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I am submitting herewith a thesis written by Xiaogu Li entitled “Consumer Willingness to Pay for Eco-labeled Refrigerators.” 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.

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Consumer Willingness to Pay for Eco-labeled Refrigerators

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ABSTRACT

The United States Environmental Protection Agency has used environmental information provision as a policy tool to take advantage of consumer preferences for products that meet higher environmental standards. Such environmental programs include a variety of policies ranging from eco-labeling programs to voluntary environmental agreements between governments and manufacturers. This study analyzes the effects of two such programs - the ENERGY STAR program, an eco-labeling program, and the Climate Leaders program, a voluntary environmental agreement program - on consumer preferences for a household appliance. The study estimates consumer willingness to pay (WTP) for the two programs and examines factors that motivate WTP. A particular interest for the ENERGY STAR program is in determining how the offer of a mail-in rebate affects these preferences. Data used for this study was collected from an online survey conducted in the United States during March and April, 2009. Conditional and random parameter logit models, with product attributes only and with demographic and other individual characteristics as interaction terms, are used to analyze the data. Findings from this study imply that consumers are willing to pay a premium equivalent to a significant portion of the purchase prices for the products approved by either program. Also, it is found that consumers who are more concerned about environmental issues, such as global climate change, and who have confidence in the effects of collective action, are more likely to engage in the purchase of such environmentally friendly products. These results should help government agencies and manufacturers evaluate the effectiveness of environmental information provision programs.

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Chapter 1: Introduction

In recent years, the idea of consumers being influenced by “green” (or environment-friendly) product attributes has generated a great deal of interest. Consumers with environmental concerns appear willing to pay more for products that are produced, distributed, and used in a way that generates less environmental damage. For example, previous studies have found that consumers are more prone to purchase goods that can help reduce global warming (Kahlor and Rosenthal, 2009), energy exploitation (Grover and Babiuch, 2000), water pollution (Hurley, Miller, and Kliebenstein, 2006) or species extinction (Kotchen and Reiling, 2000).

Government agencies, such as the United States Environment Protection Agency (USEPA), have taken various actions to exploit consumers’ preferences for green goods. One popular action has been the introduction of eco-labeling programs. The rationale for these programs is that there exists a variety of goods and services which can be considered either green or “brown” (conventional/non-environmentally friendly) goods, and that information that distinguishes the two is either costly or impossible for consumers to acquire. Eco-labeling programs are, therefore, designed to allow consumers to differentiate green goods from brown goods (Kennedy, Laplante and Maxwell, 1994; Clark, 2001). This study analyzes consumer preferences for one such program - the ENERGY STAR labeling program, which was established in 1992 and is awarded to energy-efficient home appliances (USEPA, 2007).

The study also analyzes consumer preferences for a different type of information provision program. The Climate Leaders program, which was started in 2002, recognizes companies who commit to the use of “green” energy and the reduction of greenhouse

gases (GHG) (USEPA, 2009). These programs are similar in terms of promoting energy saving and environmental protection (USEPA, 1998); however, there are also substantial differences.

By purchasing an ENERGY STAR product, consumers generate public and private benefits, as the appliance significantly reduces energy consumption over similar products that did not qualify for the ENERGY STAR (Sanchez, Brown, Webber, and Homan, 2008; Banerjee and Solomon, 2003). Thus, consumers can save on energy bills (private benefit) while reducing their impact on environmental quality through the reduction of GHG emissions (public benefit) (USEPA 2007a, 2007b, 2007d, 2007e). In addition, some home appliance retailers provide coupons, discounts or mail-in rebates for ENERGY STAR products¹. The benefits generated from Climate Leaders products, however, mainly occur during the production process, and there are no private benefits to consumers that correspond to the cost savings enjoyed by consumers of ENERGY STAR products. Therefore, consumption decisions occur after the environmental benefits associated with the Climate Leaders program whereas they occur before any environmental benefits associated with the ENERGY STAR program. In addition, the Climate Leader Partners award is given to the company while the ENERGY STAR label is attached to the product. How these differences might affect consumer preferences for products with either the ENERGY STAR label or manufactured by a company participating in the Climate Leaders program is an empirical question and one of the questions that motivate this thesis.

¹ Major U.S. retailers such as Best Buy, Sears and Wal-Mart have all provided some discounts or mail-in rebates to consumers who purchase ENERGY STAR labeled appliances. As of June 2010, such discounts ranged from \$50 to \$300 (U.S.) for refrigerators. In addition, some on-line retailers such as Bestbuy.com offer free delivery for ENERGY STAR labeled appliances.

This thesis analyzes consumer preferences for eco-labeled refrigerators, focusing on separate analyses and comparisons among three different scenarios: ENERGY STAR without rebates, ENERGY STAR with rebates, and Climate Leaders program. Data from a national online consumer survey is used, and a major research goal is to determine respondents' willingness to pay (WTP) for product attributes in each scenario. Thus, the two primary objectives of this thesis are to: 1) compare consumers' WTP for ENERGY STAR labeled refrigerators with and without monetary rebates; and 2) estimate consumers' WTP for refrigerators manufactured by companies participating in the Climate Leaders program. The former is the subject of Chapter 2, while the latter is the subject of Chapter 3. Chapter 4 presents some concluding comments and ideas for future research.

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Chapter 2: Willingness to Pay for ENERGY STAR Labeled Refrigerators and Impacts of the Offer of Mail-in Rebates

Introduction

Modern economies are characterized by industrialization and heavy use of electric energy. Demand for electricity has been soaring in past decades in most of the world, particularly in countries with large populations and economies such as Brazil (Almeida, Schaeffer and Rovere, 2001), China (Lu, 2006), Japan (Ueno, Sano, Saeki and Tsuji, 2006), Mexico (Arroyo-Cabanas, Aguillon-Martinez, Ambriz-Garcia and Canizal, 2009) and the United States (Meyers, McMahon, McNeil and Liu, 2003).

The rising demand for electricity generates increasing environmental and energy challenges. On one hand, the fact that more electricity is required to be generated is placing increasing pressure on upstream energy resources such as crude oil, coal and natural gas, the reserves of which are being depleted. And, increasing energy prices and unstable political situations in energy resource exporting countries have increased the insecurity of energy supplies. On the other hand, the generation and consumption of electricity emit greenhouse gases (GHG) such as carbon dioxide (CO₂), carbon monoxide (CO) and nitrogen oxide compounds (NO_x). Energy sectors are responsible for approximately 65% of the GHG emissions generated by human activities (IEA 2009). GHGs, mainly CO₂, become quite stable once released into the atmosphere and keep absorbing thermo radiation from the earth's surface, which accelerates global warming and contributes to global climate change (e.g. Cox, Betts, Jones, Spall and Tottedell, 2000). Scientists have warned that, once a certain threshold concentration of GHGs are reached, severe consequences such as catastrophic climate events and interrupted thermo

circulation might lead to irreversibly large losses to human society and the earth's ecosystem (Ansar and Sparks, 2009).

These challenges call for policies that lead to higher energy efficiency and lower GHG emissions. The provision of information on the environmental effects of consumption is often put forward as an “appealing alternative” (Bjørner, Hansen and Russell, 2004) to traditional approaches to environmental regulation, as it appears to be less confrontational than traditional policies. The practice of attaching an “eco-label” or “green label” to products or services indicating that the labeled varieties are more environment-friendly and energy-efficient than unlabeled ones, or “eco-labeling”, has become a popular way to provide environmental information to consumers. Rather than implementing mandatory policies, eco-labeling programs such as the ENERGY STAR program work with the “invisible hand” of the market to transform the market for energy-consuming products and promote increased market share for energy efficient products.

The U.S. Environment Protection Agency (USEPA) introduced the ENERGY STAR labeling program in 1992. The U.S. Department of Energy (USDOE) joined USEPA in administrating the program in 1996. ENERGY STAR is a voluntary labeling program in which the two government agencies establish environmental and energy efficiency performance criteria for a variety of products and services² and award a “label” (See Figure 2-1) to products that meet these criteria. As described by USEPA in its promotional materials, the ENERGY STAR program is designed to achieve two main objectives through higher energy efficiency: reduce GHG emissions and help households

² To be more precise, the ENERGY STAR program also includes other items, such as energy efficient homes and office buildings. Thus the terminology “product” as used here is not limited to consumer goods and services that are sold in stores.

reduce their energy costs. It is expected that consumers who are concerned about the environment or expect cost savings in energy consumption, or both, will switch from using product varieties that are less energy-efficient to the labeled varieties that meet the criteria set forth by the ENERGY STAR program.

USDOE is currently promoting the ENERGY STAR program by providing additional incentives, in the form of monetary rebates, to consumers who purchase energy efficient household appliances. A nationwide program, the State Energy Efficient Appliance Rebate Program (SEEARP), was approved by the U.S. Congress in the 2005 Energy Policy Act to develop rebate programs in all 56 U.S. states and territories. Funded by the American Recovery and Reinvestment Act and administered by the USDOE, SEEARP is designed to encourage consumers to purchase ENERGY STAR qualified household appliances and replace their outdated, inefficient appliances (USDOE, 2010). A total fund of \$300 million is to be allocated nationally, and according to a USEPA market study, over 50 million Americans were eligible for rebates in 2009 (USEPA, 2010). Through the national rebate program, the average values of rebates for ENERGY STAR qualified refrigerators in the U.S. range from \$50 to \$700 (USDOE 2010). Compared with an estimated average price range for refrigerators between \$926 and \$2,408 (Clark, Jensen, Russell, Yen and Hanemann, 2011), consumers could save anywhere from 6% to 30% of their purchasing costs through rebates. Through June 30, 2010, it is reported that a total of 689,000 rebate applications were approved and paid to consumers (USDOE, 2010). The effects of rebates on consumer behavior are often discussed in marketing studies (e.g. Tat, 1994; Soman, 1998; Silk and Janiszewski, 2008);

however, to our knowledge, we could find no previous studies on the possible effects of rebates on consumer preferences for ENERGY STAR labeled refrigerators.

Thus, this study attempts to analyze the differences between willingness to pay (WTP) for ENERGY STAR labeled products that are sold with a mail-in rebate and without such a rebate, and what factors influence those differences. The factors examined include environmental concern, energy cost-savings, and demographic and socioeconomic status. The remainder of this chapter is organized as follows. The next section provides a review of the relevant literature. A discussion of the methods and procedures employed in this study follows. The results are then presented and in the final section some conclusions and ideas for further research are offered.

Literature Review

The idea of providing environmental information to consumers is based on the goal of empowering consumers to act on their preferences for environment-friendly and energy-saving (often referred to as “eco” or “green”) products and services. Previous studies have shown that consumers have exhibited interest in “green” goods of various categories (household products, appliances, foods, etc.) and are willing to pay more for these goods than for conventional alternatives with similar product attributes (e.g. Bjørner, Hansen and Russell, 2004; Loureiro, McCluskey and Mittelhammer, 2001; Cason and Gangadharan, 2002; Amacher, Koskela and Ollikainen, 2004; Banerjee and Solomon, 2003). The motivation that drives consumers to make such “green” purchasing choices could come from a variety of sources, such as the public benefits associated with reduced emissions and better environmental quality or the private benefits associated

with cost saving in energy consumption and monetary rebates. Theoretical models assume that people generate higher utility from such diverse sources as: better environmental quality (Kennedy, Laplante and Maxwell, 1994), the money they can expect to save with the use of energy-saving products (Banerjee and Solomon, 2003), a better self image (Johansson-Stenman and Martinsson, 2006), or an improved moral reputation achieved by conforming to social norms (Bernabou and Tirole, 2006; Brekke, Kipperberg and Nyborg, 2007).

Manufacturers have attempted to capitalize on consumer interest in green goods by telling consumers how green their products are in advertisements (Mason, 2008). This type of environmental information is often referred to as “self-labeling” (Baski and Bose, 2007) or “first party information” (OECD, 1997), as it comes directly from the manufacturer and directly targets potential consumers without the involvement of government agencies or other third parties. But many may doubt the reliability of first party information, as manufacturers would be motivated to exaggerate the environment-friendly nature of their products (Harbaugh, Maxwell and Roussillon, 2006). Many studies (e.g. Kuhn, 1999; Mason, 2006, 2008; Amacher, Koskela and Ollikainen, 2004; Innes, 2006; Hamilton and Zilberman, 2006; Harbaugh, Maxwell and Roussillon, 2006; Baski and Bose, 2007; Ibanez and Grolleau, 2008) have noted that such risks of moral hazard and imperfect competition could degrade the quality of such information and reduce consumer interest in green products, resulting in market failures. In extreme situations, the presence of misleading environmental information could even force the

“honest” environment-friendly manufacturers out of the market, leading to adverse selection or the “Lemons” effect described by Akerlof (1970).

With uncertainty and asymmetry of information between manufacturers and consumers in the market for green products, there is a role for government agencies in the provision of environmental information. For example, an “official” label, operated by a government agency, could help alleviate the information asymmetry and uncertainty associated with first party information. In fact, according to a study reported by OECD (1997), the so-called *Type I* (third party, often supported by governments³) labels are the most common type of eco-labels around the world, such as *Der Blaue Engel* (“The Blue Angel”) initiated in Germany (then West Germany) in 1977, *Environmental Choice* initiated in Canada in 1988, *Nordic Svanen* (“Nordic Swan”) initiated in Nordic countries in 1989, and *European Flower* initiated in the European Union in 1992.

