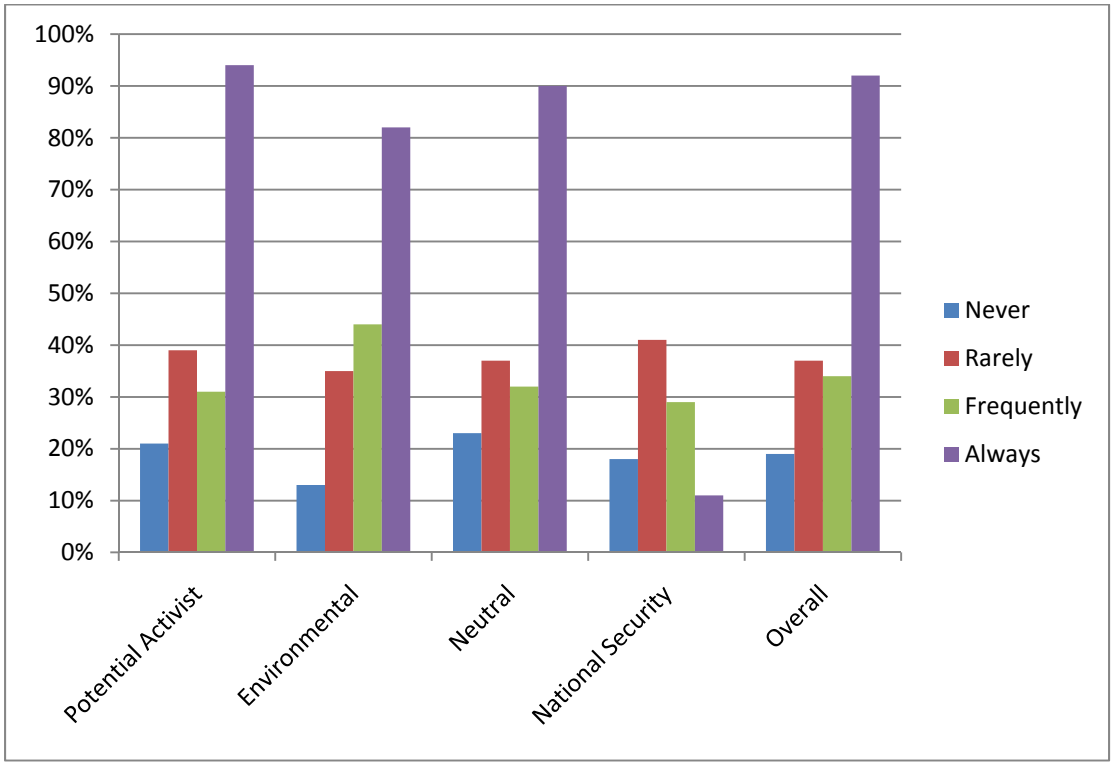


Figure 2.6 How often do you go out of your way to buy cheaper fuel? (See Table 2.2 for significance.)

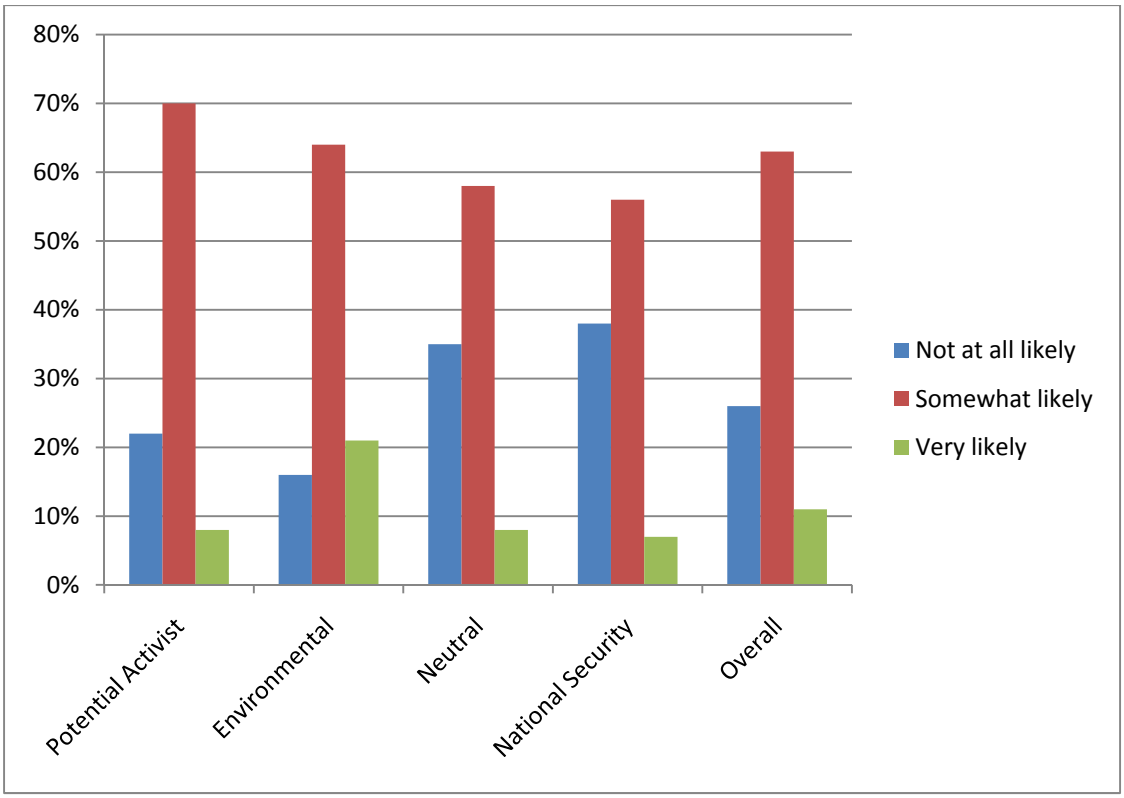
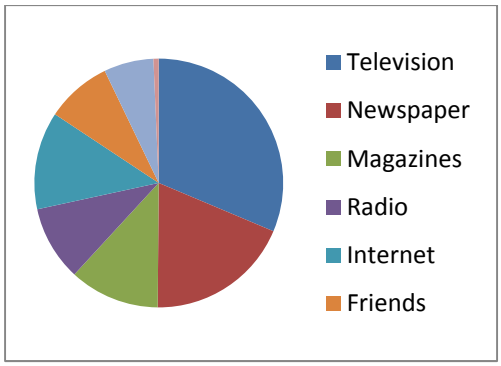
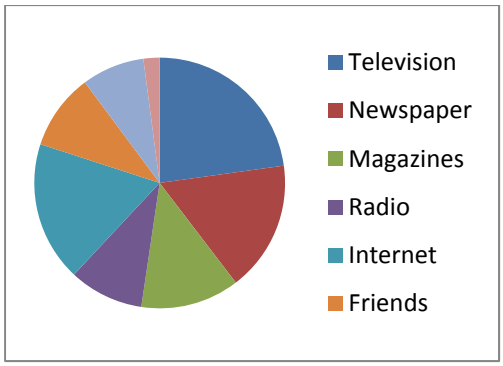


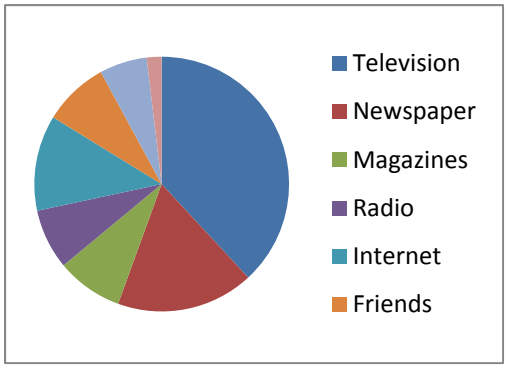
Figure 2.7 If similarly priced to other automobiles, how likely is it that the next automobile you purchase will be a Flex-Fuel Vehicle? (See Table 2.2 for significance.)



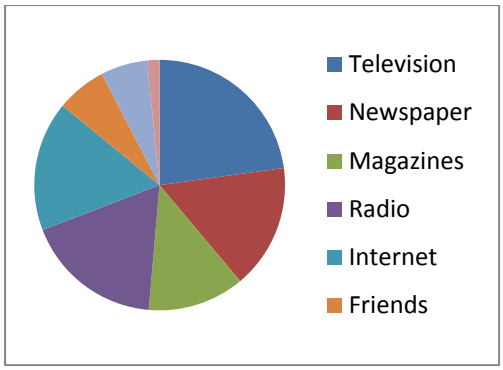
Potential Activist



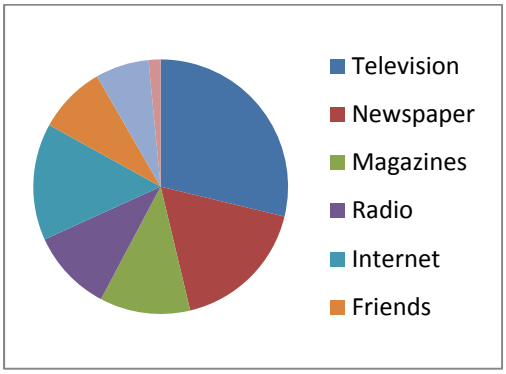
Environmental



Neutral



National Security



Overall

Figure 2.8 Where do you generally get information about environmental issues?

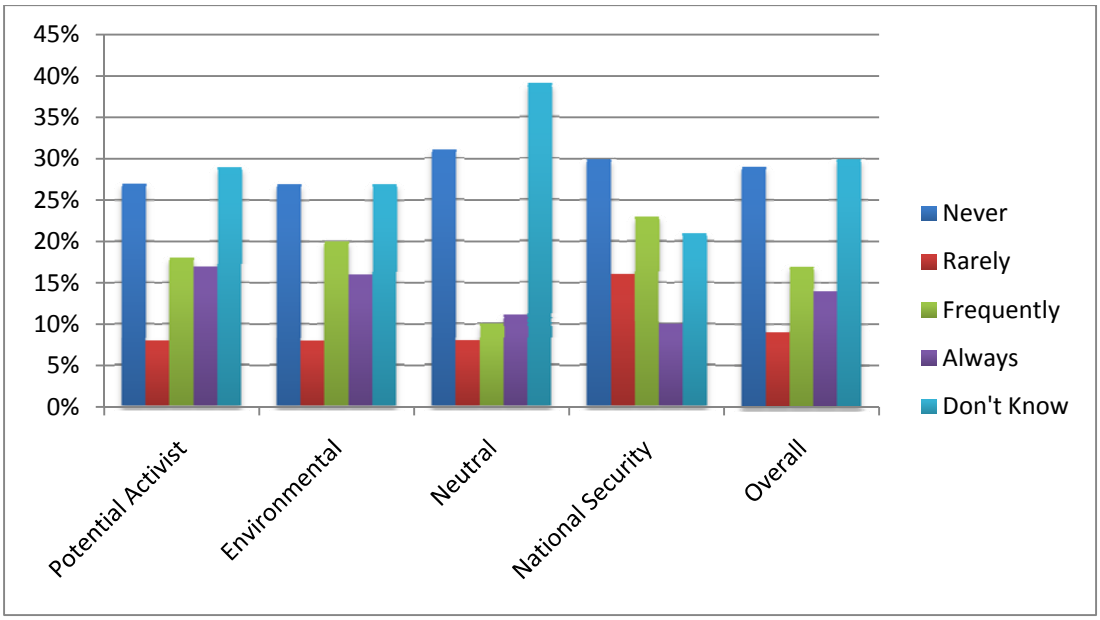


Figure 2.9 How often do you buy an ethanol blend for the vehicle you drive the most often? (See Table 2.2 for significance.)

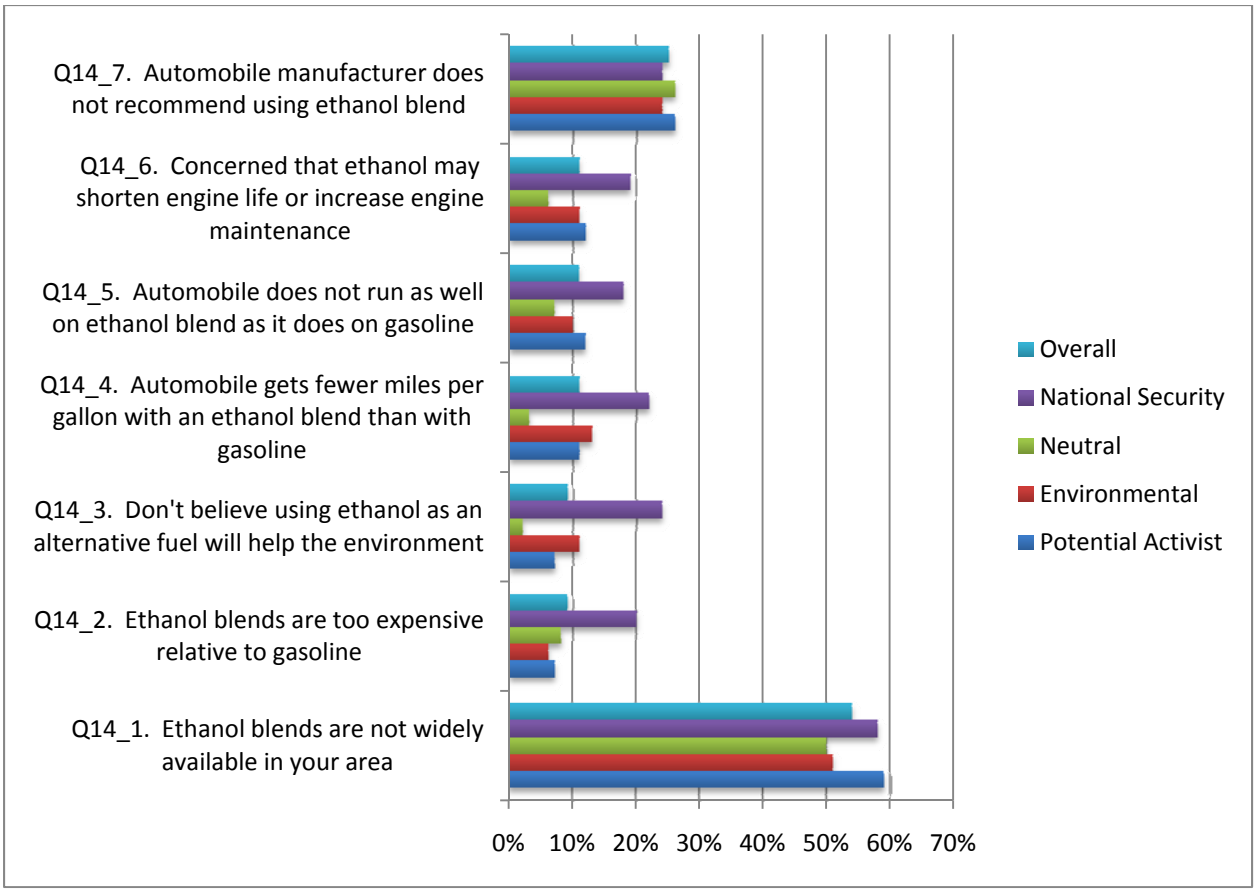


Figure 2.10 Why do you rarely, if ever, buy an ethanol blend for this automobile? (See Table 2.2 for significance.)

Part 3: Willingness to Pay for Reductions in Greenhouse Gas Emissions Through Purchases of E85

Abstract

While environmental concern has waxed and waned over time, issues like as climate change have come to the forefront of both domestic and international discussion and policy. The role of greenhouse gas emissions in contributing to climate change has been acknowledged. As a major source of emissions, transportation fuels are an obvious source of potential reductions in greenhouse gas emissions. This study segments consumers into four distinct market segments and uses a contingent choice method to determine willingness to pay for reductions in greenhouse gas emissions through purchases of E85 ethanol blends. Overall, willingness to pay is estimated at about 0.18 cents per gallon for each percentage in emissions reductions when compared with gasoline containing no ethanol (E0). Willingness to pay for emissions reductions varies in significance and degree across the four market segments. The diversity between the four segments implies that marketing plans should take into account the heterogeneity of consumers and make efforts to account for their varied needs and preferences.