An eco-labeling program initiated in the United States is the ENERGY STAR program. In general, home appliances along with other energy-consuming products sold in the United States have to meet basic energy efficiency standards set forth by the U.S. federal and/or state governments. The criteria of energy efficiency for a product to be certificated with an ENERGY STAR label are higher than the general federal and state standards (USEPA, 2007). Currently, the ENERGY STAR labels are applied to over fifty categories of products and over 40,000 product models (USEPA, 2011). In 2009 alone, USEPA estimates that Americans saved enough energy to avoid GHG emissions equivalent to those from 30 million cars, while saving nearly \$17 billion on their utility

³ See OECD 1997. Three types of labels were distinguished: Type I (third party certification), Type II (manufacturers’ self labeling), and Type III (pre-set standard and based on independent verification of information).

bills through the use of ENERGY STAR products (USEPA, 2010). In the long term, USEPA estimates that by 2016 ENERGY STAR products will have reduced GHG emissions by nearly 500 million metric tons of carbon equivalents and saved consumers over \$202 billion (2006) in total energy costs (USEPA 2007).

Environmental concern is often found to be positively related with consumer choice of eco-labeled products and WTP for those products. For example, in a study of the *Nordic Svanen* label, Bjørner, Hansen and Russell (2004) examined a Danish consumer panel with detailed information on actual purchases from the beginning of 1997 to January 2001 and found that the label had a significant effect on consumers' brand choices for toilet paper, corresponding to a marginal WTP for the label of 13–18% of the price of the toilet paper.

Private benefits, on the other hand, are also factors that can motivate consumers to purchase green products (Kotchen, 2006, 2007). Particularly, because household appliances that are declared to be “cost-saving” are often purchased with higher prices than the prices of appliances that have lower energy efficiency (Wallander, 2008), hence from the perspective of consumers they often expect that the premium they paid for energy efficient appliances can be compensated by accumulative cost savings during the lifetime of the appliance (McNeil, 2010). While energy prices vary in different regions, there is evidence that energy efficient refrigerators can generate significant energy savings. For example, by replacing older model refrigerators with newer, more-efficient models in Mexico, a annual electricity saving of 4.7 TWh (trillion watt-hour), which represents one third of the domestic electricity consumption, could be achieved (Arroyo-

Cabanas et al., 2009). Further, it is estimated that the implementation of *GBI2021.2*, the mandatory national standard for refrigerator efficiency, could save at least 1,292.2 TWh in China from 2003 to 2023 (Lu, 2006). Studies on energy efficient refrigerators in Canada (Young, 2008), Japan (Shimoda et al., 2010), Malaysia (Saidur et al., 2007), India (McNeil, 2010) and Brazil (Vendrusculo et al., 2009) also found similar results.

Therefore, consumers may be motivated to pay for energy efficiency to generate cost-savings. For example, Revelt and Train (1998) estimated consumer preference for energy-efficient refrigerators through data collected in southern California, and found that consumers were willing to pay \$2.12 to \$2.46 per dollar saved on energy costs. Similarly, Sammer and Wuestenhagen (2006) studied the effects of the European Energy Label, and found that European consumers were willing to pay a premium of about 30% of the purchase price for eco-labeled washing machines. Ward et al. (2011) focused on the effects of the ENERGY STAR label on consumer preferences for refrigerators, and found WTP for the label to be between \$249.82 and \$349.30, depending on the specific econometric models used. However, that study did not consider what effects a mail-in rebate might have on consumer preferences.

The promotional strategy of providing monetary incentives to offset purchase costs to consumers is observed in a variety of markets (Tat, 1994; Soman and Gourville, 2005; Silk and Janiszewski, 2008; Aydin and Porteus, 2009). The provision of price-related incentives is done to attract price-sensitive consumers. In providing these incentives, manufacturers and vendors expect to increase unit sales and discriminate among consumers with different price sensitivities (Silk and Janiszewski, 2008). Popular

incentives of this type include manufacturers' or store coupons, instant discounts or rebates at point of sale, and mail-in rebates after purchase.

Mail-in rebates offer consumers monetary reimbursements *after* purchasing a product (Jolson, Wiener and Rosecky, 1987; Tat, Cunningham III and Babakus, 1988), conditional on their investment of effort (Silk and Janiszewski, 2008) in following the instructions and requirements imposed by manufacturers or vendors. A typical rebate process might last for several months, as consumers need to mail application for the rebate with proof of purchase and rebate forms to manufacturers or vendors, wait for the application to be approved, and, after approval, wait for the rebate check to arrive (Soman, 1998; Soman and Gourville, 2005). Manufacturers and vendors prefer rebates to instant discounts because rebates provide partial money reimbursements only after sales of products (Soman, 1998; Aydin and Porteus, 2009), and most of the efforts required to award the rebate are borne by consumers (Tat, 1994). However, the monetary and time costs make the rebate process tedious to consumers, and it is often found that the actual rate of consumers that apply for rebates are much lower than expected (Soman and Gourville, 2005; Silk and Janiszewski, 2008). Therefore, the efficiency of, and consumer response to, mail-in rebates are often questioned in marketing studies (Soman and Gourville, 2005; Silk and Janiszewski, 2008).

Besides, the information about the product that mail-in rebate delivers to consumers is uncertain. For example, Revelt and Train (1998) treated rebate as a dummy variable in their study on refrigerators, explaining that a rebate is perceived by consumers in two possible ways: consumers may consider a rebate as a positive signal of cost-saving,

or consider a rebate as a negative signal as refrigerators with rebates are “too poor to sell on their own merits”. They concluded that consumers hold various views about rebates, with the number of consumers who held positive perceptions being about the same as those who held negative perceptions.

Datta and Gulati (2010) examined the effects of rebates on the market share of ENERGY STAR qualified appliances, and quantified the costs and benefits of providing rebates to consumers. Their results indicated that an increase of one dollar of rebate values leads to a 0.3% increase in demand for ENERGY STAR labeled clothes washers. Rebates appeared to have no significant effects on dishwasher or refrigerator purchases.

Data and Survey Methods

The data for conducting this study were collected through an online survey hosted by Knowledge Networks[®] (KN) during March and April of 2009⁴. Unlike other Internet research that covers only individuals with Internet access, KN surveys are not limited to current Internet users or computer owners. KN recruits potential panelists aged eighteen years or older by probability-based sampling to represent the U.S. population. KN selects households using list-assisted random-digit dial (RDD) techniques based on a sample frame of the U. S. residential landline telephone universe. About 70% of the sample telephone numbers could be matched with a valid postal address, and such address-matched cases were all mailed an advance letter informing them that they had been selected to participate in the panel. Trained interviewer/recruiters then attempt to

⁴ See Clark et al. (2011) for details of this survey, its background, purpose and design.

interview all sampled phone numbers known to be associated with households⁵ (Dennis, 2009). Households that informed interviewers that they had a home computer and Internet access were asked to take their surveys using their own equipment and Internet connection. If the household did not have a computer and access to the Internet, they were provided with a laptop computer (previously a WebTV device was provided) and free monthly Internet access. Incentive points redeemable for cash were provided to other respondents for completing surveys (Dennis, 2009).

Panel members selected for this survey were contacted by a personalized e-mail invitation with an Internet link to the survey. The goal for the survey was to collect a total of 1,200 qualified interviews. Invitations to participate in the study were sent to a random sample of 2,195 panel members, and 1,395 qualified responses were collected before the survey was closed for further responses, providing a completion rate of 64%. After the study data were returned from the field, KN designed a post-stratification process to adjust for survey non-response and non-coverage due to possible sampling and non-sampling errors from the sampling design and recruitment strategy. For example, KN excluded those banks of telephone numbers (a bank consists of 100 numbers) with less than 2 directory-listings. Additionally, an over-sample was conducted with high concentrations of minority groups (mainly African American and Hispanic households) based on Census data, while telephone numbers that did not match valid mailing addresses or households living in geographic areas which were not covered by MSN[®] TV service network were under-sampled. A panel demographic post-stratification weight was

⁵ Cases sent to recruiters were dialed for up to 90 days with at least 14 dial attempts on cases where no one answered the phone calls. Extensive refusal conversion was also performed.

designed for sample adjustments using demographic distributions retrieved from the most recent data from the Current Population Survey. Several benchmark distributions were utilized: gender (male, female), age (18-29, 30-44, 45-59, and 60 or above), race/ethnicity (White/Non-Hispanic, Black/Non-Hispanic, Other and two or more Races/Non-Hispanic, Hispanic), education (less than high school, high school, some college, bachelor and beyond), census region (Northeast, Midwest, South, West), reside in metropolitan area (yes, no) and Internet access (yes, no). All completed cases from the field data were used to calculate comparable distributions to compare with the benchmark distributions using an iterative proportional fitting procedure. After this final post-stratification adjustment, the distribution of the calculated weights were examined to identify and, if necessary, trim outliers at the extreme upper and lower tails of the weight distribution. The post-stratified and trimmed weights were then scaled to the sum of the total sample size. The resulting weights were applied to all the results in this study.

The survey employed a contingent choice experiment to collect data on consumer preferences. The contingent choice experiment technique (sometimes also referred to as conjoint analysis) represents an extension of the traditional contingent valuation method (Mitchell and Carson, 1989), and has been widely employed in psychology, marketing and transportation research (Louviere, 1988). The contingent choice experiment is designed to model respondents' choices as a function of the features of a product or service (Vermeulen, Goos and Vandebroek, 2008). Respondents in a contingent choice experiment are provided with a series of choice sets with more than two alternatives that have comparable but different attributes, and each respondent is asked to repeatedly

choose a preferred alternative out of each set of alternatives (Vermeulen, Goos and Vandebroek, 2008). The results of choice experiments allow the estimation of preferences over of a product and are consistent with random utility theory (Adamowicz, Boxall, Williams and Louviere, 1998).

Among all ENERGY STAR qualified household appliances, refrigerator/freezer (“refrigerator”) is selected to be the object of this study. According to USDOE, refrigerators consume more energy than most other home appliances (see Figure 2-2). Also, consumers are familiar with ENERGY STAR labeled refrigerators, as 74% of households reported having seen the ENERGY STAR label on refrigerators (USEPA, 2007b). In addition, the ENERGY STAR label appears to be popular in the refrigerator market, as labeled refrigerators had captured approximately 58% of the market, as reported in the 2005 Residential Energy Consumption Survey (Davis, 2010).

Four different versions of the survey were fielded with the only difference between the four being the type of environmental label used in the choice task (and the wording of information screens and follow-up or debriefing questions that referenced the label). The first two versions used an ENERGY STAR label. The description of the ENERGY STAR label was the same in the two versions except that one not only promised energy cost savings but also a \$50 mail-in rebate from the respondent’s utility company. The third survey version used the manufacturer’s participation in the Green Power Partnership (USEPA, 2011c) as the basis for a label, while the fourth used participation in the Climate Leaders program (USEPA, 2011b) as the basis. Respondents were randomly assigned to one of the four different versions of the survey instrument: 1)

ENERGY STAR with rebate (355 responses, 25.4% of the total completed and valid responses); 2) ENERGY STAR without rebate (349 responses, 25%); 3) Green Power Partners (338 responses, 24.2%) and 4) Climate Leaders (353 responses, 25.3%). Responses for 1) and 2) are used in the analysis described in this chapter.

Prior to the choice experiment, respondents were asked questions about their home and household characteristics, usage and knowledge of refrigerators, when and how they acquired their refrigerators, and what their roles were in decision-making related to refrigerator purchase.

These questions were followed by a series of “information screens” where the respondents were provided basic information about the refrigerator attributes that appeared in the contingent choice experiment. Each information screen was immediately followed by a question asking whether the respondent had enough information about this attribute and was ready to proceed, or would like more information. If the respondent indicated that they would like more information on the attribute, another screen with more details on the attribute was provided. Figure 2-3 shows the information screens for both the with and without rebate versions of the ENERGY STAR label. Both information screens informed respondents of how much they could expect to save in annual electricity costs with an ENERGY STAR labeled refrigerator as compared to a refrigerator that only met the basic federal standard for energy consumption. An estimated annual electricity cost saving of \$14 was provided to respondents based on USEPA estimates of cost-savings ranging from \$12 to \$15.

The contingent choice experiment followed the information screens. At the beginning of the choice experiment, respondents were asked to assume that all of the choices fit in the space that they had for a refrigerator, were available in the color or finish that they wanted, and had both automatic defrost and a built-in icemaker. The contingent choice experiment consisted of fourteen choice tasks, that required respondents to answer the following question:

“If you needed to buy a refrigerator and these were your only options, which would you choose?”

The respondents were allowed to choose from three varieties of refrigerators defined by different combinations of product attributes, including price (\$879, \$929, \$979, and \$1,029), brand (LG, GE, Whirlpool, and Kenmore), configuration (side-by-side and French door), internal capacity (23.78, 24.52, 25.34, and 25.83 cubic feet), external dispenser (none, ice only, water only, or both ice and water), and ENERGY STAR label (yes, and no). A “None” option was also available to the respondents (Vermeulen, Goos and Vandebroek, 2008). Thus, a total of four choices were available to the respondents in each choice task. An example of one of the choice tasks is provided in Figure 2-4.

Several sets of Likert-scale questions were presented to respondents following the conjoint choice experiment. These questions focused on respondent behavior and attitudes toward the environment and climate change. Some of the questions were based on the New Ecological Paradigm (Dunlap, van Liere, Mertig, and Jones, 2000). Further, the data were complemented with individual demographic characteristics provided by KN.

Econometric Framework

The data collected from responses to the choice tasks reflect respondents' preferences for the alternatives that are described by the attributes. Such preferences usually vary based on the differences in attributes that define each alternative, and can be used to examine WTP for attribute changes (Adamowicz et al., 1998). Consumer preferences can be characterized using a random utility model (RUM). A RUM can be expressed as (McFadden, 1974):

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

where U_{ij} is the utility individual i receives from choosing alternative j ($j \in J$). $V_{ij} = V(X_{ij})$ is the “approximated” utility characterized by a vector of observable attributes, X_{ij} . β is a vector that measures the weights that the individual places on these attributes, and ε_{ij} represents all other unobservable and unknown factors and is treated as random. Utility is assumed to be strictly monotonic, homogeneous of degree zero and quasi convex in all income and prices. Individual i chooses alternative j if $U_{ij} > U_{is}, \forall j \neq s$ and $j, s \in J$. The outcome of the model can then be predicted through estimation of the probability that the alternative j is chosen, and the estimation is heavily influenced by the assumptions placed on the error terms.

Conditional Logit

If one assumes that the error terms are independent and identically distributed (IID) with extreme values across individuals, then the probability that the individual

chooses alternative j can be estimated using the conditional logit (CL) model (McFadden, 1974):

$$P_{ij} = \exp(\boldsymbol{\beta}'\mathbf{X}_{ij}) / \sum_{k=1}^J \exp(\boldsymbol{\beta}'\mathbf{X}_{ik}) \quad (2)$$

The maximum likelihood estimated parameter vector $\hat{\boldsymbol{\beta}}$ is defined through maximizing the sample log-likelihood:

$$\log(L(\boldsymbol{\beta})) = \sum_{i=1}^N \sum_{j=1}^J \kappa_{ij} \ln P_{ij} \quad (3)$$

where κ_{ij} is a dichotomous indicator such that $\kappa_{ij} = 1$ if alternative j is chosen and zero if not.

Independence of Irrelevant Alternatives

As is commonly acknowledged, there are several limitations to the CL model. One such limitation is the property that the relative odds ratio of choosing one alternative against any other alternative is not affected by any factors other than the attributes of the two alternatives:

$$\frac{P_{ij}}{P_{is}} = \frac{\exp(\boldsymbol{\beta}'\mathbf{X}_{ij}) / \sum_{k=1}^J \exp(\boldsymbol{\beta}'\mathbf{X}_{ik})}{\exp(\boldsymbol{\beta}'\mathbf{X}_{is}) / \sum_{k=1}^J \exp(\boldsymbol{\beta}'\mathbf{X}_{ik})} = \frac{\exp(\boldsymbol{\beta}'\mathbf{X}_{ij})}{\exp(\boldsymbol{\beta}'\mathbf{X}_{is})} \quad (4)$$

This property, known as independence of irrelevant alternatives (IIA), means that the probability of choosing between any two alternatives is unaffected by the presence or absence of any other alternatives in the choice set (Train, 2003; Hensher and Greene, 2003). In addition, the CL fails to take into consideration variation across individual decision-makers' "tastes" (Train 2003) or preferences, this principle is referred to as

homogeneity across individuals (Train 2003; Hensher 2004). Even repeated and over time choices made by a single individual are considered irrelevant of each other.

Random Parameter Logit

The random parameter or mixed logit (RPL) model avoids IIA and the homogeneity of preferences limitations that characterize the CL model (McFadden and Train, 2000; Train, 2003; Hensher and Greene, 2003; Hensher, 2004). The RUM equation for the RPL model takes a similar form as in Equation (1), except that the weight parameter is treated as random and allowed to vary across individuals (and is thus marked with subscript i) in order to accommodate individual heterogeneity, or:

$$U_{ij} = \beta_i' X_{ij} + \varepsilon_{ij} \quad (5)$$

where the vector of parameters β_i represents the weights individual i places on attributes X_{ij} , and ε_{ij} is the random error term. Thus, the probability of individual i choosing alternative j is defined as:

$$P_{ij} = \int \left(\exp(\beta_i' X_{ij}) / \sum_{k=1}^J \exp(\beta_i' X_{ik}) \right) f(\beta|\mu) d\beta \quad (6)$$

where $f(\beta|\mu)$ is the density of all possible values of β_i characterized by parameters μ (Train 2003).

Because P_{ij} is now determined by an indefinite multidimensional integral that does not have a closed form solution (Train, 2000), outcomes are acquired through “simulation” which includes repeatedly drawing values of β_i from the density $f(\beta|\mu)$ and using the draws to evaluate the logit probability (Brownstone and Train, 1999; Train,

2000, 2003; Hensher and Greene, 2003). Based on the average evaluated logit probabilities from the repeated draws, the vector of maximum likelihood estimators $\hat{\mu}$ is defined by maximizing the “simulated” log-likelihood:

$$\log (L(\mu)) = \sum_{i=1}^N \sum_{j=1}^J \kappa_{ij} \ln P^{Sim}_{ij} \quad (7)$$

where P^{Sim}_{ij} is the simulated value of the probability of individual i choosing alternative j . The vector of preferences β is now determined by two elements: the mean of individual preferences for each attribute that is “fixed” and constant across the population of all individuals (“homogeneous preferences”), and the individual’s particular preferences for a certain attribute that are stochastic deviations from the mean (“random/heterogeneous preferences”). Thus, in the RPL specification, the factors that affect the utility individual i derives from choosing alternative j can now be interpreted as:

$$U_{ij} = \beta_i' X_{ij} + \varepsilon_{ij} = \mu_i' X_{ij} + (\xi_i' X_{ij} + \varepsilon_{ij}) \quad (8)$$

where μ_i stands for the homogeneous preferences, and ξ_i stands for the stochastic deviation or the heterogeneous preferences, which is assumed IID with extreme values.

Calculating Willingness-to-Pay

For the CL model, WTP for the m^{th} non-price attribute is the negative of the ratio of the estimated parameters of attribute m and the price attribute, or:

$$WTP_m = -\hat{\beta}_m / \hat{\beta}_{P_j} \quad (9)$$

where $\hat{\beta}_m$ is the estimated parameter of the m^{th} attribute and $\hat{\beta}_{p_j}$ is the estimated price parameter.

For the RPL model, the means of the estimated parameters can be used to estimate WTP (Hensher and Greene, 2003). Thus, the WTP for the m^{th} non-price attribute is:

$$WTP_m = -\hat{\mu}_m / \hat{\beta}_{p_j} \quad (10)$$

where $\hat{\mu}_m$ is the maximum likelihood estimated parameter of the m^{th} attribute and $\hat{\beta}_{p_j}$ is the estimated price parameter. For this study, each individual's utility is homogeneous of degree zero in income and prices, i.e., the parameter of price is assumed “fixed” with random deviation equal to zero⁶.

Incorporating Demographic Characteristics

Differences in demographic, socioeconomic and other individual characteristics can also be incorporated into the analysis, by creating interaction terms of between product attributes and these characteristics in both the CL (Steckel and Vanhonacker, 1988) and the RPL (Gonul and Srinivasan, 1993; Brandt, Lavin and Hanemann, 2008) models. With interaction terms, the RUM equation for the CL model is defined as:

$$U_{ij} = \beta'X_{ij} + \theta_i'(Z_iX_{ij}) + \varepsilon_{ij} \quad (11)$$

⁶ This assumption does not have to be made, particularly if one defines the price parameter to be distributed other than normally and finds evidence that there are random effects in the price parameter. See Hensher and Greene (2003) for details on different possible distributions.

where Z_i is a vector of characteristics for individual i and θ_i is a vector of parameters for the interaction terms, $Z_i X_{ij}$. The WTP for the m^{th} non-price attribute is then obtained as follows:

$$WTP_m = -\frac{\hat{\beta}_m + \hat{\theta}_i' \bar{Z}_i}{\hat{\beta}_{P_j}} \quad (12)$$

where $\hat{\beta}_m$ is the estimated parameter of the m^{th} attribute, $\hat{\beta}_{P_j}$ is the estimated price parameter, $\hat{\theta}_i$ is the estimated vector of parameters and $\bar{Z}_i$ is the sample mean of individual characteristics. Similarly, the RUM equation for the RPL model is:

$$U_{ij} = \mu_i' X_{ij} + \xi_i' X_{ij} + \theta_i' (Z_i X_{ij}) + \varepsilon_{ij} \quad (13)$$

In this case, WTP for the m^{th} non-price attribute is obtained as follows:

$$WTP_m = -\frac{\hat{\mu}_m + \hat{\theta}_i' \bar{Z}_i}{\hat{\beta}_{P_j}} \quad (14)$$

Selection of the Random Terms

When estimating an RPL model with many attributes, it is important to investigate the candidates for random parameters. Theoretically, this procedure is needed to ensure that the specification of an RPL model is appropriate. Practically, this procedure is necessary because of the limitations of statistical software packages. For example, in the STATA software package, the maximum number of random parameters allowed in one equation is 20. Previous studies have suggested several approaches to investigate this issue. Estimating a CL model would be a “good starting point”, as it would help to ensure that the data are clean (Hensher and Greene, 2003) and the

significances of parameters from a preliminary model that has less complex relationships among variables (Louviere, Hensher and Swait, 2000) can help establish candidate attributes. Once a (preliminary) set of candidates are obtained, they can be further tested for the significances of the random effects.

One option is the Lagrange Multiplier test proposed in McFadden and Train (1998) for the significance of random error components. The test procedure was succinctly summarized by Brownstone (2001) and works by constructing artificial variables:

$$W_{ij} = (X_{ij} - \bar{X}_j)^2, \text{ with } \bar{X}_j = \sum X_{ij}P_{ij} \quad (15)$$

where P_{ij} is the CL choice probability. The CL model is then re-estimated including these artificial variables. The null hypothesis of no random effects in attributes X_{ij} is then rejected if the coefficients of the artificial variables W_{ij} are significantly different from zero. A Wald or likelihood ratio test statistic can also be used to carry out the actual test for the joint significance of the artificial variables. These tests can be carried out with most software packages that estimate the CL models. However, because these tests are only for the joint significances of variables, they are not as useful for identifying which parameters to randomize in an RPL model specification (Hensher and Greene, 2003).

Another test is to run the RPL model assuming all parameters are random, and then examine the significances of the estimated standard deviations using a zero-based t -test for individual parameters and a likelihood-ratio (LR) test for the overall contribution of the additional information (Hensher and Greene, 2003). However, when a large

number of explanatory variables are included, it can be problematic to run the model with a full set of random parameters.

In this study, we use the LR test suggested in Hensher and Green (2003) to test the significance of our choice of random parameters. Since we have more than 30 variables in the model, which exceeds the limit of variables allowed to be randomized in STATA, we were not able to test neither the overall nor the individual significance of the random effects for all of the variables. Still, we managed to put those fixed parameters into several groups and do the LR test one at a time for each group, and it appears from the results presented in Table 2-12 that our established form of random parameters is acceptable⁷.

Simulation with Halton Random Draws

The estimation process for the RPL models involves random draws of possible parameter values, which rely on Halton sequences (Halton, 1960). The methodology of Halton draws used for RPL estimation is defined as follows (Train, 2000): 1) generate a Halton sequence for each dimension of the mixing distribution $f(\boldsymbol{\beta}|\boldsymbol{\mu})$ using prime numbers; and 2) calculate for each element of each sequence the inverse of the cumulative mixing distribution that is appropriate for that dimension. For example, calculate the inverse cumulative normal distribution of each element of each sequence if $f(\boldsymbol{\beta}|\boldsymbol{\mu})$ is normally distributed. The results are the Halton draws from the mixing distribution. The length of each sequence is determined by the number of observations (N) and the number of draws performed (R), and $(N \times R) + 10$ elements are generated.

⁷ The groups of explanatory variables with “fixed” parameters, except the price variable, are: age and gender, income, education, race”, location, household characteristics, and attitudes.

Theory suggests dropping the first ten elements of each sequence because they tend to be highly correlated; after dropping those elements, each of the next R elements are used for each observation (Train, 2000).

In applications, the simulation process usually requires a large number of Halton draws to assure low simulation errors (Train, 2000), which translates into extended processing time (Train, 2000; Bhat, 2001; Hensher and Greene, 2003; Chang and Lusk, 2011). There is no generally agreed standard on how large the number of draws needs to be, but a generally agreed idea is that the draws are sufficient when the random parameters are confirmed “stable” (Hensher and Greene 2003). So how many draws are sufficient? With an example model of three alternatives and two random parameters, Hensher and Greene (2003) stated that as low as 25 “intelligent” draws are “sufficient to produce stability ... although 100 appear to be a ‘good’ number”. Similarly, Bhat (2001) and Train (2003) suggested that, in a model with a relatively small number of alternatives and observations, simulation variance in the estimated parameters was lower using 100 than 1,000 Halton draws. However, more complex models with more random parameters and larger sample sizes require more draws (Hensher and Greene, 2003), and for this analysis, 1,000 Halton random draws were used to estimate the RPL models.

To analyze WTP for ENERGY STAR labels, and compare the potential differences between WTP for the label with and without rebates, we employ both the CL and the RPL models. For each version of survey data, a CL and an RPL model, consisting of only the product attributes, and a CL and an RPL model, consisting of both the attribute variables and interaction terms between the ENERGY STAR label and all

demographic, attitudinal and other factors were estimated. Model estimation was conducted with the STATA software package and for the RPL models, the *mixlogit* module (Hole, 2007).

Variables and Model Specification

Variable names, definitions and descriptions, along with sample statistics, are presented in Table 2-1. The product attribute variables included in this study are price (*Price*), capacity (*Capacity*), three binary variables for brands (*LG*, *GE*, and *Kenmore*, where *Whirlpool* is the base case), one binary variable for configuration (*Frenchdoor*, where the *Side-by-Side* is the base case), three binary variables for the design of external dispensers (*Ice* for ice-only dispensers, *Water* for water-only, and *IandW* for both ice and water, where no external dispenser is the base case), and the variable for the ENERGY STAR certification (*Label*). All product attributes but price were randomized in the RPL models. Assuming the price parameter to be “fixed” allows us to obtain normally distributed estimates of WTP for the non-price attributes (Train, 2000). In addition to the product attribute variables, an alternative specific constant (*ASC*) was created to indicate the “None” option, where $ASC = 1$ for the none option.