Introduction

As a result of human activities, greenhouse gas (GHG) emissions such as carbon dioxide, methane gas, and nitrous oxide have increased. While the United States addresses oil security and concerns about climate change, the transportation sector merits significant attention as the primary consumer of imported oil and creator of one third of total U.S. greenhouse gas emissions (Gallagher and Collantes 2008). Between 1970 and 2004, GHG emissions increased 70 percent, and their effects on climate have been noted (IPCC 2007). Increases in average air and ocean temperatures, increased melting of snow and ice, and rising average sea levels around the world are evidence of the effects of GHG emissions on the climate system (IPCC 2007). This threat of

global climate change has provided reason and incentive to develop energy from renewable and sustainable sources.

Currently, policymaking strategies have focused on economy-wide GHG reduction policies (Gallagher and Collantes 2008). Corporate Average Fuel Economy Standards for passenger cars were raised in the Energy Independence and Security Act of 2007(EISA). EISA also contains provisions for aggressive reductions of GHG emissions. As a result, the case for renewable forms of energy has moved from the area of niche markets to one of economic incentive and necessity as renewable technologies become environmentally and economically viable alternatives to energy from fossil fuels (Herzog et al. 2001). As the global market demands more energy, it will be necessary to provide an energy product that is efficient and sustainable. Research indicates that there is substantial economic potential for the reduction of GHG emissions in the coming years (IPPC 2007). One means of reducing GHG emissions in the short run would be to substitute fossil fuels with a renewable fuel such as ethanol. Of all the types of renewable energy, substitution for liquid transportation fuels will likely come from biomass (EIA 2008). As a result of increased demand, global production of biofuels has doubled in the last five years, and it will likely double again in the next four (United Nations 2007). Ethanol as an alternative fuel has the potential to provide a secure and sustainable fuel source as well as reduce GHG emissions. In terms of feedstock options, the greatest potential for reducing GHG emissions and their associated costs is the development of second-generation feedstocks and fuels (United Nations 2007). Minimal utilization of resources such as land traditionally used for food crops, water, and fertilizer, and the potential for high yields have contributed to increased interest in the possibility of cellulosic ethanol from dedicated energy crops like switchgrass (Biomass Research and Development Board 2008). The use of wood wastes has

also become an appealing feedstock source as it utilizes byproducts of the lumber industry. Wood wastes include wood chips, sawdust, scrap timber, timber from thinning of forests for forest management, and construction debris.

In the discussion on alternative fuels and renewable energy, it is crucial to consider the consumer. Consumers are ultimately responsible for purchasing decisions related to alternative fuels, provided that legislation does not stipulate otherwise. According to Roe et al. (2001), purchases made by consumers can, in part, support the future of "renewable generation capacity" in the United States, and it is crucial to recognize the elements that will shape and affect the demand for these renewable sources. Consumers' attitudes and preferences towards alternative fuel sources is a key component of determining the feasibility of using agricultural residues and dedicated energy crops as feedstocks for alternative transportation fuels. In determining a market for a new product, market research and segmentation is often used to identify preferences and needs of distinct market segments and address these needs with specific marketing strategies. Wendell R. Smith's pioneering article emphasized the role of the consumer in the market, and discussed the strategy of market segmentation (1956). In the years since this article was written, market segmentation has become a commonly utilized marketing tool (Claycamp and Massy 1968; Wind 1978). Classification of consumers into groups or market segments is often used in order to gain better understanding of consumers' needs and motivations in order to facilitate the marketing of a product (Smith 1956; Baker and Burnham 2001). A common way of segmenting markets is through clustering. Clustering is a basic investigation technique that involves grouping similar objects together based on a set of characteristics (Everitt 1993). It is the art of finding groups in data, and is very much reliant on the meaningful interpretation of the researcher or classifier (Kaufman and Rousseeuw 2005). Simply stated, mathematical methods

of cluster analysis involve the gathering of similar objects (data) into distinct clusters that are internally homogeneous and externally heterogeneous.

Objective

The objective of this research is to determine WTP for reductions in greenhouse gas emissions via E85 ethanol purchases made by distinct market segments.

Literature Review

WTP for Greenhouse Gas Emissions Reductions

Research indicates that consumers are willing to pay (WTP) more for environmentally friendly products, and that those individuals who make a special effort to buy green products have an interest in new products, are information seekers, are especially price sensitive, and may give preference to the first product to meet their environmental needs (Shrum, McCarty, and Lowrey 1995). DeCicco and Mark (1998) cited the U.S. transportation sector as an area for significant reductions in GHG emissions. Social costs pollution, health threats, oil spills, and ecosystem damage were mentioned as negative externalities resulting from the transportation sector's reliance on fossil fuels. Their analysis suggests a transition towards a technology innovation strategy that promotes research and development of advanced vehicles and renewable fuels.

Research suggests that WTP for renewable energy differs by source (Borchers, Duke, and Parsons 2006; Jensen et al. 2004). These studies establish that a positive WTP for green electricity exists and that individuals do have preferences in terms of the source of renewable energy. Other research has looked at consumer characteristics and willingness to pay in the

United States and United Kingdom, and concludes that consumers do value environmental benefits from green energy (Roe, et al. 2001; Zarnikau 2003; Diaz-Rainey and Ashton 2007). These studies ascertain that the green energy market is establishing recognition and acceptance among consumers.

In terms of ethanol as an alternative fuel, the interaction between intended purchases of E10 blended fuel and environmental, political and national security benefits have been addressed (Bhattacharjee, Petrolia, and Herndon 2008). Their study uses a contingent valuation method in a simultaneous latent variable framework to assist in understanding the way consumers' perceptions about ethanol are developed and influence buying behavior. They found males, liberals, and those who were familiar with ethanol to have higher WTP. In their study, concerns about economy and environment rather than national security shaped individuals' overall perception towards ethanol use.

Jeanty and Hitzhusen (2006) use a contingent valuation method to estimate WTP for air pollution reduction from using biodiesel in diesel engines. The study focuses on valuing the following benefits of biodiesel: reduction in CO_2 emissions by 75 percent, reductions in fine particulates by 47 percent, sulfur emissions by 100 percent, and volatile organic compounds by 56 percent. They reported premiums by the gallon of $0.09, $0.20, and $0.31 depending on the statistical model.

Gould and Golob (2008) reported on perceived environmental efficacy as a consideration for car buyers. Their research looks at Electric Vehicles (EV), and suggests that environmental friendliness is a new dimension of vehicle choice faced by consumers. When initially surveyed, 78 percent of respondents indicated that EV was a key solution for solving air pollution. Another study by Achnicht (2009) estimated WTP for abatement of CO_2 emissions among

German car buyers, and examined whether CO_2 emissions per kilometer is a relevant attribute when choosing a vehicle. A stated-preference choice model was used to determine that CO_2 emissions are a significant attribute related to vehicle choice. Women, younger respondents, and those who possessed a Higher Education Entrance Qualification were willing to pay more for CO_2 reductions.

Li et al. (2009) used a mixed-mode contingent valuation survey to estimate WTP for increased research and development in support of replacing fossil fuels in the U.S. energy supply. Payments would be made in the form of increased electricity and gasoline prices. The estimated mean household mean WTP was $137/year. WTP was higher for females, liberals, respondents with higher incomes, and those who considered energy issues to be important.

Berk and Fovell (1999) used a contingent valuation method to estimate Los Angeles residents' WTP to prevent significant climate change in their region. Respondents were presented with summer and winter climate change scenarios for their region. An average dollar amount to prevent the scenarios ($40) was inserted at random into the WTP question. The overall mean WTP was $13.70/month to prevent the climate change scenarios. WTP estimates were influenced by respondent's desire to prevent increases in summer temperatures and decreases in winter precipitation in their region.

O'Connor et al. (2002) investigated who, specifically, wants to reduce GHG emissions. Data was collected from a mail survey of 623 residents of Central Pennsylvania. In this region, the costs of GHG mitigation exceed the potential benefits from slowing global warming. Ordinary least squares analysis revealed that respondents who can correctly identify causes of global warming and who expect negative consequences are likely to support both government

initiatives focused on replacing fossil fuels and voluntary actions to do the same. Economic circumstances and concerns were not found to be significant predictors for desire to reduce GHG emissions. The belief that environmental protection efforts do not threaten jobs, limit personal freedoms, or hurt the economy are strong predictors for support of mitigation of GHG emissions in this study. Overall, respondents wanted to reduce emissions if they understood the causes of climate change, if they perceived climate change to be a significant risk, and if they felt that climate change mitigation policies would not cost them their jobs.

Solomon and Johnson (2009) conducted a case study of Michigan, Wisconsin, and Minnesota residents to determine how these residents valued climate protection through the potential purchase and consumption of cellulosic ethanol. Using a multi-part, split-sample contingent valuation method, the authors found that 83.8% of respondents were willing to pay extra (mean population average of $252/year) for cellulosic ethanol. Variables that were significant determinants of WTP were household income, political views, gender, climate change concerns and beliefs, and WTP $0.40/gallon more for gasoline if the money is used to stop climate change. Several other studies have addressed support for climate change mitigation policies and related consumer preferences and environmental values (Dietz, Dan, and Shwom 2007; Berrens et al. 2004; Hidano, Kato, and Aritomi 2005; Wood et al. 1995).

Market Segmentation

Discovering and describing market segments is a marketing tool that is frequently used to classify consumers into groups that can be targeted more efficiently. Cluster analysis is a popular method by which this can be achieved. A popular method used to find clusters in a data

set is a two-step process that involves a hierarchical method followed by a non-hierarchical method (Sharma and Kumar 1998; Punj and Stewart 1983; Kuo, Ho, and Hu 2002).

Van de Velde et al. (2009) used a two step cluster method to cluster consumers based on their perceived importance of fuel characteristics and beliefs about biofuels. They used a hierarchical cluster method to create an agglomeration schedule and dendrogram from which a four cluster solution was determined to be optimal. The second step used the cluster centers from the hierarchical method to refine the solution using a k-means cluster analysis. Clusters were identified as Performance Oriented Consumers, Society-Oriented Consumers, Environment-Oriented Consumers, and Convenience- Oriented Consumers. These clusters were profiled and implications for target marketing the segments were discussed.

Steinley (2003) also discussed the two-step clustering method. He cautions about the starting values or seeds used in the k-means cluster procedure: "Because there could be numerous local optima in a data set, the choice of starting values for the k-means algorithm is all the more crucial." He goes on to say that researchers have often chosen to use starting seeds from a hierarchical method like Ward's Minimum Variance to obtain the starting seeds for the k-means method (Milligan 1980; Waller et al. 1998).

Data and Methods

Survey Methods

Data for this analysis comes from the Ethanol Conjoint Survey conducted online in January and February 2009. Knowledge Networks (KN) provided the survey sample and online survey administration services. The sample was taken from Knowledge Networks' online research panel which is designed to be representative of the U.S. population. Panel members

were recruited by telephone using random digit dialing (RDD). Address-based sampling methods were also used to account for RDD's declining effectiveness (due to cell phones, etc.). Free internet access and a laptop computer were provided to panel members on an as-needed basis in exchange for agreeing to complete at least one survey each week. Panel members who complete longer surveys, i.e. longer than 15 minutes, receive incentive points that are redeemable for cash. Each panel member completed an initial profile survey that collected essential demographic information. This profile is updated annually.

Panel members selected for this survey were sent an email informing them that there was a new survey available to take and a link was provided to the survey. Automatic email reminders were sent to non-responders after three days. Panel membership for this survey was compared to the most recent demographic distribution data from the Current Population Survey and was adjusted to correct for known deviations in panel recruitment from an equal probability sample of the U.S. population, as well as non-response and non-coverage bias in panel membership.

The survey was fielded to 2,851 panel members age 18 and older, and a total of 1,909 responses were collected. The survey instrument began with two screening questions. If the household did not currently own or lease at least one automobile or the household automobile driven the most often did not have a gasoline or gasoline/electric engine, the respondent was screened out of the survey. 1,727 out of 1,909 respondents passed the screening and provided useable responses to the survey. Out of these usable responses, 1,668 were used for the cluster analysis based on the completeness of responses to the clustering questions.

A survey weight was designed to account for non-response to the survey and was calculated by comparing respondent demographics with benchmark demographics from the

Current Population Survey (i.e., gender, age, ethnicity, education, census region, metropolitan area, and access to the internet). An iterative proportional fitting procedure was used to calculate the weights (Knowledge Networks 2009). The distribution of the calculated weights was examined to identify and trim outliers at the extreme upper and lower tails of the weight distribution. The results are presented here weighted with the resulting weights.

The survey instrument contained eight "information screens" that provided respondents with some basic information on ethanol blends and feedstocks. The first screen explained gasoline and ethanol, and provided information related to the amount of crude oil consumed in the U.S. that comes from foreign sources. The second screen described E10, E85, and Flex Fuel Vehicles (FFVs), and warned that E85 could only be used in FFVs. The third screen explained the differences in octane levels of gasoline and E85. The fourth screen explained that ethanol has lower energy content relative to gasoline, and that this translates into increased frequency of refueling. The fifth screen explained that the use of ethanol reduces the amount of GHG and other pollutants released into the atmosphere. Lastly, three screens provided information on the three different feedstocks used in the analysis: switchgrass, wood wastes, and corn.

Questions in the survey addressed issues such as familiarity and experience with ethanol and FFVs, vehicle ownership, driving patterns, future automobile purchases, respondent attitudes towards a variety of topics including fuel security, personal actions, the food vs. fuel debate, and the environment, membership in environmental organizations, and sources of environmental information. The survey also contained a contingent choice exercise in which respondents were asked to choose between different variations of E85 and either an E10 or E0 blend, depending on the version of the survey to which the respondent was assigned. Respondents were asked to assume that their automobile was compatible with E85 when responding to the contingent choice

questions. The contingent choice exercise contained fourteen different choice tasks; however, three of these were fixed or holdout tasks that were constant across all respondents.[5] (See Figure 3.1 for an example of the choice task.) Three of the alternatives were an E85 blend with differing levels of attributes and the fourth alternative was either E10 from corn or E0. The levels of the fuel attributes for the three E85 blends varied from one alternative to another and from one choice task to another; however, the levels of the attributes for the E10 alternative were constant across all choice tasks. [6]

The fuel alternatives varied in terms of four attributes: price, feedstock used to produce the ethanol, level of GHG emissions reductions compared with either E0 or E10, and nearest availability of the fuel. An example vehicle that gets 20 miles per gallon was used to calculate price per mile. For the E10 survey, the price levels used for the E85 alternatives were 6.7, 7.1, 7.5, 7.9, and 8.3 cents for each mile driven. The E10 alternative was priced at 7.5 cents per mile. For the E0 survey, the price levels used for the E85 alternatives were 6.2, 6.6, 7, 7.4, and 7.8 cents for each mile driven. The E0 alternative was priced at 7.0 cents per gallon. The levels of GHG emissions reduction in both surveys for the E85 alternatives were 10 percent, 50 percent, and 73 percent. The percentages for E85 fuel imported were 10, 33, and 50. E10 was listed as 60 percent imported and E0 was listed as 67 percent imported. Availability of the E85 alternatives were presented as being at a station that was either "on your way", or either 2 or 5 minutes "out of your way". The E10 and E0 alternatives were presented as being 2 minutes out of the way.

[5] Holdout tasks are used as a means of assessing the validity of econometric models used to analyze responses to the choice tasks (Johnson 1997).
[6] Structured this way, the E10 alternative acted similar to the "None" option that is commonly included in contingent choice tasks.