Age, gender, race, household income, education, number of household members, ownership status of living quarters, and residential location enter the models by interacting with the *Label* variable. Including socioeconomic characteristics allows us to account for heterogeneous preferences among different individuals. Previous studies have suggested possible effects of these characteristics:

- Age was found to be positively related to participation in green electricity programs (Clark, Kotchen, and Moore, 2003), but negatively related to WTP of metropolitan residents in East Berlin for foods that are produced with techniques consistent with environmental stewardship (Moon, Florkowski, Bruckner and Schonhof, 2002). We expect age to be negatively related to WTP for *Label*, as younger people might be more amenable to purchase of eco-labeling products.
- Education was found to have a positive impact on consumer demand for eco-labeled apples (Blend and van Ravenswaay, 1999), but a negative impact on consumer demand for eco-labeled seafoods (Johnson, Wessells, Donath and Asche, 2001). In this study, we assume that more education leads to better understanding of the labeling program and the attributes and functions of a labeled refrigerator, and thus education should have positive effects on WTP for the label.
- Females have been found to have stronger environmental attitudes and behaviors than males (Zelezny, Chua and Aldrich, 2000). Specifically, females with presence of children and a large household size are found with higher concerns of environmental quality and thus have higher WTP for eco-labeled food (Loureiro, McCluskey and Mittelhammer, 2002). Thus, we hypothesize that female respondents will have higher WTP for the label than the male respondents, and a larger household size will have a positive impact on the WTP for the label.
- The status of living quarters has been found to be highly correlated with the households' attitudes towards energy efficient appliances. Davis (2010) compared the appliance ownership patterns between homeowners and renters and

suggested that renters are significantly less likely to have energy efficient refrigerators and other appliances. Thus, we expect to find that renters have a lower WTP for the ENERGY STAR label than homeowners.

- To capture the possible impacts of regional differences in energy costs on consumer preferences, we include a variable that defines the average electricity rate per kilowatt-hour (*Kwh*) by county. Ward et al. (2011) found electricity rate to be significantly and positively related with consumer preferences for ENERGY STAR labeled refrigerators. We expect to find similar results.

We used factor analysis (FA) to retrieve the latent “factors” from responses to the Likert-scale questions asking respondents about their environmental attitudes and awareness. FA assumes that observed variables are linear combinations of underlying unobserved variables, a.k.a. “factors” and error terms; some of the factors are considered “unique” to two or more variables and will not contribute to covariation, while the “common” factors will. Therefore through estimating interdependencies among those variables, common factors can be determined and scales or factor scores can be constructed (Kim and Mueller, 1978). Using the *factor* command in STATA, a preliminary factor analysis was applied on the responses to the opinion questions, and the VARIMAX method was applied to the results (Johnston, Wessells, Donath and Asche, 2001). The initial analysis gave a set of five estimated factors, and only the first two factors were kept as they were the only two factors with eigenvalues that exceeded the threshold eigenvalue of one (Variyam, Jordan and Epperson, 1990). The STATA *predict* command generated scores for these two factors. These factors can be characterized

based on the questions included in each as: 1) the perception of consumer effectiveness in the effects of their behaviors on the environmental quality and the manufacturers (*PCE*); and 2) attitudes towards and awareness of global climate change (*GCC*). Chronbach's alpha (Chronbach, 1970) was used to test the reliability of the resulting factor scores, and both appeared to be reliable. The factor weights and scores can be found in Table 2-3.

Results

The total possible records for the choice experiment is $14 \times 4 \times N$ (N = number of respondents), where $N = 355$ for the without rebate version of the survey (19,880 possible records), and $N = 349$ for the with rebate version (19,544 possible records). Taking out missing values, the actual number of records obtained and relevant to this study was 19,132 for the without rebate version, and 18,276 for the with rebate version.

The estimation results for the CL and RPL models are presented in Table 2-4 through 2-7. The fact that all or most of the random deviations of the RPL estimate results are significant at a 1% level or higher indicates that the application of RPL models to these data sets is warranted. Further, the log-likelihood values are significantly greater for the RPL models than the CL models for both regressions with only explanatory variables for product attributes and with all factors, and for both refrigerators with rebate and without rebate. A simple likelihood-ratio test also showed that the RPL models are preferred to the CL models (degrees of freedom = 10, and all tests have significantly large test statistics; see Tables 2-4 through 2-7). Furthermore, similar likelihood-ratio tests also suggested that the inclusion of factors representing respondents' demographic and socioeconomic characteristics is justified and preferred to the attribute only models.

As expected, the estimated parameters for the price variables are significant and negative for all models, implying that refrigerators are normal goods and that respondents are price-sensitive.

The ENERGY STAR variable parameters are positive and significant (1% or higher level of significance) in six of the eight models. The lone exceptions are the CL and RPL models with all factors for the ENERGY STAR without rebate. Generally, the variables for refrigerator brands have negative parameters and are not significant, except that the variable for the brand of LG is negative and significant in all model specifications while Kenmore and GE are negative and significant in some models. These results suggest that Whirlpool, the base case, is clearly preferred to LG and somewhat preferred to Kenmore and GE. The parameter estimates for refrigerator capacity are significant and positive in all models. Similarly, the parameter estimates for external dispensers of water, ice or both water and ice (*Water*, *Ice* and *IandW*) are generally positive and significant. Refrigerator configuration, i.e. French door or Side by side (*Frenchdoor*), is not significant in any of the models.

The estimated parameters for the interaction terms between demographic, socioeconomic and attitudinal variables and the label variable have various outcomes. The variable for age ($Age \times Label$) has negative and significant parameters in the with rebate CL model but positive and significant parameters in without rebate CL model. The variable for squared age ($Age^2 \times Label$) is also significant in these two models, but with opposite signs.

Male is negative and significant in both of the with rebate models but insignificant in both of the without rebate models. When significant, the race variables ($White \times Label$, $Black \times Label$, and $Hispanic \times Label$) are negative.

The education variables ($College \times Label$ and $Bachelor \times Label$) are generally positive and significant in the with rebate models, but are not significant in either of the two without rebate models.

Of the variables representing income ($Inc1 \times Label$, or income between \$30,000 to \$60,000; $Inc2 \times Label$, or \$60,000 to \$85,000; and $Inc3 \times Label$, or income more than \$85,000 per year), only the highest category was positive and significant in both CL models while the second highest was negative and significant in the with rebate RPL model. The fact that respondents of the lowest range of income level showed higher interests in labeled refrigerators, supports our hypothesis that the private benefits from energy cost-saving can attract consumers to purchase energy efficient refrigerators. Meanwhile, we might also infer from the fact that respondents of the highest range of income level showed even higher interests to support our hypothesis that WTP is positively correlated with income.

The parameter estimate for household size ($HHSize \times Label$) was negative and significant for the with rebate CL model but positive and insignificant otherwise. Larger families imply more frequent refrigerator use (more things to be refrigerated and more often the refrigerator doors are opened and closed) and, thus, higher energy consumptions. Therefore energy efficient refrigerators may appear as better choices. The parameter estimate for home ownership ($Ownership \times Label$) was positive and significant in the

with rebate RPL model but insignificant otherwise. This result indicates that if respondents live in rented places, they are likely to have limited choices of refrigerators because they may not be able to bring or purchase their own refrigerators with them, or that they have limited income and cannot afford purchasing houses or appliances.

Residential location does not have a constant effect in all models. Compared to the base case of respondents living in western U.S., the parameter estimate for living in the South ($South \times Label$) was negative and significant for the without rebate RPL model and positive and significant for the with rebate CL model, but insignificant otherwise. On the other hand, compared with rural residents, the estimate parameter for urban residents ($Metro \times Label$) was positive and significant for the without rebate CL model, but negative and significant for the with rebate CL and RPL models.

The estimated parameter for attitudinal variable reflecting respondents' perceived consumer effectiveness ($PCE \times Label$) was positive and significant in with rebate RPL model, and the estimated parameters for environmental concerns towards global climate change ($GCC \times Label$) were positive and significant in all models, which meet our hypothesis that consumers who believe their collective actions can have significant effects and who have higher environmental concerns are more likely to engage in environmentally oriented actions, such as purchasing eco-labeled refrigerators. The lone unexpected results were that the estimated parameters for PCE were not significant in without rebate CL and RPL models, and that the estimated parameter for PCE was negative and significant in the with rebate CL model.

Further, it is shown that respondents who live in regions with higher electricity prices ($Kwh \times Label$) are more willing to buy ENERGY STAR refrigerators regardless of whether these refrigerators are with or without rebates.

Estimated Willingness-to-Pay

Estimates of WTP for all of the refrigerator attributes are presented in Tables 2-8 through 2-10. Estimates of WTP for the ENERGY STAR label are positive and significant for all models. The WTP estimates using the RPL model results are, on average, larger than the WTP estimates using the CL model results. Similarly, the models including attributes and interactions generate higher WTP estimates than the models using product attributes only in all cases except the without rebate CL model.

Furthermore, for the attribute only models, WTP for the ENERGY STAR label with rebate are, on average, lower than WTP for the label without rebate. However, when all interactions are included, WTP estimated from the with rebate models are higher than WTP estimated from the without rebate models. Overall, the highest WTP estimate is associated with the with rebate RPL model that includes both attributes and interactions (\$394.28).

Conclusions and Implications

In this study, we used data collected from contingent choice experiments for consumer preferences for refrigerators and the USEPA ENERGY STAR eco-labeling program. In general, the findings from this study provide evidence that refrigerator consumers are willing to pay significantly more for refrigerators that have been awarded

the USEPA ENERGY STAR label. Depending on the econometric models used, the WTP estimates for the ENERGY STAR label range from \$81.68 to \$394.28.

We also examined the effect of offering a \$50 mail-in rebate for ENERGY STAR qualified refrigerators. The results of our study suggest that WTP differed but not necessarily in the way one might expect. Normally, we found that, when including interactions between individual characteristics and the label attribute, consumers have higher WTP for refrigerators that are sold with a rebate. Overall, this result may inform government agencies and other regulators that the practice of applying eco-labels to energy-consuming appliances such as refrigerators can influence consumer behavior and provide incentives for manufacturers to produce more energy efficient appliances.

We have also investigated the motivations for consumers to purchase eco-labeled refrigerators. Similar to findings of previous studies, we found that age, education level, gender, and income all have significant effects, while factors such as numbers of family members, living quarter ownership status, locations of residency and whether living in rural or urban areas also play important roles.

Not surprisingly, we also found that environmentally concerned consumers and those who believed that their consumption decisions would have an positive impact are more willing to purchase environment-friendly products such as eco-labeled refrigerators. On the other hand, consumers who care about private benefits such as energy cost savings are also more willing to purchase eco-labeled refrigerators. Taken together, these results suggest that government sponsored eco-labeling programs can help reduce market failures associated with environmental externalities and information asymmetry.

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Figures and Tables



Figure 2-1. ENERGY STAR[®] Label

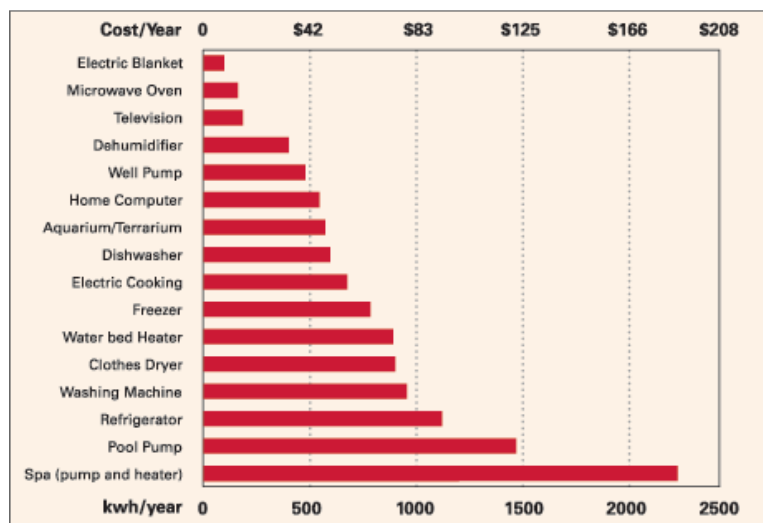


Figure 2-2. Energy Consumption of Various Home Appliances

Source: USDOE, Energy Efficiency and Renewable Energy (EERE).
<http://www1.eere.energy.gov/consumer/tips/appliances.html>



All refrigerators sold in the US are required to meet federal standards limiting their energy consumption. ENERGY STAR refrigerators consume at least 20% less energy than the federal standard.

An ENERGY STAR refrigerator will save a household in your region of the country about \$14 per year in electricity costs over a refrigerator that only meets the federal standard.

By consuming less electricity, ENERGY STAR refrigerators also reduce the emission of greenhouse gases associated with energy production. Studies suggest that greenhouse gases contribute to global climate change.

Would you like more information on ENERGY STAR or are you ready to proceed with the survey?

Select one answer only

☒ Ready to proceed

☐ Would like more information

ENERGY STAR is a voluntary labeling program, jointly administered by the U.S. Environmental Protection Agency and the U.S. Department of Energy to identify and promote energy-efficient products to reduce greenhouse gas emissions.

ENERGY STAR, which began in 1992 with a label for computers, now applies to over 60 product categories for the home and office.

Products awarded the ENERGY STAR deliver the same or better performance as comparable models while using less energy and reducing electricity costs.

Figure 2-3: Example of Energy Star Information Screen

If you needed to buy a refrigerator and these were your only options, which would you choose?

You may assume that all of these choices fit in the space that you have for a refrigerator, are available in the color or finish that you want, and have both automatic defrost and a built-in icemaker.

Please select a refrigerator by clicking one of the buttons below:

	Alternative 1	Alternative 2	Alternative 3	NONE: I wouldn't choose any of these ☐
Price	\$929	\$1,029	\$929	
Brand	General Electric	Kenmore	LG	
Configuration	Side-by-side	French door	Side-by-side	
Capacity (cu. ft.)	23.78	25.34	24.52	
Through-the-Door Dispenser	Water	Ice	Ice & Water	
Energy Star	No	Yes	Yes	
Your choice	☐	☐	☐	

Next

Figure 2-4. Example of Sample Choice Experiment Task

Table 2-1. Variable Names, Definitions and Sample Statistics

Variable	Definition and Description	Sample Means	
		No Rebate	Rebate
Dependent Variable		N = 19132	N=18276
<i>Chosen</i>	1 if the alternative is chosen, 0 otherwise	0.25	0.25
Explanatory Variable			
<i>Price</i>	\$879, \$929, \$979, or \$1,029	715.854	715.947
<i>Label</i>	1 if Energy Star qualified, 0 if not	0.385	0.383
<i>Capacity</i>	23.78, 24.52, 25.34, 25.83 cubic feet	18.631	18.633
<i>Frenchdoor</i>	1 if French door style, 0 if side-by-side	0.385	0.383
Refrigerator Brands (with "Whirlpool" as base case)			
<i>LG</i>	1 if LG brand, 0 otherwise	0.199	0.200
<i>GE</i>	1 if GE brand, 0 otherwise	0.185	0.183
<i>Kenmore</i>	1 if Kenmore brand, 0 otherwise	0.183	0.183
External Dispenser Type (with "No Ice or Water" as base case)			
<i>Ice</i>	1 if equipped with external dispenser of ice only, 0 otherwise	0.201	0.201
<i>Water</i>	1 if equipped with external dispenser of water only, 0 otherwise	0.184	0.182
<i>IandW</i>	1 if equipped with external dispenser of both ice & water, 0 otherwise	0.180	0.183
<i>ASC</i>	1 if “None” option, 0 otherwise	0.25	0.25
<i>Age</i>	Age of respondent in years divided by 10	1.780	1.772
<i>Age2</i>	<i>Age</i> * <i>Age</i>	0.927	0.928
<i>Male</i>	1 if male, 0 otherwise	0.188	0.178
Race (with "Non-White, Black nor Hispanic" as base case)			
<i>White</i>	1 if White	0.267	0.263
<i>Black</i>	1 if African-American	0.044	0.046
<i>Hispanic</i>	1 if Hispanic	0.047	0.053
Education (with "Less than college level education" as base case)			
<i>College</i>	1 if have some college level education	0.111	0.110
<i>Bachelor</i>	1 if hold bachelor's or higher degree	0.101	0.101
Household Income (with "Less than \$30,000" as base case)			
<i>Inc1</i>	1 if \$30,000 to \$60,000	0.134	0.121
<i>Inc2</i>	1 if \$60,000 to \$85,000	0.062	0.076

(Continued from Table 2-1)

Variable	Definition and Description	Sample Means	
		No Rebate	Rebate
<i>Inc3</i>	1 if \$85,000 or higher	0.081	0.083
<i>HHSize</i>	Head count of household members, 1-10	1.003	1.013
<i>Ownership</i>	1 if Own the current living quarters, 0 if rent or others	0.270	0.276
Residential location (with "West" as base case)			
<i>NE</i>	1 if reside in Northeast	0.075	0.071
<i>MW</i>	1 if reside in Midwest	0.087	0.086
<i>South</i>	1 if reside in South	0.136	0.140
<i>Metro</i>	1 if reside in metropolitan areas	0.323	0.325
<i>PCE</i>	Factor analysis index score for perceived consumer effectiveness	-0.006	-0.009
<i>GCC</i>	Factor analysis index score for attitude towards global climate change	0.010	0.033
<i>Kwh</i>	Average price of electricity by county of residence (cents per kWh)	4.581	4.648

Table 2-2. Attitudinal Questions Included in the Study*

-
1. When I buy products, I consider how my use of them will affect the environment.
 2. By choosing environmentally friendly products, I signal to manufacturers the types of products they should be producing.
 3. Global climate change will have a noticeably negative impact on the environment in which my family and I live.
 4. There is no urgent need to take measures to prevent global climate change today.
 5. The production of electricity from renewable sources such as solar, wind and biomass is an effective way to combat global climate change.
 6. The most effective way to combat global climate change is to reduce energy consumption.
 7. We need more government regulations to force people to protect the environment.

* Likert-scale answer choices: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly Agree.

Table 2-3. Factor Analysis Index for Attitudinal Questions

	Chronbach's alpha	Factor Weight
1. Perceived Consumer Effectiveness (<i>PCE</i>)	0.7937	
1-1. When I buy products, I consider how my use of them will affect the environment.		0.6517
1-2. By choosing environmentally friendly products, I signal to manufacturers the types of products they should be producing.		0.6408
2. Attitudes towards Global Climate Change (<i>GCC</i>)	0.7903	
2-1. Global climate change will have a noticeably negative impact on the environment in which my family and I live.		0.6450
2-2. There is no urgent need to take measures to prevent global climate change today.		-0.5585
2-3. The production of electricity from renewable sources such as solar, wind and biomass is an effective way to combat global climate change.		0.6456
2-4. The most effective way to combat global climate change is to reduce energy consumption.		0.6983
2-5. We need more government regulations to force people to protect the environment.		0.5761

Table 2-4. Conditional and Random Parameter Logit Results for without Rebate Attribute Only Models

	Conditional Logit			Random Parameter Logit		
Variable	Estimate	Std. Error	p-value	Mean of Est.	Std. Error	p-value
<i>Price</i>	-0.004***	0.000	0.000	-0.008***	0.001	0.000
<i>Label</i>	1.021***	0.053	0.000	2.214***	0.214	0.000
<i>Capacity</i>	0.096***	0.032	0.003	0.164***	0.060	0.007
<i>Frenchdoor</i>	-0.064	0.050	0.194	-0.142	0.329	0.666
<i>LG</i>	-0.250***	0.072	0.000	-0.509***	0.122	0.000
<i>GE</i>	-0.100	0.070	0.154	-0.196*	0.108	0.070
<i>Kenmore</i>	-0.149**	0.071	0.035	-0.244*	0.130	0.061
<i>Ice</i>	0.297***	0.074	0.000	0.375*	0.219	0.086
<i>Water</i>	0.242***	0.076	0.002	0.282*	0.156	0.069
<i>IandW</i>	1.004***	0.071	0.000	1.685***	0.352	0.000
<i>ASC</i>	-0.313	0.898	0.727	-1.910	1.738	0.272
<u>Random Deviation</u>						
<i>Label</i>				2.088***	0.250	0.000
<i>Capacity</i>				0.098**	0.049	0.047
<i>Frenchdoor</i>				2.769***	0.316	0.000
<i>LG</i>				-0.594***	0.217	0.006
<i>GE</i>				0.442	0.716	0.537
<i>Kenmore</i>				0.842***	0.174	0.000
<i>Ice</i>				1.048***	0.207	0.000
<i>Water</i>				0.889***	0.357	0.013
<i>IandW</i>				2.107***	0.455	0.000
<i>ASC</i>				-3.779***	0.389	0.000
Log-likelihood	-6158.371			-4179.520		
Log-likelihood ratio (LR) Test: LR Statistic = 3957.702, degrees of freedom (df) = 10						

Note: *, **, and *** indicate significance at 10%, 5% and 1% levels, respectively.

Table 2-5. Conditional and Random Parameter Logit Results for without Rebate All Factors Models

Variable	Conditional Logit			Random Parameter Logit		
	Estimate	Std. Error	p-value	Mean of Est.	Std. Error	p-value
<i>Price</i>	-0.004***	0.000	0.000	-0.008***	0.001	0.000
<i>Label</i>	-0.112	0.432	0.796	2.662	2.210	0.228
<i>Capacity</i>	0.108***	0.033	0.001	0.092*	0.055	0.093
<i>Frenchdoor</i>	-0.002	0.051	0.964	-0.149	0.313	0.634
<i>LG</i>	-0.247***	0.073	0.001	-0.405***	0.111	0.000
<i>GE</i>	-0.112	0.072	0.118	-0.193*	0.117	0.100
<i>Kenmore</i>	-0.182***	0.072	0.011	-0.149	0.129	0.246
<i>Ice</i>	0.265***	0.075	0.000	0.353**	0.162	0.029
<i>Water</i>	0.205***	0.079	0.010	0.191	0.145	0.188
<i>IandW</i>	0.952***	0.073	0.000	1.502***	0.249	0.000
<i>ASC</i>	0.061	0.911	0.946	-3.215*	1.789	0.072
<i>Age × Label</i>	0.325**	0.140	0.020	-0.407	0.481	0.398
<i>Age2 × Label</i>	-0.436***	0.144	0.002	0.267	0.486	0.583
<i>Male × Label</i>	-0.063	0.076	0.411	0.511	0.343	0.136
<i>White × Label</i>	-0.492***	0.172	0.004	-0.186	1.025	0.856
<i>Black × Label</i>	0.007	0.213	0.975	-0.127	0.765	0.868
<i>Hispanic × Label</i>	-0.008	0.194	0.968	0.462	0.850	0.587
<i>College × Label</i>	-0.128	0.091	0.162	-0.006	0.395	0.988
<i>Bachelor × Label</i>	0.112	0.102	0.270	0.072	0.573	0.900
<i>Inc1 × Label</i>	-0.028	0.104	0.788	0.212	0.550	0.700
<i>Inc2 × Label</i>	-0.007	0.120	0.954	-0.628	0.482	0.192
<i>Inc3 × Label</i>	0.313***	0.127	0.014	0.937	0.770	0.224
<i>HHSIZE × Label</i>	0.016	0.029	0.593	0.103	0.104	0.321
<i>Ownership × Label</i>	0.365***	0.101	0.000	-0.189	0.599	0.752
<i>NE × Label</i>	0.156	0.135	0.249	-0.010	0.870	0.991
<i>MW × Label</i>	0.007	0.118	0.950	-0.851	0.656	0.195
<i>South × Label</i>	-0.118	0.108	0.276	-0.791*	0.470	0.092
<i>Metro × Label</i>	0.409***	0.101	0.000	0.502	0.519	0.333
<i>PCE × Label</i>	0.035	0.051	0.483	0.324	0.266	0.223
<i>GCC × Label</i>	0.241***	0.050	0.000	0.770**	0.365	0.035
<i>Kwh × Label</i>	0.034***	0.015	0.021	0.029	0.057	0.615

(Continued from Table 2-5)

Random Deviation						
Variable	Estimate	Std. Error	p-value	Mean of Est.	Std. Error	p-value
<i>Label</i>				1.740***	0.201	0.000
<i>Capacity</i>				0.179***	0.015	0.000
<i>Frenchdoor</i>				2.715***	0.505	0.000
<i>LG</i>				0.551***	0.186	0.003
<i>GE</i>				0.384	0.244	0.115
<i>Kenmore</i>				0.681**	0.306	0.026
<i>Ice</i>				1.162***	0.185	0.000
<i>Water</i>				0.832***	0.200	0.000
<i>IandW</i>				2.216***	0.219	0.000
<i>ASC</i>				2.048***	0.529	0.000
Log-likelihood	-5725.423			-3927.899		
LR Test: LR Statistic = 3595.048, df = 10						

Note: *, **, and *** indicate significance at 10%, 5% and 1% levels, respectively.

Table 2-6. Conditional and Random Parameter Logit Results for with Rebate Attribute Only Models

	Conditional Logit			Random Parameter Logit		
Variable	Estimate	Std. Error	p-value	Mean of Est.	Std. Error	p-value
<i>Price</i>	-0.006***	0.000	0.000	-0.011***	0.001	0.000
<i>Label</i>	1.041***	0.054	0.000	2.302***	0.217	0.000
<i>Capacity</i>	0.079**	0.033	0.017	0.133**	0.054	0.015
<i>Frenchdoor</i>	-0.028	0.052	0.595	0.139	0.204	0.495
<i>LG</i>	-0.244***	0.075	0.001	-0.323***	0.121	0.008
<i>GE</i>	-0.003	0.071	0.964	-0.048	0.143	0.737
<i>Kenmore</i>	-0.078	0.076	0.300	-0.086	0.125	0.490
<i>Ice</i>	0.378***	0.078	0.000	0.501**	0.200	0.012
<i>Water</i>	0.348***	0.079	0.000	0.450**	0.186	0.016
<i>IandW</i>	1.140***	0.075	0.000	2.103***	0.281	0.000
<i>ASC</i>	-2.434***	0.926	0.009	-6.177***	1.781	0.001
<u>Random Deviation</u>						
<i>Label</i>				2.135***	0.163	0.000
<i>Capacity</i>				0.154***	0.012	0.000
<i>Frenchdoor</i>				2.750***	0.230	0.000
<i>LG</i>				-0.509***	0.174	0.003
<i>GE</i>				-0.852***	0.170	0.000
<i>Kenmore</i>				0.573***	0.201	0.004
<i>Ice</i>				1.496***	0.191	0.000
<i>Water</i>				0.995***	0.227	0.000
<i>IandW</i>				2.112***	0.256	0.000
<i>ASC</i>				-1.452***	0.213	0.000
Log-likelihood	-5973.480			-4107.376		
LR Test: LR Statistic = 3732.208, df = 10						

Note: *, **, and *** indicate significance at 10%, 5% and 1% levels, respectively.