Cluster Methods

Survey respondents were clustered based on their responses to fifteen questions measured on a Likert-scale ranging from 'strongly disagree' to 'strongly agree'. These questions pertained to attitudes and behaviors related to fuel security, the food vs. fuel debate, environmental concern, perceived consumer effectiveness (PCE)[7], and faith in the efficacy of others (FIO)[8]. A complete list of cluster variables can be found in Tables 16 through 20[9]. A popular two-stage cluster method in which a hierarchical cluster method is followed by a non-hierarchical method was chosen for this analysis (Sharma and Kumar 1998; Punj and Stewart 1983; Kuo, Ho, and Hu 2002). Ward's Minimum Variance method was the hierarchical method used to determine the optimal number of clusters. Ward's Minimum Variance method minimizes the within-cluster sum of squares (Ward 1963). At each stage of the analysis, joining of every possible pair of clusters is considered, and the two clusters whose union results in the minimum increase in 'information loss' are combined (Everitt 1993). The number of clusters was determined based on inspection of the dendrograms and the author's interpretation of the relevance of three, four, and five cluster solutions. Based on these observations, a four-cluster solution emerged as optimal. Cluster centroids were saved from the Ward's analysis to be used as starting seeds for the k-means analysis. It is widely recognized in the literature that the performance of the k-means method depends largely on the initial seeds used to begin the clustering process (Pena, Lozano, and Larranaga 1999; Kuo, Ho, and Hu 2002; Steinley 2003). Steinley cautions about the starting

[7] PCE measures the extent to which an individual feels that his or her consumption behavior has an impact on a given situation (Berger and Corbin 1992). Berger and Corbin's study suggests that PCE is extremely influential as a representative of the environmental attitude/consumer behavior relationship (1992).
[8] Faith in others represents a circumstance in which rather than changing a personal action, an individual could choose to support policies, research, or groups to solve a particular problem. Bergin and Corbin's study suggests that an individual's level of FIO will influence the extent to which the individual supports other's actions in pursuing a solution to a problem (1992).
[9] All tables located in the appendix.

seeds used in the k-means procedure (2003): "Because there could be numerous local optima in a data set, the choice of starting values for the k-means algorithm is all the more crucial." The author goes on to say that researchers have often chosen to use starting seeds from a hierarchical method like Ward's Minimum Variance to obtain the starting seeds for the k-means method (Milligan 1980; Waller et al. 1998). The results from the Ward's method analysis were refined using the k-means non-hierarchical method. The k-means method is a simple, non-parametric clustering method that minimizes within-cluster variability and maximizes between-cluster variability. The starting seeds used for the k-means method are the centroids taken from the Ward's method. The four clusters were named based on inspection and interpretation of the mean responses to the clustering variables. Cluster one is called 'Potential Activist', cluster two is called 'Environmental', cluster three is called 'Neutral', and cluster four is called 'National Interest'.

WTP

Since the early 1970's, conjoint analysis has been used extensively in consumer research as a means of predicting consumer preferences among multi-attribute alternatives (Green and Srinivasan 1978). The type of conjoint analysis that will be used in this research is contingent choice. In this scenario, respondents choose a preferred product with a set bundle of attributes among two or more choices. The set of attributes for all products are the same, but the level of attributes differs among products. This method was chosen because of its similarity to the actual purchase decisions faced by consumers. The inclusion of price as a product attribute in this survey will allow willingness to pay values to be estimated for changes in levels of greenhouse gas emissions reductions.

Economic Modeling

It is assumed that consumers are utility maximizing, and that when presented with a set of alternatives, they will select the alternative that provides the greatest amount of utility relative to the other alternatives. It is also assumed that the utility received from a certain alternative is related to a set of observable attributes associated with that alternative, Z_{nj}. In turn, the utility that individual n receives from the jth alternative can be expressed as $U_{nj} = \theta' Z_{nj} + \varepsilon_{nj}$, where Z_{nj} is a vector of observed attributes of the alternatives, θ is a vector of unobserved parameters to be estimated, and ε_{nj} is an error term. If the choice among alternatives is treated only as a function of characteristics, a conditional logit model can be used (McFadden 1973). For this model, the probability of selecting alternative j can be expressed as:

$$(1) \quad \Pi_{nj} = \frac{\exp(\theta' Z_{nj})}{\sum_i \exp(\theta' Z_{nj})}$$

where Z_{nj} are the product characteristics of the jth alternative. The WTP for a particular attribute is calculated by:

$$(2) \quad WTP_l = -\frac{\theta_l}{\theta_P},$$

where P is price and l is a non-price attribute.

However, the conditional logit is limited in that it assumes homogeneity of individuals, implying that there is homogeneity of preferences across the sample. The model can be modified to incorporate heterogeneity of preferences across consumers by using a random parameters model (Train 1998). Utility within this framework can be expressed as:

(3) $U_{nj} = (\bar{\theta} + \sigma)' Z_{nj} + \varepsilon_{nj} = \theta' Z_{nj} + \sigma' Z_{nj} + \varepsilon_{nj}$,

where $\bar{\theta}$ is a vector of mean parameters to be estimated across the *n* individuals, and σ is a vector of estimated standard deviations of these parameters. WTP can be estimated using (Revelt and Train 1998):

(4) $WTP_l = -\frac{\bar{\theta}_l}{\theta_P}$.

Heterogeneity of preferences may also be incorporated into the model by including demographic characteristics and attitudinal variables in a "mixed" model (Hanley, Mourato, and Wright 2001). When the fixed parameter model is modified to include these demographic and attitudinal variables, then utility can be expressed as:

(5) $U_{nj} = (\theta + \gamma X_n + \varphi Y_n)' Z_{nj} + \varepsilon_{nj} = \gamma X_n Z_{nj} + \varphi Y_n Z_{nj} + \theta' Z_{nj} + \varepsilon_{nj}$,

where X_n are demographic characteristics and Y_n are taste indicators and γ and φ are their associated parameters. Both the demographic and attitudinal variables enter the model as interactions with the product attributes. In this case, if the demographic and attitudinal variables are interacted with non-price variables, then the WTP for attribute *l* calculated at the sample mean becomes:

(6) $WTP_l = -\frac{\theta_l + \gamma_l \bar{X}_n + \varphi_l \bar{Y}_n}{\theta_P}$.

This "mixed" model is modified by Lavin and Hanemann (2008) to incorporate both the demographic characteristics and taste indicators of the consumers into the random parameters model. Utility in this model can be expressed as:

(7) $U_{nj} = (\bar{\theta} + \gamma X_n + \varphi Y_n + \sigma)' Z_{nj} + \varepsilon_{nj} = \gamma X_n Z_{nj} + \varphi Y_n Z_{nj} + \bar{\theta}' Z_{nj} + \sigma' Z_{nj} + \varepsilon_{nj}$,

where X_n are demographic characteristics and Y_n are taste indicators and γ and φ are their associated parameters. Again, $\overline{\theta}$ is a vector of mean parameters, and σ is a vector of estimated standard deviations of the parameters. This becomes the random parameters logit with demographic and taste indicators interacted with the product attributes. The random parameters logit is estimated with simulated maximum likelihood and , in this case, using Halton draws with 1,000 replications. The parameters are assumed to follow a normal distribution. If the demographics and attitudinal variables are interacted with non-price variables, then the individual-level estimate for WTP for attribute *l* becomes:

$$(8) \qquad WTP_{nl} = -\frac{\theta_{nl} + \gamma_l X_n + \varphi_l Y_n}{\theta_P}.$$

Individual-level WTP is calculated according to equation (8) using the simulated individual-level parameters for the non-price attributes, the individual's demographic characteristics and attitudes, and the fixed parameters on these characteristics and attitudes, and the fixed parameter on price.

Point estimates can be calculated at the means of the random parameters and means of the demographic and attitudinal variables using equation (9) (Hensher and Greene, 2002):

$$(9) \quad WTP_l = -\frac{\overline{\theta}_l + \gamma_l \overline{X} + \varphi_l \overline{Y}}{\theta_P}.$$

In this analysis, the fixed parameters models that are estimated are the conditional fixed parameters logit on product attributes and a fixed parameters logit on product attributes including interactions of the reduce variable with demographic and attitudinal variables. The random parameters models estimated are the random parameters logit on product attributes only and the

random parameters model on product attributes and interactions of demographic and attitudinal variables with the reduce variable.

Product attributes, demographic characteristic and attitudinal variable definitions, hypothesized signs and sample means are presented in Tables 1 and 2. The fuel attributes are price (*Price*), blend and feedstock (*E85Corn*, *E85Grass*, or *E85Wood*), minutes out of the consumer's way that he or she must travel to purchase the fuel (*Inconvenience*), percent of greenhouse gas emissions reductions from E10 or E0 depending on survey version (*Reduce*), and percent of fuel from imported sources (*Import*).

Hypotheses

It is hypothesized that WTP for emissions reductions will be positive overall (Jeanty, Haab and Hitzhusen 2007) and that the estimated mean WTP will be about 0.0069 cents per mile for each percent in emissions reductions (0.138 cents per gallon for a 20 mpg vehicle) (Jensen et al. 2010). Based on findings by Solomon and Johnson (2009), it is hypothesized that females, those with more liberal political views, higher household incomes, and those with concerns for and beliefs in climate change will have a higher preference for reducing GHG emissions reductions through E85 purchases.

It is hypothesized that consumer cluster(s) defined by concern for environmental issues, interest in/support for environmentally friendly behavior, acknowledgment of the effects of climate change, interest in national security issues as they relate to import of fossil fuels, and the belief that farmland should be used to produce food and not fuel will be more likely to be willing to pay a premium for reductions in greenhouse gas emissions through cellulosic ethanol purchases. This is based on the assumption that consumers' overall concern for the environment,

national security, and food production will lead them to derive utility from the purchase and/or support of products that have a positive effect on these issues.

It is also hypothesized that consumer cluster(s) defined by lesser concern for environmental issues, interest in/support for environmentally friendly behavior, acknowledgment of the effects of climate change, interest in national security issues as they relate to import of fossil fuels, and the belief that farmland should be used to produce food and not fuel will not be willing to pay a premium for reductions in greenhouse gas emissions through ethanol purchases. This is based on the assumption that an overall lack of concern for or knowledge of environmental issues will provide less utility relative to purchase and/or support of products that have a positive effect on the environment.

Results

The models were estimated using both fixed parameters logit and random parameters logit, one including the product attributes only and a second including product attributes, demographic characteristics, and attitude variables. In each case, a log-likelihood ratio test revealed that the random parameters logit model was preferred over the fixed parameters logit. Comparisons were then made between the log-likelihood functions for the random parameters models that included both product attributes along with demographics and attitudes and those that included product attributes only. Results indicated that the models containing demographic and attitude interaction variables were significant for all clusters except for the E0 version on the National Interest cluster. Results for this cluster indicate that the model without interactions is preferred in this case. Log-likelihood tests were also performed to test the suitability of splitting the sample into clusters to be examined. Results of these tests for both the E0 and E10 versions

for the random parameters logits with interactions revealed that splitting the sample into clusters is justified. These tests are summarized in presented in Tables 3.20 through 3.41. In terms of estimated WTP, *t*-tests assuming unequal variances revealed that all clusters except for the Potential Activists had significantly different mean WTP than the entire sample. Significant differences between clusters were also found.

Table 3.12 and 3.13 contain WTP estimates for the fuel attributes using the coefficients from the four different models reported in Tables 3.2 through 3.11. Figures 3.3 through 3.7 profile the four clusters. The estimates of WTP for the first model are calculated using equation (2). The WTP estimates for the second model are calculated at the cluster means of the demographic and attitudinal variables as in equation (6). Estimates of WTP for models 3 and 4 (random parameters logits) are calculated using equation (9). WTP estimates are also calculated at the cluster means of the demographic and attitudinal variables.

Potential Activist Cluster

The Potential Activist cluster is the largest of the four and contains 560 respondents. While the members of the Potential Activist cluster feel strongly about many of the clustering questions, they have neither the highest or lowest mean response relative to agreement or disagreement for all but two of the clustering questions. This cluster leans toward supporting national security efforts and domestic oil drilling. Issues surrounding climate change are of greater importance to this cluster than the National Interest and Neutral clusters, but not greater than the Environmental. The Potential Activists are also second behind the Environmentals when it comes to environmental issues both now and in the future; however, they are the least likely to feel that they have enough information to make well-informed decisions about environmental issues. This segment has varying levels of perceived consumer effectiveness

(PCE). They tend to disagree that personal actions don't have any significant effect on the environment, but they are also the most likely out of the four clusters to agree that most people aren't willing to make sacrifices to protect the environment. Finally, the Potential Activists are second most likely behind the National Interests to agree that science and technology will solve environmental problems. Cluster variable means can be found in the cluster profiles.

The estimated coefficients on *Price*, *Import*, *Reduce*, *Inconvenience*, *E85corn*, *E85grass*, and *E85wood* for the Potential Activist cluster for the E10 survey version were all as expected. *Price*, *Import*, and *Inconvenience* were all negative and significant suggesting that consumers in the Potential Activist Cluster prefer fuel from domestic sources, convenience, and are sensitive to changes in price. The estimated coefficients on *E85corn*, *E85grass*, and *E85wood* were all positive and significant indicating a preference for E85 regardless of feedstock. In addition, the coefficient on the *Reduce* variable was positive and significant suggesting that this cluster has a preference for GHG reducing fuels that can provide emissions reductions greater than what E10 can provide.

The coefficient for the interaction of *Reduce* and *Hisp* was negative and significant. This suggests that Hispanics in the Potential Activist cluster have less of a preference for emissions reductions through E85 purchases than whites (the base case). The coefficient for *Income1* interacted with *Reduce* was positive and significant. This was not expected, but could be explained by Klineberg, McKeever, and Rothenbach (1998) which found that respondents in higher income brackets were less likely to support either a tax on fossil fuels or stronger government regulations to control pollution. As was expected, the coefficient of *Lowpce* interacted with *Reduce* was negative and significant. This supports the idea that consumers with low PCE are less likely to support environmental improvements through personal purchasing

decisions because they are less likely to believe that their actions make a significant difference. Both the *Ff* and *Nat3* variables were interacted with *Reduce* and their coefficients were found to be negative and significant. This was expected and suggests that those who support increased domestic drilling and using farmland for food not fuel are less likely to prefer reducing GHG emissions through E85.

In the E0 version, the only differences from the E10 version were that the interaction coefficient between *Over45* and *Reduce* was found to be significant and negative and the *Nat3* and *Ff* interaction variables were no longer significant.

Consumers in the Potential Activist cluster had a significantly positive mean WTP and were willing to pay about 0.0068 cents per mile (.14 cents per gallon) for each percentage reduction in GHG emissions in the E0 version and about 0.0037 cents per mile (.07 cents per gallon) in the E10 version. It is interesting here to note that estimated WTP decreases by 50% with the E10 version. This could because consumers already feel that they are reducing emissions with E10 and are less willing to pay for additional reductions.

Environmental Cluster

The Environmental Cluster is the second largest cluster with 459 respondents who are most likely to agree that climate change is occurring, and that it will lead to environmental and health problems around the world. This cluster strongly disagrees that there is no urgent need to take measures to prevent climate change. The Environmentals are second most likely behind the National Interests cluster to agree that U.S. farmland should be used to produce food and not fuel and that increased corn ethanol production will lead to higher food prices. This cluster believes that reducing dependence on foreign oil is important, but that it is not more important than

protecting the environment. In accordance, the Environmentals are the least likely to support opening up more U.S. lands for oil drilling. Concerns for the loss of the world's forest are highest in this cluster as well as concern for the state of the environment both present and in the future. They have high PCE and believe more than any other cluster that their personal actions do have an effect on the quality of the environment; however, like the Potential Activists, they are likely to agree that most people are not willing to make sacrifices to protect the environment. They are second behind the National Interest cluster in agreement to feeling that they have enough information to make well-informed decisions on environmental issues. Not surprisingly, the Environmentals feel most strongly that we have a responsibility to protect the environment for future generations.

The estimated coefficients on *Price*, *Import*, *Inconvenience*, *E85grass*, and *E85wood* for the Environmental cluster for the E10 survey version were all as expected; however, the *Reduce* variable was not significant as was expected. This may be due to the fact that ethanol is currently only available from corn and members of this cluster do not feel that corn ethanol is an effective means of reducing emissions. On this same note, the *E85corn* variable was not significant as expected; nevertheless both *E85grass* and *E85wood* were positive and significant. So while this cluster does have a preference for E85, they do not prefer a corn feedstock. *Price*, *Import*, and *Inconvenience* were all negative and significant suggesting that like the Potential Activists, consumers in the Potential Activist Cluster prefer fuel from domestic sources, convenience, and are sensitive to changes in price.

The interaction between *Politother* and *Reduce* is significant and negative suggesting that consumers in the Environmental cluster with an independent or other political affiliation are less likely to prefer reduction of GHG emissions through E85 purchases relative to democrats in the

same cluster. Those with lower incomes were also less likely to prefer GHG emissions reductions through E85 purchases when E10 is an option. This contradicts the findings for the Potential Activist cluster, but could be due to an E0 versus E10 comparison in which the consumer feels that they are already reducing emissions with E10, so they are not inclined to pay for more?

The only difference in fuel attribute variables from the E10 version was that *Reduce* is positive and significant. This could be because the E0 fuel option offers no GHG reductions compared with the E85 options. In this survey version, blacks are less likely to prefer reducing GHG emissions. Consistent with the Potential Activist cluster, those in the highest income category were less likely to prefer reducing GHG emissions through E85 purchases. The interaction between the *Ff* variable and *Reduce* was also negative and significant. This was expected as the Environmental cluster feels strongly that farmland should be used for food not fuel. Finally, the interaction between *Ghg* and *Reduce* was positive and significant. This was expected as the Environmental cluster was most familiar with GHG's.

In terms of mean WTP for GHG emissions reductions, consumers in the Environmental cluster were willing to pay about 0.0246 cents per mile (.49 cents per gallon) in the E0 version and about 0.0201 cents per mile (.40 cents per gallon) in the E10 version for each percentage reduction in emissions. The difference in mean WTP for the two survey versions is not as drastic as for the Potential Activists suggesting that consumers in the Environmental cluster are still willing to pay for reducing GHG emissions whether some reduction is already in effect via E10. This cluster had the highest mean WTP of the four.

Neutral Cluster

The Neutral Cluster is the third largest with 410 respondents. The means for the cluster variables were overall neutral (all within .40 of 3.00). This being said, there are still comparisons that can be made with other segments. This cluster is the least concerned about the food versus fuel issue and improving national security by reducing dependence on foreign oil. They are second behind the Environmental cluster in disagreement that reducing dependence on foreign oil is more important than protecting the environment and that more land in the U.S. should be opened for oil drilling. They are second most likely behind the National Interest cluster to disagree that climate change is occurring, that it will lead to environmental and health problems around the world, and that there is an urgent need to prevent it. The Neutrals are also second behind the National Interest cluster in their lack of concern for the loss of the world's forests and for the state of the environment both now and in the future. After the Potential Activist cluster, they are the second most likely to believe that they don't have enough information to make well-informed decisions on environmental issues. While they disagree more than any other cluster that people are not willing to make sacrifices to protect the environment, they are the least likely out of the four clusters to agree that we have a responsibility to protect the environment for future generations.

The estimated coefficients on *Price*, *Import*, *Reduce*, *Inconvenience*, *E85corn*, *E85grass*, and *E85wood* for the Neutral cluster for the E10 survey version were all as expected. *Price*, *Import*, and *Inconvenience* were all negative and significant suggesting that consumers in the Neutral cluster prefer fuel from domestic sources, convenience, and are sensitive to changes in

price. The estimated coefficients on *E85corn*, *E85grass*, and *E85wood* were all positive and significant indicating a preference for E85 regardless of feedstock. The coefficient on the *Reduce* variable was insignificant suggesting that this cluster has no preference for E85 in terms of reducing GHG emissions.

The coefficient of the interaction between *Over45* and *Reduce* was negative and significant. This follows other studies that suggest that age and support of environmental improvements are negatively correlated (Klineman, McKeever, and Rothenbach 1998). Also, the coefficient of the interaction between *Income2* and *Reduce* was significant and positive. This is interesting because this income category contains the most respondents for this cluster. The interactions between *Fiohi* and *Lowpce* and *Reduce* were both significant and positive. This was expected for the *Fiohi* interaction as those who have high faith in others are more likely to make purchases that they feel will allow others to solve problems. The positive coefficient on *Lowpce* was not expected as consumers with low perceived consumer effectiveness are generally less likely to pay for an environmental improvement because they do not feel that their actions have a significant impact. Finally, the interaction coefficient on the *Ff* variable was negative and significant. As would be expected, consumers who believe that farmland should be used for food not fuel would have less of a preference for reducing GHG emissions via a fuel source that uses a feedstock that utilizes potential farmland. It is worth noting here that consumers in the Neutral profile are the least familiar with switchgrass and wood wastes as ethanol feedstocks.

In terms of fuel attributes, the only difference in the E0 version was that the *Import* variable was insignificant. This indicates that Neutrals did not have a preference for percentage of imported fuel in a fuel product in the E0 survey version. With the interacted variables, the coefficients for *Income1* and *Fameth* were significant and negative. In terms of familiarity with

ethanol, this relationship may be due to the fact that consumers in this cluster are least informed about ethanol as an alternative fuel or they may not believe that ethanol is environmentally beneficial. Finally, the coefficient on the *Ghg* variable was positive and significant suggesting that consumers in the Neutral cluster who were more familiar with GHG's had a higher preference for reducing GHG emissions through E85 purchases compared with E0.

Although found to be insignificant, estimated mean WTP for reduction in GHG emissions for the E10 versions was about 0.00028 cents per mile (0.005 cents per gallon) and about .0050 cents per mile (0.1 cents per gallon) for the E0 version.

National Interest

Cluster four, National Interest, is the smallest of the four with 210 respondents. This cluster agrees more strongly than any other cluster that U.S. farmland should be used for food not fuel, and that increasing corn ethanol production will lead to higher food prices. National security is of utmost importance to this cluster as they are most likely to agree that reducing our dependence on foreign oil is important and that it is more important than protecting the environment. Hence, they also feel most strongly about opening more U.S. lands for oil drilling. In terms of climate change, the National Interest cluster is the least likely of all the clusters to agree that climate change is occurring and that it will lead to health and environmental problems around the world. The National Interest cluster is also the most likely to disagree that there is an urgent need to take measure to prevent climate change, that they are concerned for the loss of the world's forests, and that they are concerned for the state of the environment both now and in the future. This segment feels most strongly about their ability to make well- informed decisions on environmental issues, but they are also most likely to agree that personal actions do not have any significant effect on the quality of the environment. The National Interest cluster is the most

likely to agree that science and technology will develop solutions for environmental and pollution problems and the third most likely out of the four cluster to agree that there is a responsibility to protect the environment for future generations.

The estimated coefficients on *Price*, *Import*, *Reduce*, *Inconvenience*, *E85grass*, and *E85wood* for the National Interest cluster for the E10 survey version were all as expected. *Price*, *Import*, and *Inconvenience* were all negative and significant suggesting that consumers in the National Interest cluster prefer fuel from domestic sources, convenience, and are sensitive to changes in price. The estimated coefficients on *E85grass*, and *E85wood* were positive and significant while *E85corn* was insignificant indicating a preference for E85 from switchgrass or wood waste feedstocks. The coefficient on the *Reduce* variable was insignificant suggesting that this cluster has a no preference regarding the potential of E85 to reduce GHG emissions.

In terms of variables interacted with the *Reduce* variable, the coefficient on *Male* was negative and significant. This was expected as females have traditionally been found to show more support for pro-environmental choices (Solomon and Johnson 2009; Klineberg, McKeever, and Rothenbach 1998). The coefficient on the *Otheth* variable was found to be significant and positive. Compared to whites, consumers reporting to be an ethnicity other than white, black or Hispanic show a greater preference for reductions in GHG emissions through E85 purchases compared with E10. As was the case with the Passive Activist cluster, consumers in the lowest income category showed more of a preference for reducing GHG emissions through E85 purchases compared with E10. Interestingly, the coefficient on the *Clc* variable was significant and positive; while the coefficient on *Ghg* was significant and negative. This suggests that while members of the National Interest cluster are quite familiar with both GHG's and climate change, they may not perceive E85 as a means of effectively reducing GHG emissions; therefore, they

are less likely to prefer it as means of reducing emissions. This finding would also indicate that GHG emissions and climate change tend to be somewhat independent of each other in the minds of the National Interest cluster. It is interesting to note that the *Nat3* variable was not significant. This could be because this variable specifically deals with domestic drilling and was not perceived by respondents to have a direct effect on national security.

For the E0 version, the random parameters logit with attributes only was the preferred model. The coefficients on *Price* and *Inconvenience* were both negative and significant as expected. The coefficient on *E85corn* was negative and significant, while the coefficient for *E85wood* was positive and significant. This implies that the National Interest cluster may be more willing to support an alternative fuel that is not perceived to compete with food crops for land usage. The *Reduce* variable narrowly missed significance at the 0.1 level of significance.

The estimated mean WTP for GHG emissions reductions in the E10 version is -0.02043 cents per mile (-0.41 cents per gallon) and is insignificant. The estimated mean WTP for each percentage change in GHG emissions reductions in the E0 version is -0.0336 cents per mile (-0.67 cents per gallon) and is significant. This is further confirmation that the National Interest cluster prefers E0 to all other alternatives.

Overall

Overall, the 1,668 respondents were most concerned about reducing dependence on foreign oil, the occurrence of global climate change, and a responsibility to protect the environment for future generations. Approximately 85 percent are at least somewhat familiar with climate change, and 86 percent were familiar with ethanol prior to taking the survey.

Familiarity with corn as an ethanol feedstock was much higher versus switchgrass and wood wastes.

The estimated coefficients on *Price*, *Import*, *Inconvenience*, *E85corn*, *E85grass*, and *E85wood* for the overall sample for the E10 survey version were all as expected. *Price*, *Import*, and *Inconvenience* were all negative and significant suggesting that overall consumers prefer fuel from domestic sources, convenience, and are sensitive to changes in price. The estimated coefficients on *E85corn*, *E85grass*, and *E85wood* were all positive and significant indicating a preference for E85 regardless of feedstock. The coefficient on the *Reduce* variable was insignificant suggesting that overall consumers have no preference for GHG reducing fuels that can provide emissions reductions greater than what E10 can provide. Again, this could be because E10 already provides a percentage of emissions reductions in a fuel product. In terms of interaction variables in the E10 version, *Male*, *Lowpce*, and *Nat3* were all significant and negative as expected. The *Fiohi* variable was positive and significant which was also expected.

All of the fuel attribute coefficients in the E0 version were as expected and significant including the *Reduce* variable. Again, overall it appears that when consumers are faced with a fuel option that offers no reduction in emissions, they are more likely to prefer an option that does offer emissions reductions. According to significant interaction variables, it appears overall that men, those over age forty-five, those with incomes over $100,000, those with low PCE, and those that believe that farmland should be used for food not fuel are all less likely to prefer to reduce GHG emissions through E85 when compared with their respective base case and given E0 as the 'no E85' alternative. Overall, those who were familiar with GHG's were more likely to prefer to reduce emissions through E85 purchases than those who were not familiar.

In terms of WTP for GHG emissions reductions through E85 purchases the estimated mean WTP for each percentage reduction is about 0.0063 cents per mile (0.13 cents per gallon) and is significant. This is similar to findings by Jensen, et al. 2010. For the E0 version, the estimated WTP is also significant and is about 0.0088 cents per mile (.18 cents per gallon).

Discussion

Results from this study reveal that in general consumers are willing to pay for reductions in greenhouse gas emissions through purchases of E85. The overall mean estimated WTP is 0.18 cents per gallon and .13 cents per gallon, and is significant when compared to both E0 and E10 respectively. Variation between clusters ranges from a high mean WTP of 0.49 cents per gallon to insignificant to a low of -0.61 per gallon. There were significant differences in these WTP values, which suggest that segmenting the sample would be beneficial in target marketing strategies. In addition, demographics and attitudes that significantly affected WTP were different across clusters and survey versions.

Consumers in the Potential Activist cluster with an income from $0 to $24,999 were willing to pay more for GHG emissions reductions; the same income group in the Environmental cluster was willing to pay less. The income variable was quite inconsistent across survey versions and clusters. Klineberg, McKeever, and Rothenbach's work on demographic predictors of environmental concern may offer some insight on this (1998). Their study finds that income has significant effects in measuring willingness to *accept* higher costs for goods and the frequency of pro-environmental behaviors. They also go on to say that environmental concern is associated with many potential tradeoffs that could essentially lead to inconsistency in responses (Klineberg, McKeever, and Rothenbach 1998). Further research should investigate these

inconsistencies and try to understand and account for them. A cluster analysis based on income might be a place to start for this.

In general, those with low PCE were willing to pay less than those with high PCE for reductions in GHG emissions via fuel purchases. This result was expected. Similarly, high FIO resulted in a higher willingness to pay for GHG reductions overall. This was also expected and provides a potential opportunity by which alternative fuels and related research could be marketed to these consumers who feel that. Further research could look at PCE in detail and determine the best means to market the idea of environmental improvement to an individual who is doubtful of the impact of their personal actions. As was found in this cluster analysis, consumers with low PCE often have high FIO. Presenting an E85 fuel purchase as a means of supporting GHG emissions research may be a way to capitalize on the beliefs of these consumers in the fuel market.

In general, females and those familiar with GHG's were willing to pay more for emissions reductions than males and those who were unfamiliar with GHG emissions. In the case of the National Security cluster, those familiar with GHG's were WTP less for emissions reductions through E85 purchases than those who were familiar. Additionally, those in the National Security cluster who were familiar with climate change were WTP more than those in the same cluster who were unfamiliar. In fact, the *Clc* variable was insignificant overall and in all clusters other than National Security in its effects on WTP. This result suggests that, overall, consumers may not be convinced of the role that E85 plays in mitigating climate change. Additionally, familiarity with GHG emissions only positively affected WTP in the E0 survey versions. Consumers may feel that since E10 already provides some emissions reductions,

additional reductions provide less utility relative to the cost. Additional research to look at various levels of ethanol blends other than E85 may shed some light on this relationship.

The advantage of segmentation becomes clear as these differences emerge between clusters. Marketing plans that focus on a general population lose the advantage of segment-specific consumer characteristics that can provide valuable insight into consumer preferences and needs. When products have multiple attributes that appeal differently to consumers it is possible to market the products in such a way as to appeal to a variety of preferences.