Table 2-7. Conditional and Random Parameter Logit Results for with Rebate All Factors Models

Variable	Conditional Logit			Random Parameter Logit		
	Estimate	Std. Error	p-value	Mean of Est.	Std. Error	p-value
<i>Price</i>	-0.006***	0.000	0.000	-0.011***	0.001	0.000
<i>Label</i>	2.601***	0.440	0.000	5.572***	1.414	0.000
<i>Capacity</i>	0.076***	0.035	0.028	0.130**	0.061	0.034
<i>Frenchdoor</i>	-0.058	0.055	0.284	-0.156	0.240	0.516
<i>LG</i>	-0.236***	0.079	0.003	-0.351**	0.147	0.017
<i>GE</i>	0.015	0.075	0.839	0.010	0.155	0.947
<i>Kenmore</i>	-0.076	0.079	0.332	-0.118	0.135	0.379
<i>Ice</i>	0.359***	0.081	0.000	0.495**	0.209	0.018
<i>Water</i>	0.321***	0.082	0.000	0.433**	0.207	0.036
<i>IandW</i>	1.143***	0.078	0.000	2.055***	0.297	0.000
<i>ASC</i>	-2.617***	0.959	0.006	-6.424***	1.860	0.001
<i>Age × Label</i>	-0.378***	0.129	0.003	-0.831	0.526	0.114
<i>Age2 × Label</i>	0.313***	0.125	0.012	0.816	0.540	0.131
<i>Male × Label</i>	-0.252***	0.084	0.003	-0.670**	0.306	0.028
<i>White × Label</i>	-0.753***	0.211	0.000	-2.119**	0.895	0.018
<i>Black × Label</i>	-0.994***	0.243	0.000	-3.158***	0.961	0.001
<i>Hispanic × Label</i>	-0.360	0.236	0.126	-1.551*	0.893	0.082
<i>College × Label</i>	0.204**	0.099	0.039	0.743**	0.369	0.044
<i>Bachelor × Label</i>	0.218**	0.109	0.047	0.299	0.326	0.358
<i>Inc1 × Label</i>	-0.093	0.111	0.401	-0.200	0.416	0.631
<i>Inc2 × Label</i>	-0.091	0.129	0.480	-1.751***	0.405	0.000
<i>Inc3 × Label</i>	0.323**	0.139	0.020	-0.580	0.427	0.174
<i>HHSIZE × Label</i>	-0.061*	0.033	0.066	0.052	0.083	0.533
<i>Ownership × Label</i>	0.033	0.112	0.770	2.088***	0.396	0.000
<i>NE × Label</i>	0.069	0.139	0.621	-0.578	0.502	0.250
<i>MW × Label</i>	-0.053	0.136	0.698	-0.336	0.412	0.414
<i>South × Label</i>	0.203*	0.114	0.075	-0.040	0.370	0.913
<i>Metro × Label</i>	-0.326***	0.118	0.006	-1.192***	0.367	0.001
<i>PCE × Label</i>	-0.121**	0.054	0.026	0.522*	0.290	0.072
<i>GCC × Label</i>	0.148***	0.055	0.007	0.739***	0.201	0.000
<i>Kwh × Label</i>	0.039***	0.015	0.009	0.083*	0.048	0.081

(Continued from previous page)

Random Deviation						
Variable	Estimate	Std. Error	p-value	Mean of Est.	Std. Error	p-value
<i>Label</i>				2.336***	0.196	0.000
<i>Capacity</i>				0.162***	0.013	0.000
<i>Frenchdoor</i>				3.015***	0.229	0.000
<i>LG</i>				0.710***	0.129	0.000
<i>GE</i>				0.970***	0.181	0.000
<i>Kenmore</i>				0.642***	0.190	0.001
<i>Ice</i>				1.447***	0.287	0.000
<i>Water</i>				1.173***	0.231	0.000
<i>IandW</i>				2.309***	0.220	0.000
<i>ASC</i>				0.656***	0.163	0.000
Log-likelihood	-5469.061			-3822.744		
LR Test: LR Statistic = 3292.634, df = 10						

Note: *, **, and *** indicate significance at 10%, 5% and 1% levels, respectively.

Table 2-8. Estimated WTP for Refrigerator Attributes for without Rebate Survey

Attributes only				
Attribute	Conditional Logit		Random Parameter Logit	
	Mean Estimate	Std. Error.	Mean Estimate	Std. Error.
<i>Label</i>	244.064***	28.4255	285.002***	53.644
<i>Capacity</i>	23.077***	8.1214	21.098***	8.253
<i>Frenchdoor</i>	-15.398*	12.2805	-17.965	42.961
<i>LG</i>	-59.539***	18.011	-65.539***	19.311
<i>GE</i>	-23.569*	16.8525	-24.489*	13.484
<i>Kenmore</i>	-35.546**	17.7903	-31.545**	18.289
<i>Ice</i>	70.985***	18.7729	47.429*	28.256
<i>Water</i>	57.928***	19.2333	36.289**	20.924
<i>IandW</i>	239.959***	31.0522	216.020***	53.673

All Factors				
Attribute	Conditional Logit		Random Parameter Logit	
	Mean Estimate	Std. Error.	Mean Estimate	Std. Error.
<i>Label</i>	81.683*	65.734	325.654*	189.030
<i>Capacity</i>	26.180***	8.480	12.287**	7.727
<i>Frenchdoor</i>	-0.671	12.465	-18.492	41.985
<i>LG</i>	-59.633***	18.459	-53.791***	18.230
<i>GE</i>	-27.055**	17.805	-24.994*	15.261
<i>Kenmore</i>	-44.127***	18.490	-20.153*	18.285
<i>Ice</i>	63.939***	18.851	47.026**	24.107
<i>Water</i>	49.570***	19.948	25.242*	19.869
<i>IandW</i>	230.360***	31.260	198.602***	44.758

Note: *, **, and *** indicate significance at 10%, 5% and 1% levels, respectively.

Table 2-9. Estimated WTP for Refrigerator Attributes for with Rebate Survey

Attributes only				
Attribute	Conditional Logit		Random Parameter Logit	
	Mean Estimate	Std. Error.	Mean Estimate	Std. Error.
<i>Label</i>	172.945***	15.513	207.831***	27.124
<i>Capacity</i>	13.179**	5.633	12.067**	5.156
<i>Frenchdoor</i>	-4.667	8.818	12.346	18.242
<i>LG</i>	-40.405**	12.673	-29.043**	11.255
<i>GE</i>	-0.401	11.937	-4.463	13.135
<i>Kenmore</i>	-12.935	12.720	-7.679	11.463
<i>Ice</i>	62.777**	13.233	44.822*	17.999
<i>Water</i>	57.800***	13.457	40.129*	16.214
<i>IandW</i>	189.415***	18.186	189.823***	30.507

All Factors				
Attribute	Conditional Logit		Random Parameter Logit	
	Mean Estimate	Std. Error.	Mean Estimate	Std. Error.
<i>Label</i>	329.791***	51.189	394.276***	92.462
<i>Capacity</i>	12.352**	5.742	11.465**	5.584
<i>Frenchdoor</i>	-9.516	9.044	-13.523	21.617
<i>LG</i>	-38.469**	13.173	-31.104**	13.200
<i>GE</i>	2.546	12.279	0.708	13.945
<i>Kenmore</i>	-12.437	12.869	-10.485	12.074
<i>Ice</i>	58.410***	13.345	43.554**	18.032
<i>Water</i>	52.299**	13.687	38.376*	18.191
<i>IandW</i>	186.096***	18.059	181.968***	30.545

Note: *, **, and *** indicate significance at 10%, 5% and 1% levels, respectively.

Table 2-10. Comparison of WTP for Energy Star Labels with and without Rebates

Attributes only				
Model Version	Conditional Logit		Random Parameter Logit	
	Mean Estimate	Std. Error.	Mean Estimate	Std. Error.
<i>Energy Star without Rebate</i>	244.064***	28.426	285.002***	53.644
<i>Energy Star with Rebate</i>	172.945***	15.513	207.831***	27.124
All Factors				
Model Version	Conditional Logit		Random Parameter Logit	
	Mean Estimate	Std. Error.	Mean Estimate	Std. Error.
<i>Energy Star without Rebate</i>	81.683*	65.734	325.654*	189.030
<i>Energy Star with Rebate</i>	329.791***	51.189	394.276***	92.462

Note: *, **, and *** indicate significance at 10%, 5% and 1% levels, respectively.

Table 2-11. Responses to Reasons Why the “None” Option was Chosen

<u>Answers</u>	<u>Frequency</u>	
	<u>No Rebate</u>	<u>With Rebate</u>
The refrigerators offered were too expensive	42	44
The refrigerators offered did not have the features you wanted	116	106
The refrigerators offered were not better than your current refrigerator	36	44
Other (Specified separately).	27	31
Total	221	225
Total Respondents	355	349

Table 2-12 Log-likelihood Ratio Tests for Determining Random Terms

<u>RPL Models for Without Rebate (Log-likelihood value = -3927.899)</u>							
	Education	Income	Race	Age and Gender	Residence Location	Household	Attitudes
Log-likelihood	-5675.709	-5669.696	-5668.019	-5645.383	-5675.948	-5690.981	-5664.487
df	2	3	3	3	4	2	3
LR Statistics	3495.620***	3483.594***	3480.240***	3434.968***	3496.098***	3526.164***	3473.175***
<u>RPL Models for With Rebate (Log-likelihood value = -3822.744)</u>							
	Education	Income	Race	Age and Gender	Residence Location	Household Characteristics	Attitudes
Log-likelihood	-5416.696	-5442.415	-5438.009	-5415.227	-5425.461	-5433.067	-5434.686
df	2	3	3	3	4	2	3
LR Statistics	3187.904***	3239.342***	3230.530***	3184.966***	3205.434***	3220.646***	3223.884***

Note: *, **, and *** indicate significance at 10%, 5% and 1% levels, respectively. LR statistics are calculated as $-2 \times (\log \text{likelihood value of the original model} - \log \text{likelihood value of the alternative model})$

Chapter 3: Consumer Preferences for Refrigerators Manufactured by “Climate Leaders”

Introduction

Voluntary environmental programs involve collaborative arrangements between firms and regulators that are based upon government offers of positive publicity and technical assistance to firms that reach certain environmental protection goals (Lyon and Maxwell, 2007), or commit to actions that will lead to improvement in their environmental performance (Delmas and Terlaak, 2001).

Voluntary environmental programs differ from traditional policy instruments such as environmental taxation and emissions limits, in that they are less confrontational (Bjørner, Hansen and Russell, 2004) and are expected to generate win-win strategies for both participating firms and regulators. With the establishment of a cooperative relationship with regulators, participating firms can reduce their regulatory burden (Delmas and Keller, 2005), gain experience and develop techniques to deal with environmental programs, (Pizer, Morgenstein and Shih, 2008), and use such information to enhance their public reputation as socially responsible and environmentally-concerned citizens. To regulators, voluntary environmental programs have also provided opportunities to adjust their policies to reflect emerging environmental problems in industries (Pizer, Morgenstein and Shih, 2008) and achieve environment protection goals more efficiently.

As a result of these benefits, voluntary programs have become increasingly popular policy tools around the world (Delmas and Terlaak, 2001). At least 13,000 private sector firms had participated in some form of voluntary environmental program by the end of the 1990s (Mazurek, 2002), and over 300 such programs have been initiated

in the European Union (E.U.) (Borkey and Leveque, 1998). For example, the *Agreement on Climate Protection*, which started in 1995 between the German government and business, set a ten-year goal of reducing carbon dioxide (CO₂) emissions by 20% from 1990 levels (German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 1995). Similarly, the E.U. and the European Automobile Manufacturers Association signed a voluntary agreement on reducing CO₂ emissions of passenger vehicles sold in the E.U. from an average carbon equivalent of 186 gram/kilometer in 1995 to 140 gram/kilometer or less by 2008 (Capros, Kouvaritakis, and Mantzos, 2001). Other important voluntary environmental programs in the E.U. include agreements on liquid waste minimization in the United Kingdom, on vehicle recycling in France, and on chemical industry emission reductions in the Netherlands (Delmas and Terlaak, 2001).

The United States (U.S.) initially lagged behind the rest of the world (and especially the E.U.) in the adoption of voluntary environmental programs (Delmas and Terlaak, 2001). The total number of agreements initiated between the U.S. Environmental Protection Agency (USEPA) and U.S. industrial firms was 28 in the year 1996 (USEPA, 2005) and only 42 between 1988 and 1998 (Mazurek, 1998). However, the number of voluntary environmental programs in the U.S. has undergone an “explosive growth” since then (Pizer, Morgenstein and Shih, 2008). USEPA, along with other federal agencies such as the U.S. Department of Energy (USDOE), has initiated or revised a number of voluntary programs, including Energy Star, WasteWise, Combined Heat and Power Partnership, Clean Energy-Environment State Partnership, Green Power Partnership, and Climate Leaders. More recently, President Obama announced a new interagency initiative to develop a comprehensive and coordinated federal strategy aimed

at speeding the development and deployment of new voluntary environmental programs, with a goal of at least 5 to 10 new programs by 2016. The federal government expects that these programs will “encourage voluntary reductions from large corporations, consumers, industrial and commercial buildings and major industrial sectors” (USEPA, 2011).

While many firms and regulators have accepted voluntary environmental programs as marketing opportunities and policy tools, the effectiveness of these programs is, to some extent, dependent upon how consumers and other stakeholders react to them. The opportunities for consumers to be directly involved in and have effects on voluntary environmental programs have traditionally been very limited. Some studies have argued that consumers can be indirectly involved in promoting voluntary environmental protection activities through choosing products produced by participating manufacturers over that of non-participators (Clark and Russell, 2005). In order to do so, though, consumers must be able to differentiate between the two “types” of products, which requires environmental information to be made accessible to consumers (Kennedy, Laplante, and Maxwell, 1994). Environmental information of this type can be disseminated with explicit “eco-labels” such as the ENERGY STAR labeling program, which attaches a visible label to products that meet its environmental standard, and there are a number of empirical studies of consumer preferences regarding these (e.g. Ward, Clark, Jensen, Yen, and Russell, 2011; Chapter 2 of this thesis). However, consumer preferences for voluntary environmental programs that are not explicitly designed as eco-labels is another question.