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Appendix

Table 3.1 Variable names and definitions

Variable Name	Definition
Dependent Variable:	
Chosen	1 if the alternative is chosen, 0 otherwise
Explanatory Product Attribute Variables:	
Price	6.7, 7.1, 7.5, 7.9, and 8.3 cents per mile
Import	10%, 33%, 50%, and 60% imported
Reduce	0%, 10%, 50%, and 73% GHG emissions reductions compared with either E10 or E0
Inconvenience	0, 2, or 5 minutes out of the way
E85Corn	1 if feedstock is corn grain, 0 otherwise
E85Grass	1 if feedstock is switchgrass, 0 otherwise
E85Wood	1 if feedstock is wood wastes, 0 otherwise
Explanatory Demographic Variables Interacted with Reduce Variable:	
Age	1 if over 45, 0 otherwise
Male	1 if male, 0 otherwise
Income1	1 if income is $0-$24,999, 0 otherwise
Income2	1 if income is $25,000-$49,999, 0 otherwise
Income4	1 if income is over $100,000, 0 otherwise
Black	1 if ethnicity is black, 0 otherwise
Hisp	1 if ethnicity is Hispanic, 0 otherwise
Otheth	1 if ethnicity is other or 2+races non-hispanic, 0 otherwise
Explanatory Attitude Variables Interacted with Reduce Variable:	
Clc	Familiarity with climate change (1 if not at all familiar, 2 if somewhat familiar, 3 if very familiar)
Lowpce	1 if at least somewhat agree with the statements "I don't have enough information to make well-informed decisions on environmental issues" and "My personal actions don't have any significant effect on the quality of the environment", 0 otherwise
Fiohi	1 if at least somewhat agree with the statement "Science and technology will come up with ways to solve environmental damage and pollution", 0 if otherwise

Ff	1 if at least somewhat agree with the statement "U.S. farmland should be used for producing food and not fuel", 0 otherwise
Nat3	1 if at least somewhat agree with the statement "More land in the U.S. should be opened up for oil drilling," 0 if otherwise
Fameth	1 if at least somewhat familiar with ethanol, 0 otherwise
Ghg	Familiarity with greenhouse gases (1 if not at all familiar, 2 if somewhat familiar, 3 if very familiar)

Table 3.2 Variable means and hypothesized signs by cluster

Variable	Potential Activist	Environmental	Neutral	National Interest	Overall
Chosen	NA[a] (.25)	NA (.25)	NA (.25)	NA (.25)	NA (.25)
Price	- (7.26)	- (7.27)	- (7.27)	- (7.28)	- (7.27)
Import	- (39.09)	- (39.09)	- (39.12)	- (38.99)	- (39.08)
Reduce	+ (33.21)	+ (33.26)	+ (33.31)	+ (33.23)	+ (33.25)
Inconvenience	- (2.24)	- (2.25)	- (2.25)	- (2.25)	- (2.25)
E85Corn	+ (.25)	+ (.25)	+ (.25)	+ (.25)	+ (.25)
E85Grass	+ (.25)	+ (.25)	+ (.25)	+ (.25)	+ (.25)
E85Wood	+ (.25)	+ (.25)	+ (.25)	+ (.25)	+ (.25)
Age	- (.55)	- (.47)	- (.42)	- (.67)	- (.51)
Male	- (.46)	- (.48)	- (.46)	- (.64)	- (.49)
Income1	- (.20)	- (.17)	- (.23)	- (.12)	- (.19)
Income2	- (.31)	- (.25)	- (.34)	- (.27)	- (.30)
Income4	+ (.13)	+ (.18)	+ (.12)	+ (.21)	+ (.15)
Black	- (.07)	- (.06)	- (.17)	- (.03)	- (.09)
Hisp	- (.13)	- (.13)	- (.12)	- (.12)	- (.11)
Otheth	- (.05)	- (.09)	- (.06)	- (.03)	- (.06)
ClimateChange	+ (1.88)	+ (2.35)	+ (1.59)	+ (2.22)	+ (1.96)
LowPCE	- (.73)	- (.23)	- (.39)	- (.53)	- (.48)
FoodVSFuel	- (.41)	- (.49)	- (.13)	- (.69)	- (.39)
HighFIO	+ (.53)	+ (.43)	+ (.20)	+ (.54)	+ (.42)
NationalSecurity	- (.71)	- (.21)	- (.29)	- (.96)	- (.50)
Ghg	+ (1.72)	+ (2.17)	+ (1.49)	+ (2.14)	+ (1.83)

[a]Not applicable

Table 3.3 Estimated Models of WTP for GHG Emissions Reductions (E10 Survey Potential Activist)[a]

	Conditional Fixed Parameters Logits				Random Parameters Logits			
	Model 1: Attributes		Model 2: Interactions		Model 3: Attributes		Model 4: Interactions	
Variable	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z
Price	-0.9154	-16.25***	-0.9352	-16.37***	-1.3393	-10.32***	-1.3440	-10.42***
Import	-0.0294	-16.16***	-0.0300	-16.34***	-0.0463	-8.17***	-0.0458	-8.38***
Reduce	0.0059	5.26***	0.0098	2.18**	0.0085	3.89***	0.0151	2.04**
Inconvenience	-0.1852	-12.82***	-0.1879	-12.82***	-0.2706	-7.89***	-0.2681	-7.81***
E85Corn	0.3682	2.88**	0.3903	3.06**	0.7805	3.09**	0.7573	2.93**
E85Grass	0.5098	4.21***	0.5349	4.41***	1.0352	4.22***	1.0363	4.23***
E85Wood	0.3606	2.90**	0.3742	3.00	0.2472	3.28***	0.8159	3.27***
*Repub*reduce*			0.0012	3.00**			-0.0006	-0.15
*Politothe*reduce*			0.0080	1.48			0.0072	0.59
*Over45*reduce*			0.0039	1.89*			0.0022	0.61
*Male*reduce*			0.0011	0.49			0.0009	0.25
*Black*reduce*			-0.0036	-0.88			-0.0027	-0.25
*Hisp*reduce*			-0.0072	-2.02**			-0.0139	-2.33**
*Otheth*reduce*			0.0065	1.21			0.0048	0.68
*Income1*reduce*			0.0074	2.55**			0.0104	2.02**
*Income2*reduce*			0.0058	2.48**			0.0076	1.58
*Income4*reduce*			0.0046	1.57			0.0056	0.98
*Clc*reduce*			-0.0025	-0.94			-0.0006	-0.08
*Lowpce*reduce*			-0.0074	-5.34***			-0.0088	-3.95***
*Fiohi*reduce*			-0.0002	-0.12			0.0018	0.52
*Ff*reduce*			-0.0052	-2.60**			-0.0054	-1.63*
*Nat3*reduce*			-0.0060	-2.50**			-0.0084	-1.98**
*Fameth*reduce*			-0.0002	-0.09			0.0001	0.01
*Ghg*reduce*			0.0037	1.46			0.0018	0.27
Standard Deviations:								
Import					0.0565	9.23***	0.0559	9.43***
Reduce					-0.0212	-8.54***	0.0178	7.30***
Inconvenience					0.2807	7.56***	0.2896	7.06***
E85Corn					1.1355	5.82***	1.1350	5.90***
E85Grass					-0.6197	-5.15***	-0.5797	-4.79***
E85Wood					-0.5186	-3.43***	-0.5180	-3.86***
Log Likelihood	-3330.8341		-3328.9851		-2889.3361		-2865.9228	

[a] *, **, *** represent significance levels of 0.10, 0.05, 0.01, respectively

Table 3.4 Estimated Models of WTP for GHG Emissions Reductions (E0 Survey Potential Activist)[a]

	Conditional Fixed Parameters Logits				Random Parameters Logits			
	Model 1: Attributes		Model 2: Interactions		Model 3: Attributes		Model 4: Interactions	
Variable	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z
Price	-1.0008	-17.28***	-1.0250	-17.46***	-1.5182	-11.42***	-1.5209	-11.52***
Import	-0.0237	-12.78***	-0.0242	-12.82***	-0.0258	-4.49***	-0.0238	-3.55***
Reduce	0.0696	6.23***	0.0114	2.53**	0.0109	5.38***	0.0201	2.63**
Inconvenience	-0.1517	-10.40***	-0.1522	-10.42***	-0.2529	-7.75***	-0.2473	-7.93***
E85Corn	-0.5251	-4.21***	-0.5108	-4.09***	0.6535	2.46**	0.6203	2.28**
E85Grass	-0.1626	-1.34	-0.1600	-1.31	1.1209	4.14***	1.1136	4.13***
E85Wood	-0.3363	-2.73**	-0.3309	-2.68**	0.9454	3.33***	0.9552	3.40***
*Repub*reduce*			-0.0016	-0.78			0.0012	0.29
*Politothe*reduce*			0.0008	0.15			0.0075	0.65
*Over45*reduce*			-0.0037	-1.88*			-0.0079	-2.03**
*Male*reduce*			-0.0041	-2.14**			-0.0049	-1.22
*Black*reduce*			0.0063	1.48			0.0062	0.71
*Hisp*reduce*			0.0056	1.70*			0.0025	0.50
*Otheth*reduce*			0.0070	1.79*			-0.0008	-0.11
*Income1*reduce*			0.0049	1.71*			0.0052	0.92
*Income2*reduce*			-0.0015	-0.68			0.0006	0.14
*Income4*reduce*			-0.0053	-1.76*			-0.0058	-0.72
*Clc*reduce*			0.0035	1.25			0.0012	0.21
*Lowpce*reduce*			-0.0062	-4.65***			-0.0084	-2.75**
*Fiohi*reduce*			0.0036	1.82*			0.0030	0.73
*Ff*reduce*			-0.0027	-1.45			-0.0040	-0.99
*Nat3*reduce*			0.0039	1.91*			0.0021	0.47
*Fameth*reduce*			-0.0026	-1.14			-0.0031	-0.68
*Ghg*reduce*			-0.0027	-0.98			-0.0003	-0.06
Standard Deviations:								
Import					0.0800	6.94***	0.0795	7.08***
Reduce					-0.0196	-8.11***	-0.0167	-6.34***
Inconvenience					0.2551	6.39***	0.2537	6.64***
E85Corn					0.9723	6.17***	0.9951	5.35***
E85Grass					-1.0853	-5.82***	1.0730	5.33***
E85Wood					0.7058	3.64***	0.6190	3.12***
Log Likelihood	-3381.1375		-3328.9851		-2655.2046		-2640.1532	

[a] *, **, *** represent significance levels of 0.10, 0.05, 0.01, respectively

Table 3.5 Estimated Models of WTP for GHG Emissions Reductions (E10 Survey Environmental)[a]

	Conditional Fixed Parameters Logits				Random Parameters Logits			
	Model 1: Attributes		Model 2: Interactions		Model 3: Attributes		Model 4: Interactions	
Variable	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z
Price	-0.8064	-12.37***	-0.8135	-12.38***	-1.2716	-9.47***	-1.2983	-9.49***
Import	-0.0293	-14.75***	-0.0300	-14.60***	-0.0455	-7.36***	-0.0489	-7.60***
Reduce	0.0152	11.73***	0.0175	2.89**	0.0245	6.89***	0.0237	1.44
Inconvenience	-0.1419	-8.72***	-0.1425	-8.66***	-0.2404	-5.77***	-0.2359	-5.90***
E85Corn	-0.2266	-1.27	-0.2061	-1.18	-0.1770	-0.41	-0.1927	-0.46
E85Grass	0.5518	3.19***	0.5900	3.55***	1.2450	2.67**	1.3132	3.13**
E85Wood	0.3297	1.92*	0.3717	2.24**	0.7922	1.65*	0.8649	2.04**
*Repub*reduce*			-0.0062	-2.43**			-0.0054	-0.74
*Politothe*reduce*			-0.0201	-3.52***			-0.0263	-2.64**
*Over45*reduce*			0.0023	0.99			-0.0012	-0.22
*Male*reduce*			-0.0009	-0.40			-0.0017	-0.26
*Black*reduce*			-0.0032	-0.50			0.0049	0.26
*Hisp*reduce*			-0.0009	-0.21			-0.0127	-1.32
*Otheth*reduce*			-0.0048	-1.05			-0.0026	-0.19
*Income1*reduce*			-0.0092	-2.87**			-0.0127	-1.75*
*Income2*reduce*			-0.0024	-0.80			-0.0009	-0.12
*Income4*reduce*			0.0042	1.32			0.0117	1.47
*Clc*reduce*			0.0078	2.36**			0.0099	0.77
*Lowpce*reduce*			-0.0085	-3.12**			-0.0112	-1.56
*Fiohi*reduce*			0.0049	2.06**			0.0061	0.91
*Ff*reduce*			-0.0011	-0.47			0.0020	0.32
*Nat3*reduce*			0.0007	0.24			0.0007	0.08
*Fameth*reduce*			-0.0062	-1.92*			-0.0121	-1.45
*Ghg*reduce*			-0.0046	-1.43			-0.0028	-0.23
Standard Deviations:								
Import					0.0590	9.48***	-0.0598	-8.49***
Reduce					0.0306	7.84***	0.0274	7.17***
Inconvenience					0.3103	7.28***	0.3002	8.04***
E85Corn					-1.8633	-5.48***	1.7569	6.01***
E85Grass					0.3944	1.55	0.5589	2.14**
E85Wood					-0.5338	-2.23**	-0.6166	-3.24***
Log Likelihood	-2471.47		-2410.15		-2063.86		-2041.49	

[a] *, **, *** represent significance levels of 0.10, 0.05, 0.01, respectively

Table 3.6 Estimated Models of WTP for GHG Emissions Reductions (E0 Survey Environmental)[a]

	Conditional Fixed Parameters Logits				Random Parameters Logits			
	Model 1: Attributes		Model 2: Interactions		Model 3: Attributes		Model 4: Interactions	
Variable	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z
Price	-0.7348	-12.50***	-0.7477	-12.66***	-1.2024	-10.16***	-1.2261	-10.27***
Import	-0.0193	-10.18***	-0.0198	-10.26***	-0.0274	-5.31***	-0.0286	-5.57***
Reduce	0.0172	14.24***	0.0108	2.12**	0.0300	8.63***	0.0244	1.97**
Inconvenience	-0.1336	-8.64***	-0.1354	-8.60***	-0.2259	-7.16***	-0.2290	-7.86***
E85Corn	-0.2682	-1.87*	-0.2274	-1.59	0.4300	1.44	0.4121	1.34
E85Grass	0.1757	1.29	0.2125	1.57	1.3212	4.41***	1.3062	4.02***
E85Wood	-0.0403	-0.29	-0.0017	-0.01	0.9685	3.05**	0.9600	2.92**
*Repub*reduce*			-0.0053	-2.15**			-0.0041	-0.56
*Politothe*reduce*			-0.0087	-1.57			-0.0029	-0.20
*Over45*reduce*			-0.0057	-2.66**			-0.0055	-0.87
*Male*reduce*			-0.0011	-0.48			-0.0056	-0.87
*Black*reduce*			-0.0169	-4.24***			-0.0264	-3.29***
*Hisp*reduce*			0.0027	0.62			0.0072	0.62
*Otheth*reduce*			-0.0021	-0.52			-0.0006	-0.08
*Income1*reduce*			0.0004	0.12			-0.0014	-0.19
*Income2*reduce*			-0.0054	-1.85*			-0.0049	-0.57
*Income4*reduce*			-0.0082	-3.01**			-0.0142	-2.01**
*Clc*reduce*			-0.0003	-0.08			-0.0076	-0.80
*Lowpce*reduce*			0.0018	0.74			-0.0023	-0.40
*Fiohi*reduce*			-0.0033	-1.50			-0.0019	-0.31
*Ff*reduce*			-0.0083	-3.55***			-0.0135	-2.20**
*Nat3*reduce*			-0.0015	-0.53			-0.0010	-0.12
*Fameth*reduce*			-0.0016	-0.56			0.0059	0.78
*Ghg*reduce*			0.0106	3.67***			0.0174	2.16**
Standard Deviations:								
Import					-0.0557	-8.73***	0.0566	8.92***
Reduce					0.0315	8.81***	0.0296	9.17***
Inconvenience					0.2475	6.51***	0.2440	6.77***
E85Corn					-1.5417	-7.34***	1.6404	7.33***
E85Grass					-0.9394	-4.41***	0.9354	5.00***
E85Wood					0.7939	3.94***	0.9237	4.83***
Log Likelihood	-2336.70		-2276.07		-1886.81		-1868.59	

[a] *, **, *** represent significance levels of 0.10, 0.05, 0.01, respectively

Table 3.7 Estimated Models of WTP for GHG Emissions Reductions (E10 Survey Neutral)[a]

	Conditional Fixed Parameters Logits				Random Parameters Logits			
	Model 1: Attributes		Model 2: Interactions		Model 3: Attributes		Model 4: Interactions	
Variable	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z
Price	-1.0323	-15.45***	-1.0618	-15.51***	-1.4339	-10.23***	-1.4330	-10.54***
Import	-0.0216	-10.75***	-0.0220	-10.78***	-0.0280	-5.19***	-0.0290	-5.73***
Reduce	0.0016	1.28	-0.0051	-1.16	0.0014	0.65	-0.0039	-0.71
Inconvenience	-0.1460	-8.73***	-0.1509	-8.86***	-0.2203	-5.84***	-0.2161	-6.31***
E85Corn	0.4953	3.65***	0.5338	3.91***	1.0200	4.03***	1.0118	4.03***
E85Grass	0.6133	4.54***	0.6611	4.89***	1.2329	4.61***	1.2406	4.68***
E85Wood	0.5253	3.89***	0.5718	4.21***	1.1237	4.01***	1.1210	4.08***
*Repub*reduce*			0.0038	1.56			0.0027	0.68
*Politothe*reduce*			0.0013	0.23			-0.0031	-0.39
*Over45*reduce*			-0.0097	-4.30***			-0.0084	-2.43**
*Male*reduce*			-0.0020	-0.91			-0.0039	-1.24
*Black*reduce*			-0.0062	-1.80*			-0.0046	-0.97
*Hisp*reduce*			0.0046	1.12			0.0042	0.67
*Otheth*reduce*			-0.0075	-1.77*			-0.0041	-0.72
*Income1*reduce*			-0.0003	-0.10			-0.0049	-0.93
*Income2*reduce*			0.0137	4.42***			0.0131	2.90**
*Income4*reduce*			0.0079	2.42***			0.0042	0.82
*Clc*reduce*			-0.0025	-0.80			-0.0027	-0.53
*Lowpce*reduce*			0.0040	2.07**			0.0048	1.70*
*Fiohi*reduce*			0.0097	3.37***			0.0130	2.98**
*Ff*reduce*			-0.0067	-2.26**			-0.0075	-1.93**
*Nat3*reduce*			-0.0005	-0.21			-0.0022	-0.64
*Fameth*reduce*			0.0002	0.10			0.0010	0.29
*Ghg*reduce*			0.0040	1.19			0.0042	0.70
Standard Deviations:								
Import					-0.0534	-7.44***	0.0527	8.56***
Reduce					0.0158	6.55***	0.0115	4.56***
Inconvenience					0.2829	6.24***	0.2886	6.17***
E85Corn					-0.8281	-4.81***	0.8406	4.79***
E85Grass					0.7044	2.73**	0.6657	2.67**
E85Wood					0.6307	3.63***	0.6843	4.33***
Log Likelihood	-2934.82		-2862.06		-2572.85		-2542.24	

[a] *, **, *** represent significance levels of 0.10, 0.05, 0.01, respectively

Table 3.8 Estimated Models of WTP for GHG Emissions Reductions (E0 Survey Neutral)[a]

	Conditional Fixed Parameters Logits				Random Parameters Logits			
	Model 1: Attributes		Model 2: Interactions		Model 3: Attributes		Model 4: Interactions	
Variable	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z
Price	-0.9752	-13.79***	-0.9890	-13.54***	-1.4537	-8.94***	-1.4470	-8.94***
Import	-0.0126	-5.79***	-0.0123	-5.59***	-0.0044	-0.63	-0.0036	-0.25
Reduce	0.0072	5.02***	0.0101	2.57**	0.0074	3.80***	0.0118	1.61
Inconvenience	-0.1706	-9.26***	-0.1728	-9.16***	-0.2664	-5.02***	-0.2616	-4.89***
E85Corn	-0.3776	-2.76*	-0.3049	-2.23**	0.6215	2.69**	0.6257	2.68**
E85Grass	-0.5371	-4.03***	-0.4718	-3.56***	0.4678	1.85*	0.4729	1.84*
E85Wood	-0.5466	-3.85***	-0.4700	-3.33**	0.5030	2.25**	0.5064	2.21**
*Repub*reduce*			0.0029	1.31			-0.0001	-0.02
*Politothe*reduce*			-0.0076	-1.68*			-0.0013	-0.14
*Over45*reduce*			-0.0072	-3.42***			-0.0032	-0.65
*Male*reduce*			-0.0014	-0.65			-0.0008	-0.19
*Black*reduce*			0.0057	1.70*			-0.0037	-0.54
*Hisp*reduce*			0.0086	2.08**			0.0007	0.10
*Otheth*reduce*			-0.0025	-0.50			0.0025	0.44
*Income1*reduce*			-0.0134	-4.87***			-0.0123	-2.26**
*Income2*reduce*			-0.0052	-2.01**			-0.0031	-0.52
*Income4*reduce*			-0.0027	-0.89			-0.0096	-1.57
*Clc*reduce*			-0.0072	-2.58**			-0.0079	-1.48
*Lowpce*reduce*			0.0027	1.55			0.0017	0.43
*Fiohi*reduce*			0.0028	0.99			-0.0009	-0.18
*Ff*reduce*			-0.0033	-1.15			-0.0029	-0.50
*Nat3*reduce*			-0.0002	-0.09			0.0048	0.87
*Fameth*reduce*			-0.0086	-3.61***			-0.0094	-2.32**
*Ghg*reduce*			0.0128	4.43***			0.0127	2.01**
Standard Deviations:								
Import					0.0807	6.08***	0.076	4.43***
Reduce					-0.0121	-3.63***	0.013	3.35***
Inconvenience					0.3505	5.52***	0.348	5.04***
E85Corn					1.2988	4.41***	1.337	3.74***
E85Grass					-0.6345	-3.01**	0.625	2.70**
E85Wood					0.1844	1.54	-0.057	-0.56
Log Likelihood	-2781.81		-2703.53		-2161.06		-2146.34	

[a] *, **, *** represent significance levels of 0.10, 0.05, 0.01, respectively

Table 3.9 Estimated Models of WTP for GHG Emissions Reductions (E10 Survey National Interest)[a]

	Conditional Fixed Parameters Logits				Random Parameters Logits			
	Model 1: Attributes		Model 2: Interactions		Model 3: Attributes		Model 4: Interactions	
Variable	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z
Price	-1.3785	-14.52***	-1.4088	-14.40***	-2.3255	-7.28***	-2.3654	-8.02***
Import	-0.0248	-9.33***	-0.0263	-9.59***	-0.0258	-1.45	-0.0283	-2.14**
Reduce	0.0019	1.17	0.0508	3.17**	0.0038	1.71	0.0213	1.13
Inconvenience	-0.1738	-8.04***	-0.1778	-7.91***	-0.2823	-4.55***	-0.3002	-4.78***
E85Corn	-0.1622	-0.93	-0.1185	-0.68	0.4092	1.05	0.2903	0.70
E85Grass	0.0859	0.50	0.1573	0.93	1.1950	3.84***	1.2231	4.06***
E85Wood	0.2297	1.32	0.3014	1.76*	1.3322	3.68***	1.3735	4.07***
*Repub*reduce*			-0.0042	-0.91			-0.0026	-0.42
*Politothe*reduce*			-0.0373	-3.62***			-0.0304	-1.59
*Over45*reduce*			-0.0083	-3.00**			0.0005	0.12
*Male*reduce*			-0.0105	-3.39***			-0.0103	-2.22**
*Black*reduce*			0.0033	0.29			-0.0121	-1.43
*Hisp*reduce*			0.0127	1.77			0.0002	0.03
*Otheth*reduce*			0.0276	2.78			0.0190	2.27**
*Income1*reduce*			0.0164	3.84			0.0164	2.38**
*Income2*reduce*			-0.0040	-1.14			-0.0087	-1.58
*Income4*reduce*			0.0024	0.66			-0.0013	-0.24
*Clc*reduce*			0.0030	0.72			0.0099	1.82*
*Lowpce*reduce*			-0.0024	-1.07			-0.0040	-1.46
*Fiohi*reduce*			0.0077	2.72**			0.0032	0.78
*Ff*reduce*			0.0075	2.46**			0.0037	0.83
*Nat3*reduce*			-0.0326	-2.42**			-0.0100	-0.65
*Fameth*reduce*			0.0002	0.04			-0.0024	-0.36
*Ghg*reduce*			-0.0090	-2.18**			-0.0098	-2.12**
Standard Deviations:								
Import					0.1149	3.33***	0.1123	4.23***
Reduce					-0.0055	-0.21	0.0029	0.92
Inconvenience					0.3879	4.90***	0.3867	6.53***
E85Corn					1.8073	6.07***	1.9165	6.62***
E85Grass					-0.3530	-0.84	-0.1963	-0.97
E85Wood					-1.0239	-3.29***	1.0056	3.51***
Log Likelihood	-1350.0578		-1294.7876		-1021.0333		-1003.2942	

[a] *, **, *** represent significance levels of 0.10, 0.05, 0.01, respectively

Table 3.10 Estimated Models of WTP for GHG Emissions Reductions (E0 Survey National Interest)[a]

	Conditional Fixed Parameters Logits				Random Parameters Logits			
	Model 1: Attributes		Model 2: Interactions		Model 3: Attributes		Model 4: Interactions	
Variable	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z
Price	-1.4423	-14.55***	-1.5422	-14.96***	-2.8990	-8.85***	-2.7755	-9.07***
Import	-0.0231	-7.44***	-0.0245	-7.39***	0.0104	0.53	0.0227	0.55
Reduce	0.0035	1.77*	0.0191	1.93**	0.0051	1.59	0.0003	0.01
Inconvenience	-0.2038	-8.14***	-0.2108	-8.01***	-0.3668	-4.95***	-0.3363	-4.51***
E85Corn	-1.7018	-9.11***	-1.6891	-8.62***	-1.1729	-1.96**	-0.9861	-1.34
E85Grass	-1.1107	-6.41***	-1.0630	-5.87***	0.4533	1.25	0.5829	1.67*
E85Wood	-1.0297	-5.93***	-0.9608	-5.26***	0.6367	2.10**	0.7026	2.19**
*Repub*reduce*			-0.0062	-0.99			-0.0087	-0.71
*Politothe*reduce*			0.0152	1.04			0.0152	0.72
*Over45*reduce*			0.0027	0.88			0.0054	0.52
*Male*reduce*			-0.0060	-1.95**			0.0029	0.34
*Black*reduce*			0.0147	1.52			0.0473	1.17
*Hisp*reduce*			-1.4906	-42.86***			-3.3770	-7.57***
*Otheth*reduce*			-0.0406	-4.15***			-0.0350	-1.21
*Income1*reduce*			0.0027	0.45			0.0053	0.31
*Income2*reduce*			0.0038	1.09			-0.0038	-0.47
*Income4*reduce*			-0.0014	-0.42			-0.0011	-0.11
*Clc*reduce*			-0.0148	-3.47***			-0.0101	-1.03
*Lowpce*reduce*			-0.0062	-2.60**			-0.0069	-1.05
*Fiohi*reduce*			0.0010	0.36			-0.0085	-0.99
*Ff*reduce*			-0.0174	-5.82***			-0.0087	-1.32
*Nat3*reduce*			0.0163	2.62**			0.0189	1.31
*Fameth*reduce*			-0.0028	-0.51			0.0060	0.49
*Ghg*reduce*			0.0113	2.46**			0.0088	0.94
Standard Deviations:								
Import					0.1484	7.95***	0.1456	5.11***
Reduce					0.0173	4.78***	-0.0120	-1.62
Inconvenience					0.4260	5.26***	0.3783	5.13***
E85Corn					-2.0880	-4.06***	1.8362	2.94**
E85Grass					-0.8072	-2.77**	0.5597	2.06**
E85Wood					-0.0114	-0.08	0.2254	0.72
Log Likelihood	-1122.6790		-1052.4723		-716.9564		-710.1993	

[a] *, **, *** represent significance levels of 0.10, 0.05, 0.01, respectively

Table 3.11 Estimated Models of WTP for GHG Emissions Reductions (E10 Survey Overall)[a]

	Conditional Fixed Parameters Logits				Random Parameters Logits			
	Model 1: Attributes		Model 2: Interactions		Model 3: Attributes		Model 4: Interactions	
Variable	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z
Price	-0.9660	-28.91***	-0.970	-28.91***	-1.4462	-19.11***	-1.4498	-19.11***
Import	-0.0262	-25.58***	-0.026	-25.52***	-0.0394	-12.55***	-0.0400	-12.48***
Reduce	0.0064	9.94***	0.004	1.43	0.0093	7.03***	0.0060	1.26
Inconvenience	-0.1597	-19.20***	-0.162	-19.38***	-0.2466	-12.83***	-0.2473	-12.78***
E85Corn	0.1859	2.50	0.201	2.70**	0.5538	3.45***	0.5644	3.48***
E85Grass	0.4861	6.74***	0.505	7.00***	1.1450	7.35***	1.1440	7.27***
E85Wood	0.3766	5.20***	0.392	5.41***	0.9337	5.73***	0.9383	5.74***
*Repub*reduce*			-0.003	-2.15**			-0.0042	-1.49
*Politothe*reduce*			-0.004	-1.21			-0.0056	-0.72
*Over45*reduce*			-0.001	-0.90			-0.0021	-0.81
*Male*reduce*			-0.004	-3.59***			-0.0058	-2.34**
*Black*reduce*			-0.006	-2.68**			-0.0068	-1.36
*Hisp*reduce*			-0.001	-0.58			-0.0064	-1.44
*Otheth*reduce*			-0.001	-0.42			-0.0016	-0.30
*Income1*reduce*			0.000	-0.21			-0.0032	-0.84
*Income2*reduce*			0.003	2.07**			0.0026	0.83
*Income4*reduce*			0.004	2.63**			0.0034	0.97
*Clc*reduce*			0.002	1.28			0.0027	0.58
*Lowpce*reduce*			-0.003	-2.85**			-0.0038	-2.20**
*Fiohi*reduce*			0.007	5.50***			0.0089	3.22***
*Ff*reduce*			-0.002	-1.68*			-0.0022	-0.87
*Nat3*reduce*			-0.003	-2.72**			-0.0053	-1.95**
*Fameth*reduce*			0.001	0.94			0.0016	0.53
*Ghg*reduce*			0.001	0.88			0.0029	0.65
Standard Deviations:								
Import					0.0592	15.05***	0.0595	15.14***
Reduce					-0.0222	-13.78***	0.0202	11.61***
Inconvenience					0.2991	12.91***	0.2983	13.10***
E85Corn					1.3592	10.52***	1.3445	11.79***
E85Grass					-0.5293	-4.46***	-0.5899	-4.74***
E85Wood					-0.6293	-7.17***	-0.6484	-7.02***
Log Likelihood	-10256.5260		-10166.8410		-8697.2663		-8654.2599	

[a] *, **, *** represent significance levels of 0.10, 0.05, 0.01, respectively

Table 3.12 Estimated Models of WTP for GHG Emissions Reductions (E0 Survey Overall)[a]