In this study, we investigate consumer preferences for products participating in voluntary environmental programs, by analyzing data from a contingent choice experiment survey that includes manufacturer participation in USEPA's Climate Leaders program as a product attribute. We estimate willingness to pay (WTP) for product attributes, including whether the manufacturer participates in the Climate Leaders program. We also examine how other factors influence preferences for such participation. By addressing those questions, we expect to provide a greater understanding of the potential for voluntary environmental programs to influence consumer perceptions of products manufactured by participants in these programs. The remainder of this chapter is organized as follows. The next section provides a review of the relevant literature. A discussion of the methods and procedures employed in this study follows. The results are then presented and in the final section some conclusions and ideas for further research are offered.

Literature Review

Motivations for Environment-conscious Consumption

Lancastrian utility theory posits that consumers are motivated to purchase a particular product because of the utility or satisfaction they derive from the characteristics or attributes that the product possesses (Lancaster, 1971). Prior studies suggest that, at least some consumers have preferences over the environmental attributes associated with the manufacture, distribution or use of a product (e.g. Loureiro, McCluskey and Mittelhammer, 2001; Cason and Gangadharan, 2002; Amacher, Koskela and Ollikainen, 2004; Banerjee and Solomon, 2003; Limehouse, Melvin and McCormick, 2010). These

environmental attributes could generally be considered to be contributions to public goods, and sometimes are not readily available to the consumers who purchase the goods (Cornes and Sandler, 1984). Such consumer behavior is often referred to as “environment-conscious” (Lee and Holden 1999) or “pro-environmental” consumption (Cleveland, Kalamas and Laroche, 2005; Lindenberg and Steg, 2007), and is often costly in terms of money and time to the individual consumers (Thøgersen and Olander, 2003).

The motivation to voluntarily purchase or engage in other activities that contribute to public goods have been widely discussed in the economics literature (Bergstrom, Blume and Varian, 1986; Andreoni, 1988; Cornes and Sandler, 1996). Kotchen (2007) identified three types of motivation: that these consumers are altruists; that they benefit from the aggregate level of the public good; or they make positive contributions to offset the negative impacts of their other behaviors. The literature review section of Chapter 2 includes a discussion of how such motivation might lead consumers to make environment-friendly purchases, and how the provision of environmental information through assists consumers in this regard.

However, voluntary environmental programs and agreements, usually only involve manufacturers and government agencies and the effects of these programs or agreements generally occur during the production process, such as reducing pollution emissions associated with production, or switching to the use of clean energy to power the production process (Delmas and Terlaak, 2001). On the other hand, manufacturers often take advantage of their participation in voluntary environmental programs and use their participation as a promotional strategy to deliver an environment-friendly image of themselves and their products to consumers and the society, a process known as “green

marketing” (McDaniel and Rylander, 1993). A manufacturer participating in a voluntary environmental program often informs the public about its environmental performance and commitment to social responsibility, in order to distinguish itself from non-participating competitors (e.g. Polonsky, 1995; Menon and Menon, 1997). The environment-conscious consumer “carries the strongest vote with the dollar” (McDaniel and Rylander, 1993) and can send a message to manufacturers about their concerns for the environment by “voting” for, or purchasing the products of, the manufacturers that participate in the program.

For consumers to take such actions, they need to not only be environmentally motivated but also convinced that their individual actions will have an effect, or what is referred to as perceived consumer effectiveness (PCE) (e.g. Lee and Holden, 1999; Kim and Choi, 2005; Faiers, Cook and Neame, 2007). PCE is defined as “the evaluation of the self in the context of the issue” (Berger and Corbin 1992) as being different to faith in others (FIO), which is “faith or trust in the efficacy of other factors” (Berger and Corbin, 1992). Ellen, Weiner and Cobb-Walgren (1991) describe PCE as the extent to which individuals believe that their personal actions could make a difference in solving problems, and that PCE for environmental issues is distinctly different from general environmental attitudes or concerns and has direct and unique effects on environment-conscious behaviors. It has been demonstrated that individual consumers who have strong confidence that their personal environment-friendly actions can lead to positive and effective consequences for the environment are more likely to be motivated to engage in such actions in support of their environmental concerns (Ellen, Weiner and Cobb-Walgren, 1991; Kim and Choi, 2005). Previous studies have also suggested that PCE is often affected by FIO, in other words, that these individual consumers need to

realize that their individual efforts are part of collective efforts to achieve positive outcomes, and that they need to have faith that others will do their part (Lee and Holden, 1999; Faiers, Cook and Neame, 2007).

Policy Background

The Climate Leaders program was launched in February 2002 by USEPA as a voluntary environmental program to reduce greenhouse gas (GHG) emissions and promote improved ambient environmental quality. USEPA defines the Climate Leaders program as an “industry-government partnership that provides guidance and recognition to companies developing long-term climate change strategies”. The Climate Leaders program strives to achieve these goals “through the development of rigorous accounting standards, management plan tools, and innovative reduction opportunities” (USEPA, 2011).

Thus, a company qualifies a Climate Leaders Partner (CLP) by committing to reduce their impact on the global environment through the development of a corporate-wide GHG inventory using the protocol provided by the program, setting an aggressive GHG emissions reduction goal, and annually reporting to USEPA its progress towards the goal (USEPA, 2011). CLPs range from small firms⁸ to major corporations and they represent a variety of industries and sectors from manufacturers and utilities to financial institutions and retailers (USEPA, 2011b). The number of CLPs increased from 11 initial partners at the initiation of the program in 2002 to over 250 by the end of 2010.

⁸ Small firms and business operations participate in the Climate Leaders program in the form of Small Business Network Members.

USEPA has suggested that a company participating in the Climate Leaders program and qualifying as a CLP could enjoy a range of benefits (USEPA, 2011). First, participation in the program is voluntary and cost-free. Second, participants can receive free technical assistance from USEPA on such topics as implementing GHG accounting methods, monitoring GHG emissions, and techniques to improve emission inventory management. Third, by achieving their reduction goals, CLPs could achieve cost savings through improved energy efficiency, while reducing their impact on the global environment through the reduction of GHG emissions.

CLPs also have the opportunity to receive USEPA recognition as environmental leaders and publicize a credible record of their accomplishments that can inform consumers and influence markets. USEPA publicly recognizes CLPs who have set and achieved GHG reduction goals through national press releases, national public service announcements in major national publications, and in USEPA's *Carbon Copy* newsletter. CLPs also are encouraged to publicize their participation, goals, and accomplishments, and USEPA provides them with a variety of resources to assist these efforts. In addition, CLPs are authorized to include the program label (Figure 3-1) in internal and external marketing materials (USEPA, 2011).

Though the Climate Leaders program and the CLP "label" are not as explicitly recognizable as the actual eco-labeling programs such as the ENERGY STAR, the use of the program label in this way can be seen as a form of environmental information provision, closely analogous to eco-labeling. Besides, this program fits into the discussions on green marketing strategy and effects of environment-conscious behaviors.

Therefore, it is of great interest to investigate the effects of the CLP label on consumer preferences for products that are manufactured by CLPs.

Data and Survey Methods

The data for conducting the analysis in this study were collected through an online survey hosted by Knowledge Networks[®] (KN) as described in Chapter 2. Responses of respondents who were randomly assigned to Climate Leaders versions of the survey instrument (353 responses, 25.3%) are used to achieve the objectives of this study. Information screens for the Climate Leaders label are shown in Figure 3-2, and an example of one of the choice tasks is provided in Figure 3-3.

Econometric Framework

To analyze consumer preferences for the CLP label, we employ both the conditional logit (CL) and the random parameter logit (RPL) models as discussed in Chapter 2. A CL and an RPL model which consist of only the product attributes, and a CL and an RPL model which consist of both the attribute variables and interaction terms between the CLP label and all demographic, attitudinal and other factors, respectively, were estimated. Model estimation was conducted with STATA software package, and the *mixlogit* module (Hole, 2007) with 1,000 Halton random draws were used to estimate the RPL models.

The variable names, definitions and descriptions, along with sample statistics, are presented in Table 3-1. The product attribute variables included in this study are price (*Price*), capacity (*Capacity*), three binary variables for brands (*LG*, *GE*, and *Kenmore*, where *Whirlpool* is the base case), one binary variable for configuration (*Frenchdoor*,

where the *Side-by-Side* is the base case), three binary variables for the design of external dispensers (*Ice* for ice-only dispensers, *Water* for water-only, and *IandW* for both ice and water, where no external dispenser is the base case), and the variable for manufacturer participation in the Climate Leaders program (*CLPLabel*). All product attributes but price were randomized in the RPL models. Assuming that the price parameters “fixed” allows us to obtain normally distributed estimates of WTP for the non-price attributes (Train, 2000). In addition to the product attribute variables, an alternative specific constant (*ASC*) was created to represent the “None” option.

Variables representing age, gender, race, household income, education, number of household members, ownership status of living quarters, and residential location enter the models through interactions with the *CLPLabel* variable. Including individual characteristics as interactions allows us to account for heterogeneous preferences for the CLP label variable across individuals.

Similar to the analysis procedures described in Chapter 2, we used factor analysis (FA) and STATA *predict* command to estimate PCE (*PCE*) and the attitudes towards and awareness of global climate change (*GCC*). The factor weights and scores can be seen in Table 3-3.

Results

The number of total possible records collectable for the choice experiment is 19,768. Taking out missing values, the actual number of records obtained and relevant to this study was 18,856.

The estimation results for the CL and RPL models are presented in Tables 3-4 and 3-5. The fact that almost all of the random deviations of the RPL estimate results are significant at the 1% level or higher of significance indicates that the application of the RPL models to this data set is warranted. Likelihood-ratio tests suggest that the RPL models are preferred to the CL models. Similarly, likelihood-ratio tests indicate that the models with both attributes and interactions are preferred to attribute only models ($df = 10$, and all tests have significantly large test statistics; see Tables 3-4 – 3-5).

As expected, the price variable has negative and significant parameters in all models, implying that refrigerators are normal goods and that respondents are sensitive to changes in refrigerator prices.

Parameter estimates for the CLP label variables are significant (1% of higher level of significance) and positive in all models except the RPL model with all factors. Parameter estimates for the other product attributes largely conform to *a priori* expectations. The estimated parameter for refrigerator capacity is positive and significant in both CL models but insignificant in the RPL model. The parameter estimates for the LG and GE brand variables are negative and significant in all models, while the parameter estimate for Kenmore is not significant in any of the models. These results suggest that Whirlpool, the base case, is preferred to LG or GE. The parameter estimates for the external dispensers variables (*Water* for water only dispenser, *Ice* for ice only dispenser, and *IandW* for both water and ice dispenser, as compared with refrigerators which have no dispensers available) are significant and positive in all models, suggesting that consumers prefer refrigerators with external dispensers to refrigerators without such

dispensers. Refrigerator configuration, i.e. French door or Side by side (*Frenchdoor*), is not significant in any of the models.

Generally, the interaction terms tend to perform better (in terms of statistical significances) in the CL models than in the RPL models, as only one interaction term (*PCE*) is significant in the RPL model, while quite a few interaction terms are significant in the CL model.

The parameter estimate for age ($Age \times Label$) is negative and significant in the CL model, while the variable for squared age ($Age^2 \times Label$) is positive and significant. While many prior studies have found females to be more environment-conscious, the CL parameter estimate for gender variable ($Male \times Label$, with Female as base case) is positive and significant, and it suggests that males are more likely to purchase refrigerators manufactured by CLP.

The parameter estimates for the white and black variables ($White \times Label$, $Black \times Label$) are positive and significant in the CL model, suggesting that white and black consumers may be more likely to purchase CLP labeled refrigerators than “Non-White, Black nor Hispanic people”. The parameter estimate for the Hispanic variable is insignificant in both models.

The parameter estimate for the variable that the respondents have graduated with bachelor’s degree or higher ($Bachelor \times Label$) is significant and positive, implying that those respondents are significantly more likely to purchase CLP labeled refrigerators than those who never attended college. The parameter estimate for respondents who attended college ($College \times Label$) is insignificant in both models.

Of the variables representing income ($Inc1 \times Label$, or income between \$30,000 to \$60,000; $Inc2 \times Label$, or \$60,000 to \$85,000; and $Inc3 \times Label$, or income more than \$85,000 per year), the parameter estimates for both the highest and second lowest category was positive and significant in the CL model, while the parameter estimate for the second highest was insignificant in both models.

The parameter estimate for the variable indicating that the respondents or their families own their residences instead of living in rented residences ($Ownership \times Label$) is significant and negative in the CL model but insignificant in the RPL model. The parameter estimate for South ($South \times Label$) is negative and significant in the CL model, while those for the Northeast and Midwest ($NE \times Label$ and $MW \times Label$) are insignificant in both models. The parameter estimate for respondents living in urban area ($Metro \times Label$) is significant and positive in the CL model. Such results may imply that respondents living in West as opposed to South, in a rented home, or in urban areas, are more likely to purchase CLP labeled refrigerators.

Finally, the results for attitudinal variables reflecting respondents' perceived consumer effectiveness ($PCE \times Label$) and environmental concern towards global climate change ($GCC \times Label$) have significant and positive effects which conforms to *a priori* hypotheses that consumers who believe their collective actions can have significant effects and who have higher environmental concerns are more likely to engage in environment oriented actions such as purchasing eco-labeled refrigerators.

The estimated WTPs for CLP label are significant and positive for all models, ranging from \$66.155 to \$70.256 when estimated with only product attributes, and from \$65.478 to \$209.079 when estimated with all factors included (Table 3-6).