	Conditional Fixed Parameters Logits				Random Parameters Logits			
	Model 1: Attributes		Model 2: Interactions		Model 3: Attributes		Model 4: Interactions	
Variable	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z	Est. Coeff.	Z
Price	-0.9538	-28.32***	-0.9659	-28.37***	-1.4976	-18.74***	-1.4933	-18.70***
Import	-0.0191	-17.92***	-0.0193	-17.93***	-0.0161	-4.10***	-0.0193	-6.05***
Reduce	0.0093	13.79***	0.0126	5.62***	0.0129	9.38***	0.0151	2.81**
Inconvenience	-0.1548	-17.79***	-0.1553	-17.69***	-0.2557	-11.86***	-0.2553	-12.02***
E85Corn	-0.6154	-8.75***	-0.5961	-8.42***	0.3448	2.37**	0.3661	2.54**
E85Grass	-0.3613	-5.37***	-0.3413	-5.05***	0.8559	6.02***	0.8518	6.00***
E85Wood	-0.4734	-6.77***	-0.4501	-6.40***	0.7281	5.10***	0.7216	5.07***
*Repub*reduce*			-0.0053	-4.83***			-0.0068	-2.22**
*Politothe*reduce*			-0.0040	-1.40			0.0031	0.46
*Over45*reduce*			-0.0053	-4.86***			-0.0055	-1.92*
*Male*reduce*			-0.0039	-3.69***			-0.0049	-1.74*
*Black*reduce*			0.0002	0.11			-0.0036	-0.72
*Hisp*reduce*			0.0049	2.25**			0.0035	0.67
*Otheth*reduce*			-0.0004	- 0.17			0.0019	0.43
*Income1*reduce*			-0.0027	-1.70*			-0.0034	-0.81
*Income2*reduce*			-0.0024	-1.80*			-0.0030	-0.88
*Income4*reduce*			-0.0060	-4.08***			-0.0078	-1.99**
*Clc*reduce*			-0.0039	-2.53**			-0.0031	-0.73
*Lowpce*reduce*			-0.0019	-2.25**			-0.0038	-1.80*
*Fiohi*reduce*			0.0030	2.71**			0.0037	1.28
*Ff*reduce*			-0.0042	-3.80***			-0.0063	-2.18**
*Nat3*reduce*			-0.0014	-1.24			-0.0020	-0.63
*Fameth*reduce*			-0.0038	-2.79**			-0.0027	-0.85
*Ghg*reduce*			0.0097	6.24***			0.0112	2.69**
Standard Deviations:								
Import					0.0744	12.21***	0.0761	12.77***
Reduce					0.0253	12.26***	-0.0223	-12.39***
Inconvenience					0.2849	11.38***	0.2833	11.71***
E85Corn					1.3540	10.00***	-1.3574	-10.55***
E85Grass					0.8811	8.19***	0.9072	7.42***
E85Wood					0.5586	4.62***	0.5527	5.06***
Log Likelihood	-9879.4404		-9728.2849		-7614.0686		-7569.3227	

[a] *, **, *** represent significance levels of 0.10, 0.05, 0.01, respectively

Table 3.13 Estimated WTP for GHG Emissions Reductions (E0 Survey)[a]

	Conditional Fixed Parameters Logits				Random Parameters Logits			
	Model 1: Attributes		Model 2: Interactions		Model 3: Attributes		Model 4: Interactions	
Variable	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
Reduce 1	0.0070	0.0023***	0.0071	0.0023***	0.0072	0.0028**	0.0068	0.0026***
Reduce 2	0.0235	0.0048***	0.0166	0.0066	0.0250	0.0075***	0.0246	0.0073***
Reduce 3	0.0074	0.0030**	0.0077	0.0040	0.0051	0.0030**	0.0050	0.0031
Reduce 4	0.0025	0.0028	-0.1203	0.0174***	0.0018	0.0022	-0.0336	0.0106***
Overall	0.0098	0.0015***	0.0083	0.0016***	0.0086	0.0020***	0.0088	0.0019***
Import 1	-0.0237	0.0044***	-0.0236	0.0044***	-0.0170	0.008**	-0.0157	0.0095*
Import 2	-0.0263	0.0063***	-0.0265	0.0063***	-0.0228	0.0097**	-0.0234	0.0096**
Import 3	-0.0129	0.0049***	-0.0124	0.0048**	-0.0030	0.0098	-0.0025	0.0200
Import 4	-0.0160	0.0050***	-0.0159	0.0049***	0.0036	0.0136	0.0085	0.0292
Overall	-0.0200	0.0026***	-0.0200	0.0026***	-0.0107	0.0053**	-0.0129	0.0044***
Availability 1	-0.1515	0.0326***	-0.1485	0.0320	-0.1669	0.0482***	-0.1627	0.0472***
Availability 2	-0.1818	0.0493***	-0.1809	0.0497***	-0.1879	0.0615***	-0.1869	0.0579***
Availability 3	-0.1750	0.0442***	-0.1748	0.0447***	-0.1830	0.0814**	-0.1807	0.0842**
Availability 4	-0.1412	0.0372***	-0.1366	0.0366***	-0.1266	0.0453***	-0.1211	0.0476**
Overall	-0.1622	0.0205***	-0.1608	0.0206***	-0.1709	0.0323***	-0.1710	0.0317***
E85corn 1	-0.5269	0.2443**	-0.4994	0.2395**	0.4289	0.3380	0.4057	0.3490
E85corn 2	-0.3676	0.3852	-0.3053	0.3782	0.3559	0.4909	0.3335	0.5076
E85corn 3	-0.3901	0.2786	-0.3092	0.2763	0.4263	0.3139	0.4315	0.3226
E85corn 4	-1.1813	0.3100***	-1.0964	0.3008***	-0.4060	0.4064	-0.3547	0.5264
Overall	-0.6467	0.1466***	-0.6178	0.1459***	0.2290	0.1899	0.2446	0.1889
E85grass 1	-0.1635	0.2385	-0.1559	0.2312	0.7383	0.3445**	0.7336	0.3456**
E85grass 2	0.2380	0.3714	0.2844	0.3654	1.0991	0.5515**	1.0678	0.5755*
E85grass 3	-0.5510	0.2794**	-0.4764	0.2686*	0.3218	0.3510	0.3280	0.3561
E85grass 4	-0.7696	0.2583***	-0.6884	0.2448**	0.1568	0.2677	0.2110	0.2713
Overall	-0.3793	0.1388***	-0.3532	0.1362***	0.5717	0.1914***	0.5710	0.1899***
E85wood 1	-0.3367	0.2427	-0.3234	0.2356	0.6220	0.3624*	0.6266	0.3546*
E85wood 2	-0.0552	0.3806	-0.0037	0.3693	0.8046	0.5494	0.7852	0.5664
E85wood 3	-0.5611	0.2908*	-0.4747	0.2830*	0.3461	0.3057	0.3488	0.3165
E85wood 4	-0.7135	0.2607***	-0.6230	0.2491	0.2199	0.2269	0.2543	0.2526
Overall	-0.4965	0.1450***	-0.4660	0.1431	0.48589	0.1896**	0.4828	0.1880**

[a] *, **, *** represent significance levels of 0.10, 0.05, 0.01, respectively

Table 3.14 Estimated WTP for GHG Emissions Reductions (E10 Survey)[a]

	Conditional Fixed Parameters Logits				Random Parameters Logits			
	Model 1: Attributes		Model 2: Interactions		Model 3: Attributes		Model 4: Interactions	
Variable	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error
Reduce 1	0.0060	0.0025***	0.0065	0.0025***	0.0064	0.0037*	0.0064	0.0032**
Reduce 2	0.0188	0.0042***	0.0203	0.0045***	0.0193	0.0069***	0.0201	0.0076***
Reduce 3	0.0016	0.0024	0.0007	0.0025	0.0010	0.0030	0.0003	0.0025
Reduce 4	0.0014	0.0024	0.0007	0.0024	0.0016	0.0021	-0.0204	0.0303
Overall	0.0067	0.0014***	-0.0240	0.0055***	0.0064	0.0020***	0.0063	0.0018***
Import 1	-0.0322	0.0052***	-0.0321	0.0051***	-0.6467	0.0097***	-0.0340	0.0094***
Import 2	-0.0364	0.0075***	-0.0369	0.0077***	-0.0358	0.0131***	-0.0375	0.0135***
Import 3	-0.0209	0.0044***	-0.0207	0.0044***	-0.0196	0.0085**	-0.0202	0.0080**
Import 4	-0.0180	0.0044***	-0.0187	0.0046***	-0.0111	0.0165	-0.0119	0.0121
Overall	-0.0272	0.0026***	0.0068	0.0014***	-0.0273	0.0050***	-0.0276	0.0294***
Availability 1	-0.2023	0.0380***	-0.2009	0.0374***	-0.2019	0.0588***	-0.1994	0.0579***
Availability 2	-0.1760	0.0505***	-0.1752	0.0503***	-0.1890	0.0762**	-0.1817	0.0696***
Availability 3	-0.1413	0.0374***	-0.1421	0.0373***	-0.1535	0.0614**	-0.1511	0.0571***
Availability 4	-0.1260	0.0331***	-0.1261	0.0333***	-0.1213	0.0500**	-0.1265	0.0472***
Overall	-0.1652	0.0202***	-0.1635	0.0206***	-0.1704	0.0297***	-0.1706	0.0294***
E85corn 1	0.4011	0.2874	0.4177	0.2801	0.5824	0.3829	0.5620	0.3945
E85corn 2	-0.2829	0.4343	-0.2559	0.4216	-0.1455	0.6827	-0.1474	0.6534
E85corn 3	0.4783	0.2746*	0.5031	0.2691*	0.7093	0.3620**	0.7038	0.3601**
E85corn 4	-0.1188	0.2474	-0.0847	0.2432	0.1744	0.3371	0.1223	0.3546
Overall	0.1917	0.1530	0.2106	0.1527	0.3821	0.2163**	0.3877	0.2205*
E85grass 1	0.5565	0.2757**	0.5732	0.2710**	0.7724	0.3869**	0.7707	0.3867**
E85grass 2	0.6816	0.4423	0.7257	0.4292*	0.9862	0.7440	1.0141	0.6543
E85grass 3	0.5931	0.2762**	0.6231	0.2718**	0.8577	0.3870**	0.8651	0.3768**
E85grass 4	0.0618	0.2478	0.1114	0.2382	0.5125	0.3134*	0.5192	0.2958*
Overall	0.5027	0.1536***	0.5246	0.1537***	0.7915	0.2200***	0.7894	0.2247***
E85wood 1	0.3937	0.2745	0.3992	0.2703	0.6049	0.3716*	0.6076	0.3794
E85wood 2	0.4103	0.4277	0.4560	0.4095	0.6243	0.7515	0.6707	0.6549
E85wood 3	0.5085	0.2716*	0.5380	0.2672**	0.7827	0.4027**	0.7824	0.3901**
E85wood 4	0.1661	0.2514	0.2130	0.2418	0.5736	0.3397*	0.5840	0.3118*
Overall	0.3897	0.1502**	0.4071	0.1504***	0.6452	0.2241***	0.6477	0.2270***

[a] *, **, *** represent significance levels of 0.10, 0.05, 0.01, respectively

Table 3.15 Log-Likelihood Ratios Comparing Fixed and Random Parameters Logits for E10 Potential Activist[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Fixed Coefficients-Product Attributes Only	-3330.834	882.996***	6
Random Parameters-Product Attributes Only	-2889.336		
Fixed Coefficients-Products Attributes, Demographic and Attitudinal Variables	-3328.985	926.124***	6
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-2865.923		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.16 Log-Likelihood Ratios Comparing Fixed and Random Parameters Logits for E0 Potential Activist[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Fixed Coefficients-Product Attributes Only	-3381.138	1451.866***	6
Random Parameters-Product Attributes Only	-2655.205		
Fixed Coefficients-Products Attributes, Demographic and Attitudinal Variables	-3328.985	1377.664***	6
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-2640.153		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.17 Log-Likelihood Ratios Comparing Fixed and Random Parameters Logits for E10 Environmental[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Fixed Coefficients-Product Attributes Only	-2471.468	815.216***	6
Random Parameters-Product Attributes Only	-2063.860		
Fixed Coefficients-Products Attributes, Demographic and Attitudinal Variables	-2410.154	1377.664***	6
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-2041.494	737.321***	

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.18 Log-Likelihood Ratios Comparing Fixed and Random Parameters Logits for E0 Environmental[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Fixed Coefficients-Product Attributes Only	-2336.697	899.766***	6
Random Parameters-Product Attributes Only	-1886.814		
Fixed Coefficients-Products Attributes, Demographic and Attitudinal Variables	-2276.074	814.966***	6
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-1868.591		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.19 Log-Likelihood Ratios Comparing Fixed and Random Parameters Logits for E10 Neutral[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Fixed Coefficients-Product Attributes Only	-2934.820	723.947***	6
Random Parameters-Product Attributes Only	-2572.846		
Fixed Coefficients-Products Attributes, Demographic and Attitudinal Variables	-2862.064	639.648***	6
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-2542.240		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.20 Log-Likelihood Ratios Comparing Fixed and Random Parameters Logits for E0 Neutral[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Fixed Coefficients-Product Attributes Only	-2781.810	1241.501***	6
Random Parameters-Product Attributes Only	-2161.059		
Fixed Coefficients-Products Attributes, Demographic and Attitudinal Variables	-2703.527	1114.371***	6
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-2146.342		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.21 Log-Likelihood Ratios Comparing Fixed and Random Parameters Logits for E10 National Interest

Model	Log-Likelihood	Log-likelihood Ratio	df
Fixed Coefficients-Product Attributes Only	-1350.0578	658.049***	6
Random Parameters-Product Attributes Only	-1021.0333		
Fixed Coefficients-Products Attributes, Demographic and Attitudinal Variables	-1294.7876	582.987***	6
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-1003.2942		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.22 Log-Likelihood Ratios Comparing Fixed and Random Parameters Logits for E0 National Interest

Model	Log-Likelihood	Log-likelihood Ratio	df
Fixed Coefficients-Product Attributes Only	-1122.6790	811.445***	6
Random Parameters-Product Attributes Only	-716.9564		
Fixed Coefficients-Products Attributes, Demographic and Attitudinal Variables	-1052.4723	684.546***	6
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-710.1993		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.23 Log-Likelihood Ratios Comparing Fixed and Random Parameters Logits for E10 Overall[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Fixed Coefficients-Product Attributes Only	-10256.526	3118.519***	6
Random Parameters-Product Attributes Only	-8697.266		
Fixed Coefficients-Products Attributes, Demographic and Attitudinal Variables	-10166.841	3025.162***	6
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-8654.260		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.24 Log-Likelihood Ratios Comparing Fixed and Random Parameters Logits for E0 Overall[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Fixed Coefficients-Product Attributes Only	-9879.440	4530.744***	6
Random Parameters-Product Attributes Only	-7614.069		
Fixed Coefficients-Products Attributes, Demographic and Attitudinal Variables	-9728.285	4317.924***	6
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-7569.323		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.25 Log-Likelihood Ratios Comparing Random Parameters Logits for E10 Potential Activist[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Random Parameters-Product Attributes Only	-2889.336	46.827***	17
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-2865.923		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.26 Log-Likelihood Ratios Comparing Random Parameters Logits for E0 Potential Activist[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Random Parameters-Product Attributes Only	-2655.205	30.103*	17
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-2640.153		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.27 Log-Likelihood Ratios Comparing Random Parameters Logits for E10 Environmental[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Random Parameters-Product Attributes Only	-2063.860	44.732***	17
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-2041.494		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.28 Log-Likelihood Ratios Comparing Random Parameters Logits for E0 Environmental[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Random Parameters-Product Attributes Only	-1886.814	36.446**	17
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-1868.591		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.29 Log-Likelihood Ratios Comparing Random Parameters Logits for E10 Neutral[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Random Parameters-Product Attributes Only	-2161.06	29.435*	17
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-2146.34		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.30 Log-Likelihood Ratios Comparing Random Parameters Logits for E0 Neutral[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Random Parameters-Product Attributes Only	-2161.059	29.435*	17
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-2146.342		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.31 Log-Likelihood Ratios Comparing Random Parameters Logits for E10 National Interest

Model	Log-Likelihood	Log-likelihoodRatio	df
Random Parameters-Product Attributes Only	-1021.033	35.478**	17
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-1003.294		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.32 Log-Likelihood Ratios Comparing Random Parameters Logits for E0 National Interest

Model	Log-Likelihood	Log-likelihood Ratio	df
Random Parameters-Product Attributes Only	-716.9564	13.514	17
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-710.1993		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.33 Log-Likelihood Ratios Comparing Random Parameters Logits for E10 Overall[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Random Parameters-Product Attributes Only	-8697.266	86.013***	17
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-8654.260		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.34 Log-Likelihood Ratios Comparing Random Parameters Logits for E0 Overall[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Random Parameters-Product Attributes Only	-7614.069	89.492***	17
Random Parameters-Products Attributes, Demographic and Attitudinal Variables	-7569.323		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.35 Log-Likelihood Ratios for Random Parameters Logits with Interactions Clusters vs No Clusters for E0 Overall[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Random Parameters-Clusters	-7430.759	277.128***	49
Random Parameters-No Clusters	-7569.323		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

Table 3.36 Log-Likelihood Ratios for Random Parameters Logits with Interactions Clusters vs No Clusters for E10 Overall[a]

Model	Log-Likelihood	Log-likelihood Ratio	df
Random Parameters-Clusters	-8533.100	242.319	49
Random Parameters-No Clusters	-8654.260		

[a] The log-likelihood ratio test is calculated as -2(log-likelihood restricted-log likelihood unrestricted).

	E85	E85	E85	Gasoline
Product Attributes	70% of MPG of Gasoline	70% of MPG of Gasoline	70% of MPG of Gasoline	100% of MPG of Gasoline
Price	$1.56	$1.48	$1.40	$2.00
Price per mile*	7.8 ¢	7.4 ¢	7 ¢	7 ¢
Ethanol made from	Switchgrass	Switchgrass	Corn	No Ethanol
% imported from foreign countries	10%	33%	50%	67%
Greenhouse Gas (GHG) Emissions	10% less than gasoline	10% less than gasoline	50% less than gasoline	0% less than gasoline
Available at:	Gas station located 5 minutes out of your way	Gas station located 2 minutes out of your way	Gas station located on your way	Gas station located 2 minutes out of your way
Which option do you prefer?	○	○	○	○

Figure 3.1 Example of Choice Task.

Cluster Variable	Mean
Q34_1. U.S. farmland should be devoted to producing food and not fuel.	3.22
Q34_2. Increasing ethanol production from corn will lead to higher food prices.	3.75
Q34_3. Reducing our dependence on foreign oil is important to improving our national security.	4.41
Q34_4. Reducing our dependence on foreign oil is more important than protecting the environment.	3.07
Q34_5. More land in the U.S. should be opened up for oil drilling.	3.93
Q35_1. Global climate change is occurring.	4.11
Q35_2. Climate change will lead to environmental and health problems in many parts of the world.	3.97
Q35_3. There is no urgent need to take measures to prevent climate change.	2.48
Q35_4. I am extremely worried about loss of the world's forests.	3.76
Q35_5. I am extremely worried about the state of the world's environment and what it will mean for my future.	3.73
Q36_1. I don't have enough knowledge to make well-informed decisions on environmental issues.	3.44
Q36_2. My personal actions don't have any significant effect on the quality of the environment.	2.54
Q36_3. Science and technology will come up with ways to solve environmental damage and pollution.	3.37
Q36_4. Most people are not willing to make sacrifices to protect the environment.	3.75
Q36_5. We have a responsibility to future generations to protect the environment.	4.40

Awareness of Environmental Issues		
	Familiarity with Greenhouse Gases	**…with Climate Change**
Not at all familiar	37%	24%
Somewhat familiar	55%	65%
Very familiar	8%	12%

Are you a member of an environmental organization?	
Yes	3%
No	97%
Familiar with ethanol as an alternative fuel?	
Not at all familiar	32%
Somewhat familiar	55%
Very familiar	13%

Demographics			
Gender		**Ethnicity**	
Male	46%	White	75%
Female	54%	Black	7%
		Other	4%
Age		Hispanic	14%
18-29	19%	2+ races	1%
30-44	25%		
45-59	25%	**Political Affiliation**	
60+	31%	Republican	46%
		Other	5%
Education		Democrat	49%
< High School	13%		
High School	35%	**Familiarity with ethanol feedstocks**	
Some college	29%		
Bachelor's +	23%	**Familiar with corn?**	
Income		Yes	89%
$0 to $24,999	20%	No	11%
$25,000 to $49,999	32%		
$50,000 to $99,999	35%	**Familiar with Switchgrass?**	
$100,000 or more	13%	Yes	21%
		No	79%
Region		**Familiar with wood wastes?**	
Northeast	15%	Yes	17%
Midwest	25%	No	83%
South	41%		
West	19%		

Figure 3.2 Potential Activist Profile

Cluster Variable	Mean
Q34_1. U.S. farmland should be devoted to producing food and not fuel.	3.32
Q34_2. Increasing ethanol production from corn will lead to higher food prices.	3.88
Q34_3. Reducing our dependence on foreign oil is important to improving our national security.	4.21
Q34_4. Reducing our dependence on foreign oil is more important than protecting the environment.	2.00
Q34_5. More land in the U.S. should be opened up for oil drilling.	2.37
Q35_1. Global climate change is occurring.	4.75
Q35_2. Climate change will lead to environmental and health problems in many parts of the world.	4.66
Q35_3. There is no urgent need to take measures to prevent climate change.	1.39
Q35_4. I am extremely worried about loss of the world's forests.	4.49
Q35_5. I am extremely worried about the state of the world's environment and what it will mean for my future.	4.50
Q36_1. I don't have enough knowledge to make well-informed decisions on environmental issues.	2.30
Q36_2. My personal actions don't have any significant effect on the quality of the environment.	1.67
Q36_3. Science and technology will come up with ways to solve environmental damage and pollution.	3.11
Q36_4. Most people are not willing to make sacrifices to protect the environment.	3.73
Q36_5. We have a responsibility to future generations to protect the environment.	4.79

Awareness of Environmental Issues

	Familiarity with Greenhouse Gases	…with Climate Change
Not at all familiar	13%	4%
Somewhat familiar	57%	56%
Very familiar	31%	40%

Are you a member of an environmental organization?

Yes	13%
No	87%

Familiar with ethanol as an alternative fuel?

Not at all familiar	17%
Somewhat familiar	61%
Very familiar	22%

Demographics

Gender	
Male	48%
Female	53%

Age	
18-29	21%
30-44	32%
45-59	32%
60+	15%

Education	
< High School	6%
High School	23%
Some college	28%
Bachelor's +	43%

Income	
$0 to $24,999	17%
$25,000 to $49,999	25%
$50,000 to $99,999	40%
$100,000 or more	18%

Region	
Northeast	22%
Midwest	20%
South	33%
West	25%

Ethnicity	
White	72%
Black	6%
Other	7%
Hispanic	13%
2+ races	2%

Political Affiliation	
Republican	22%
Other	5%
Democrat	72%

Familiarity with ethanol feedstocks

Familiar with corn?	
Yes	94%
No	6%

Familiar with Switchgrass?	
Yes	29%
No	71%

Familiar with wood wastes?	
Yes	28%
No	72%

Figure 3.3 Environmental Profile

Cluster Variable	Mean
Q34_1. U.S. farmland should be devoted to producing food and not fuel.	2.73
Q34_2. Increasing ethanol production from corn will lead to higher food prices.	2.96
Q34_3. Reducing our dependence on foreign oil is important to improving our national security.	3.24
Q34_4. Reducing our dependence on foreign oil is more important than protecting the environment.	2.84
Q34_5. More land in the U.S. should be opened up for oil drilling.	3.20
Q35_1. Global climate change is occurring.	3.16
Q35_2. Climate change will lead to environmental and health problems in many parts of the world.	3.09
Q35_3. There is no urgent need to take measures to prevent climate change.	2.85
Q35_4. I am extremely worried about loss of the world's forests.	3.00
Q35_5. I am extremely worried about the state of the world's environment and what it will mean for my future.	2.94
Q36_1. I don't have enough knowledge to make well-informed decisions on environmental issues.	3.04
Q36_2. My personal actions don't have any significant effect on the quality of the environment.	2.75
Q36_3. Science and technology will come up with ways to solve environmental damage and pollution.	3.00
Q36_4. Most people are not willing to make sacrifices to protect the environment.	3.15
Q36_5. We have a responsibility to future generations to protect the environment.	3.38

Awareness of Environmental Issues

	Familiarity with Greenhouse Gases	…with Climate Change
Not at all familiar	54%	45%
Somewhat familiar	42%	50%
Very familiar	4%	5%

Are you a member of an environmental organization?

Yes	4%
No	96%

Familiar with ethanol as an alternative fuel?

Not at all familiar	47%
Somewhat familiar	49%
Very familiar	4%

Demographics

Gender		Ethnicity	
Male	46%	White	66%
Female	54%	Black	16%
		Other	5%
Age		Hispanic	12%
18-29	29%	2+ races	1%
30-44	29%		
45-59	25%	**Political Affiliation**	
60+	18%	Republican	40%
		Other	8%
Education		Democrat	52%
< High School	15%		
High School	37%	**Familiarity with ethanol feedstocks**	
Some college	27%		
Bachelor's +	22%	**Familiar with corn?**	
Income		Yes	73%
$0 to $24,999	23%	No	27%
$25,000 to $49,999	34%	**Familiar with Switchgrass?**	
$50,000 to $99,999	31%	Yes	11%
$100,000 or more	12%	No	89%
Region		**Familiar with wood wastes?**	
Northeast	15%		
Midwest	23%	Yes	14%
South	39%	No	87%
West	24%		

Figure 3.4 Neutral Profile

Cluster Variable	Mean
Q34_1. U.S. farmland should be devoted to producing food and not fuel.	3.94
Q34_2. Increasing ethanol production from corn will lead to higher food prices.	4.27
Q34_3. Reducing our dependence on foreign oil is important to improving our national security.	4.57
Q34_4. Reducing our dependence on foreign oil is more important than protecting the environment.	4.16
Q34_5. More land in the U.S. should be opened up for oil drilling.	4.75
Q35_1. Global climate change is occurring.	2.36
Q35_2. Climate change will lead to environmental and health problems in many parts of the world.	2.15
Q35_3. There is no urgent need to take measures to prevent climate change.	3.99
Q35_4. I am extremely worried about loss of the world's forests.	2.50
Q35_5. I am extremely worried about the state of the world's environment and what it will mean for my future.	2.01
Q36_1. I don't have enough knowledge to make well-informed decisions on environmental issues.	2.06
Q36_2. My personal actions don't have any significant effect on the quality of the environment.	3.13
Q36_3. Science and technology will come up with ways to solve environmental damage and pollution.	3.49
Q36_4. Most people are not willing to make sacrifices to protect the environment.	3.54
Q36_5. We have a responsibility to future generations to protect the environment.	3.71

Awareness of Environmental Issues

	Familiarity with Greenhouse Gases	…with Climate Change
Not at all familiar	15%	11%
Somewhat familiar	58%	57%
Very familiar	28%	32%

Are you a member of an environmental organization?

Yes	1%
No	99%

Familiar with ethanol as an alternative fuel?

Not at all familiar	10%
Somewhat familiar	64%
Very familiar	3%

Demographics

Gender	
Male	65%
Female	36%

Age	
18-29	12%
30-44	20%
45-59	34%
60+	33%

Education	
< High School	8%
High School	22%
Some college	36%
Bachelor's +	34%

Income	
$0 to $24,999	14%
$25,000 to $49,999	27%
$50,000 to $99,999	38%
$100,000 or more	21%

Region	
Northeast	11%
Midwest	22%
South	43%
West	24%

Ethnicity	
White	91%
Black	3%
Other	3%
Hispanic	3%
2+ races	1%

Political Affiliation	
Republican	88%
Other	3%
Democrat	9%

Familiarity with ethanol feedstocks

Familiar with corn?

Yes	96%
No	4%

Familiar with Switchgrass?

Yes	43%
No	57%

Familiar with wood wastes?

Yes	44%
No	57%

Figure 3.5 National Interest Profile

Cluster Variable	Mean
Q34_1. U.S. farmland should be devoted to producing food and not fuel.	3.20
Q34_2. Increasing ethanol production from corn will lead to higher food prices.	3.63
Q34_3. Reducing our dependence on foreign oil is important to improving our national security.	4.06
Q34_4. Reducing our dependence on foreign oil is more important than protecting the environment.	2.87
Q34_5. More land in the U.S. should be opened up for oil drilling.	3.43
Q35_1. Global climate change is occurring.	3.79
Q35_2. Climate change will lead to environmental and health problems in many parts of the world.	3.67
Q35_3. There is no urgent need to take measures to prevent climate change.	2.50
Q35_4. I am extremely worried about loss of the world's forests.	3.57
Q35_5. I am extremely worried about the state of the world's environment and what it will mean for my future.	3.49
Q36_1. I don't have enough knowledge to make well-informed decisions on environmental issues.	2.86
Q36_2. My personal actions don't have any significant effect on the quality of the environment.	2.45
Q36_3. Science and technology will come up with ways to solve environmental damage and pollution.	3.22
Q36_4. Most people are not willing to make sacrifices to protect the environment.	3.55
Q36_5. We have a responsibility to future generations to protect the environment.	4.13

Awareness of Environmental Issues

	Familiarity with Greenhouse Gases	…with Climate Change
Not at all familiar	33%	23%
Somewhat familiar	52%	57%
Very familiar	15%	20%

Are you a member of an environmental organization?

Yes	6%
No	94%

Familiar with ethanol as an alternative fuel?

Not at all familiar	30%
Somewhat familiar	56%
Very familiar	14%

Demographics

Gender		Ethnicity	
Male	49%	White	74%
Female	51%	Black	9%
		Other	5%
Age		Hispanic	12%
18-29	21%	2+ races	1%
30-44	27%		
45-59	28%	**Political Affiliation**	
60+	24%	Republican	43%
		Other	6%
Education		Democrat	51%
< High School	11%		
High School	31%	**Familiarity with ethanol feedstocks**	
Some college	29%		
Bachelor's +	29%	**Familiar with corn?**	
Income		Yes	87%
$0 to $24,999	19%	No	13%
$25,000 to $49,999	30%	**Familiar with Switchgrass?**	
$50,000 to $99,999	35%	Yes	23%
$100,000 or more	15%	No	77%
Region		**Familiar with wood wastes?**	
Northeast	16%		
Midwest	23%	Yes	22%
South	39%	No	78%
West	23%		

Figure 3.6 Overall Profile

Part 4: Summary and Conclusions

Results from this study reveal that in general consumers are willing to pay for reductions in greenhouse gas emissions through purchases of E85 and that these amounts vary from one market segment to the next. The overall mean estimated WTP is 0.18 cents per gallon and .13 cents per gallon, and is significant when compared to both E0 and E10 respectively. Variation between clusters ranges from a high mean WTP of 0.49 cents per gallon to insignificant to a low of -0.61 per gallon. There were significant differences in these WTP values, which suggest that segmenting the sample would be beneficial in target marketing strategies. In addition, demographics and attitudes that significantly affected WTP were different across clusters and survey versions.

Segmentation of the sample revealed four distinct groups of potential ethanol consumers. Specific marketing strategies should be tailored to these groups based on attitudes, demographics and preferred sources of informational media. In addition, estimated WTP should be taken into account when deciding on which segments to target most aggressively. Based on estimated WTP for GHG emissions reductions the Environmentals should be the most profitable segments. However, with more information and creative marketing strategies, members of other segments could potentially become valuable consumers in the ethanol market. As an overall strategy, efforts should be made to increase the availability or at least the perceived availability of E85. Likelihood of purchase is inherently reduced if a product is not perceived to be readily available. Overall, respondents have a neutral FIO and slightly positive PCE. A message focused on the impact of one consumer's driving habits related to switching to an ethanol blended fuel may help increase likelihood of purchase so as to contribute to a common goal. Segmenting markets to delve further into motivations and preferences of a diverse nation of consumers will be vital as

researchers search not only for the best alternative energy source but also for the energy source that consumers will support.

This research only intensively explored WTP for GHG emissions reductions through purchases of E85. Other fuel attributes could be analyzed and contribute to the overall strategy for ethanol marketing. Further research should also explore WTP for GHG emissions reductions through other possible alternative fuels like electricity and hydrogen. Looking at various levels of ethanol blends my also reveal more about consumer preferences for ethanol-blended fuels.

Vita

Adrienne Elizabeth Marra was born November 29, 1982 in Hickory, NC to Leslie and Dan Marra. She grew up in Knoxville, TN and received her Bachelor's of Science in Agricultural Science from the University of Tennessee-Knoxville. She then went on to pursue a Master of Science in Agricultural Economics with a concentration in Natural Resource Economics at the University of Tennessee-Knoxville. Her plans are to make great contributions in this field and pursue a career that will foster creativity and problem solving.