Conclusions and Implications

In this study, we used data collected from contingent choice experiments for consumer preferences for refrigerators and manufacturer participation in the USEPA Climate Leaders program. In general, our findings suggest that consumers are willing to pay significantly more for refrigerators that are manufactured by companies participating in the Climate Leaders program. Depending on the econometric model used, the WTP estimates for the CLP label ranged from \$65.478 to \$209.079. In total, our findings may inform government agencies and other regulators of the effectiveness of voluntary environmental programs in affecting consumer preferences and provide incentives for more manufacturers to participate in these programs.

We have also investigated the motivations for consumers to purchase refrigerators manufactured by participants in the Climate Leaders program. In estimated results of Logit models with fixed parameters, we found differences in age, education level, gender, race, and income have significant effects, while factors such as living quarter ownership status, locations of residency and whether living in rural or urban areas also play important roles. However, when randomized parameters were included, such effects became less significant.

We also found that environment-conscious consumers are more willing to purchase environment-friendly products such as refrigerators manufactured by CLPs.

Also, not surprisingly, consumers with high PCE, i.e. consumers who have strong confidence that their personal environment-friendly actions can lead to positive and effective consequences for the environment are more likely to be motivated to purchase environment-friendly products. Overall, this study implies that voluntary environmental programs could have significant roles in transforming appliances market and helping to replace older, less environment-friendly manufacturing processes with environmentally sound alternatives.

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Figures and Tables



Figure 3-1: Logo of USEPA Climate Leaders Program



Another feature that you may consider is whether the refrigerator is manufactured by a company that participates in the CLIMATE LEADERS program.

CLIMATE LEADERS are manufacturers that develop comprehensive climate change strategies to track, report and reduce their greenhouse gas emissions.

By adopting these strategies, these manufacturers reduce the emission of greenhouse gases associated with refrigerator production. Studies suggest that greenhouse gases contribute to global climate change.

Would you like more information on CLIMATE LEADERS or are you ready to proceed with the survey?

Select one answer only

☐ Ready to proceed

☐ Would like more information

CLIMATE LEADERS is a voluntary program sponsored by the U.S. Environmental Protection Agency (EPA) as a way to reduce greenhouse gas emissions.

CLIMATE LEADERS commit to reducing their impact on the global environment by completing a corporate-wide inventory of their greenhouse gas emissions, setting aggressive reduction goals, and annually reporting their progress to EPA.

By participating in the CLIMATE LEADERS program, companies create a credible record of their accomplishments and receive EPA recognition as corporate environmental leaders.

Figure 3-2: Example of Climate Leaders Information Screen

If you needed to buy a refrigerator and these were your only options, which would you choose?

You may assume that all of these choices fit in the space that you have for a refrigerator, are available in the color or finish that you want, and have both automatic defrost and a built-in icemaker. You may also assume that there are no significant differences in energy efficiency between these choices.

Please select a refrigerator by clicking one of the buttons below:

	Alternative 1	Alternative 2	Alternative 3	
Price	\$1,029	\$979	\$929	NONE: I wouldn't choose any of these ☐
Brand	LG	Whirlpool	Kenmore	
Configuration	French door	French door	Side-by-side	
Capacity (cu. ft.)	25.83	25.34	24.52	
Through-the-Door Dispenser	None	Ice	Ice & Water	
Climate Leader	Yes	No	No	
Your choice	☐	☐	☐	

Figure 3-3. Example of Sample Choice Experiment Task

Table 3-1. Variable Names, Definitions and Sample Statistics

Variable	Definition and Description	Sample Means
Dependent Variable		N = 18856
<i>Chosen</i>	1 if the alternative is chosen, 0 otherwise	0.25
Explanatory Variable		
<i>Price</i>	\$879, \$929, \$979, or \$1,029	715.884
<i>CLPLabel</i>	1 if CLP qualified, 0 if not	0.384
<i>Capacity</i>	23.78, 24.52, 25.34, 25.83 cubic feet	18.632
<i>Frenchdoor</i>	1 if French door style, 0 if side-by-side	0.384
Refrigerator Brands (with "Whirlpool" as base case)		
<i>LG</i>	1 if LG brand, 0 otherwise	0.202
<i>GE</i>	1 if GE brand, 0 otherwise	0.183
<i>Kenmore</i>	1 if Kenmore brand, 0 otherwise	0.182
External Dispenser Type (with "No Ice or Water" as base case)		
<i>Ice</i>	1 if equipped with external dispenser of ice only, 0 otherwise	0.201
<i>Water</i>	1 if equipped with external dispenser of water only, 0 otherwise	0.182
<i>IandW</i>	1 if equipped with external dispenser of both ice & water, 0 otherwise	0.183
<i>ASC</i>	1 if "None" option, 0 otherwise	0.25
<i>Age</i>	Age of respondent in years divided by 10	1.771
<i>Age2</i>	$Age * Age$	0.925
<i>Male</i>	1 if male, 0 otherwise	0.181
Race (with "Non-White, Black nor Hispanic" as base case)		
<i>White</i>	1 if White	0.270
<i>Black</i>	1 if African-American	0.042
<i>Hispanic</i>	1 if Hispanic	0.049
Education (with "Less than college level education" as base case)		
<i>College</i>	1 if have some college level education	0.111
<i>Bachelor</i>	1 if hold bachelor's or higher degree	0.104
Household Income (with "Less than \$30,000" as base case)		
<i>Inc1</i>	1 if \$30,000 to \$60,000	0.128
<i>Inc2</i>	1 if \$60,000 to \$85,000	0.057

(Continued from Table 3-1)

Variable	Definition and Description	Sample Means
<i>Inc3</i>	1 if \$85,000 or higher	0.083
<i>HHSize</i>	Head count of household members, 1-10	1.026
<i>Ownership</i>	1 if Own the current living quarters, 0 if rent or others	0.271
Residential location (with "West" as base case)		
<i>NE</i>	1 if reside in Northeast	0.070
<i>MW</i>	1 if reside in Midwest	0.084
<i>South</i>	1 if reside in South	0.140
<i>Metro</i>	1 if reside in metropolitan areas	0.319
<i>PCE</i>	Factor analysis index score for perceived consumer effectiveness	0.020
<i>GCC</i>	Factor analysis index score for attitude towards global climate change	-0.012
<i>Kwh</i>	Average price of electricity by county of residence (cents per kWh)	4.499

Table 3-2. Attitudinal Questions Included in the Study*

-
1. When I buy products, I consider how my use of them will affect the environment.
 2. By choosing environmentally friendly products, I signal to manufacturers the types of products they should be producing.
 3. Global climate change will have a noticeably negative impact on the environment in which my family and I live.
 4. There is no urgent need to take measures to prevent global climate change today.
 5. The production of electricity from renewable sources such as solar, wind and biomass is an effective way to combat global climate change.
 6. The most effective way to combat global climate change is to reduce energy consumption.
 7. We need more government regulations to force people to protect the environment.

* Likert-scale answer choices: 1=Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, and 5=Strongly Agree.

Table 3-3. Factor Analysis Index for Attitudinal Questions

	Chronbach's alpha	Factor Weight
1. Perceived Consumer Effectiveness (<i>PCE</i>)	0.7937	
1-1. When I buy products, I consider how my use of them will affect the environment.		0.6517
1-2. By choosing environmentally friendly products, I signal to manufacturers the types of products they should be producing.		0.6408
2. Attitudes towards Global Climate Change (<i>GCC</i>)	0.7903	
2-1. Global climate change will have a noticeably negative impact on the environment in which my family and I live.		0.6450
2-2. There is no urgent need to take measures to prevent global climate change today.		-0.5585
2-3. The production of electricity from renewable sources such as solar, wind and biomass is an effective way to combat global climate change.		0.6456
2-4. The most effective way to combat global climate change is to reduce energy consumption.		0.6983
2-5. We need more government regulations to force people to protect the environment.		0.5761

Table 3-4. Conditional and Random Parameter Logit Results for Climate Leaders Survey Attributes Only Models

	Conditional Logit			Random Parameter Logit		
Variable	Estimate	Std. Error	p-value	Mean of Est.	Std. Error	p-value
<i>Price</i>	-0.006***	0.0004	0.000	-0.010***	0.001	0.000
<i>CLPLLabel</i>	0.406***	0.046	0.000	0.678***	0.102	0.000
<i>Capacity</i>	0.055*	0.031	0.074	0.088	0.057	0.123
<i>Frenchdoor</i>	0.030	0.047	0.517	-0.213	0.331	0.520
<i>LG</i>	-0.202***	0.067	0.002	-0.372***	0.119	0.002
<i>GE</i>	-0.149**	0.068	0.028	-0.311***	0.121	0.010
<i>Kenmore</i>	-0.013	0.067	0.842	-0.040	0.136	0.767
<i>Ice</i>	0.621***	0.072	0.000	0.885***	0.140	0.000
<i>Water</i>	0.437***	0.075	0.000	0.493***	0.118	0.000
<i>IandW</i>	1.325***	0.072	0.000	1.875***	0.246	0.000
<i>ASC</i>	-3.205***	0.874	0.000	-7.137***	1.798	0.000
Random Deviation						
<i>CLPLLabel</i>				1.016***	0.140	0.000
<i>Capacity</i>				0.041***	0.012	0.001
<i>Frenchdoor</i>				2.768***	0.333	0.000
<i>LG</i>				0.557***	0.176	0.002
<i>GE</i>				0.522***	0.158	0.001
<i>Kenmore</i>				0.694***	0.205	0.001
<i>Ice</i>				1.000***	0.177	0.000
<i>Water</i>				0.541***	0.230	0.019
<i>IandW</i>				2.154***	0.274	0.000
<i>ASC</i>				-4.199***	0.481	0.000
Log-likelihood	-6299.805			-4362.856		
LR Test: LR Statistic = 3873.898, df = 10						

Note: *, **, and *** indicate significance at 10%, 5% and 1% levels, respectively.

Table 3-5. Conditional and Random Parameter Logit Results for Climate Leaders Survey All Factors Models

Variable	Conditional Logit			Random Parameter Logit		
	Estimate	Std. Error	p-value	Mean of Est.	Std. Error	p-value
<i>Price</i>	-0.006***	0.000	0.000	-0.010***	0.001	0.000
<i>CLPLabel</i>	1.673***	0.417	0.000	0.655	1.169	0.575
<i>Capacity</i>	0.064**	0.032	0.044	0.039	0.059	0.511
<i>Frenchdoor</i>	0.027	0.049	0.586	-0.572	0.455	0.209
<i>LG</i>	-0.179***	0.069	0.009	-0.325**	0.128	0.011
<i>GE</i>	-0.139**	0.070	0.046	-0.295**	0.131	0.025
<i>Kenmore</i>	-0.018	0.069	0.795	-0.044	0.134	0.743
<i>Ice</i>	0.625***	0.074	0.000	0.846***	0.171	0.000
<i>Water</i>	0.439***	0.078	0.000	0.436***	0.137	0.002
<i>IandW</i>	1.365***	0.074	0.000	2.154***	0.249	0.000
<i>ASC</i>	-2.890***	0.902	0.001	-8.232***	1.953	0.000
<i>Age × Label</i>	-0.719***	0.120	0.000	-0.074	0.326	0.821
<i>Age2 × Label</i>	0.663***	0.119	0.000	0.045	0.315	0.887
<i>Male × Label</i>	0.196**	0.082	0.017	0.010	0.257	0.968
<i>White × Label</i>	0.407**	0.194	0.036	-0.161	0.413	0.696
<i>Black × Label</i>	0.581**	0.240	0.016	0.327	0.737	0.657
<i>Hispanic × Label</i>	-0.118	0.218	0.588	-0.660	0.604	0.274
<i>College × Label</i>	-0.040	0.098	0.685	-0.437	0.340	0.199
<i>Bachelor × Label</i>	0.320***	0.103	0.002	0.150	0.307	0.626
<i>Inc1 × Label</i>	0.192*	0.109	0.077	0.134	0.293	0.648
<i>Inc2 × Label</i>	0.151	0.134	0.258	0.069	0.380	0.857
<i>Inc3 × Label</i>	0.276**	0.137	0.045	0.212	0.368	0.564
<i>HHSIZE × Label</i>	0.036	0.031	0.248	0.005	0.097	0.961
<i>Ownership × Label</i>	-0.333***	0.102	0.001	-0.339	0.280	0.225
<i>NE × Label</i>	-0.206	0.136	0.129	0.017	0.373	0.965
<i>MW × Label</i>	-0.031	0.125	0.803	0.279	0.411	0.498
<i>South × Label</i>	-0.176*	0.108	0.104	0.141	0.334	0.672
<i>Metro × Label</i>	0.188*	0.110	0.088	0.324	0.307	0.291
<i>PCE × Label</i>	0.138**	0.056	0.014	0.314**	0.127	0.013
<i>GCC × Label</i>	0.233***	0.054	0.000	0.154	0.120	0.199
<i>Kwh × Label</i>	-0.008	0.015	0.616	0.020	0.045	0.665

(Continued from Table 3-5)

Random Deviation						
Variable	Estimate	Std. Error	p-value	Mean of Est.	Std. Error	p-value
<i>CLPLabel</i>				0.937***	0.124	0.000
<i>Capacity</i>				0.156***	0.017	0.000
<i>Frenchdoor</i>				2.877***	0.309	0.000
<i>LG</i>				0.410	0.339	0.227
<i>GE</i>				0.551**	0.287	0.055
<i>Kenmore</i>				0.720***	0.191	0.000
<i>Ice</i>				1.173***	0.230	0.000
<i>Water</i>				0.751***	0.228	0.001
<i>IandW</i>				2.113***	0.317	0.000
<i>ASC</i>				0.266	0.794	0.738
Log-likelihood	-5921.230			-4160.205		
LR Test: LR Statistic = 3522.05, df = 10						

Note: *, **, and *** indicate significance at 10%, 5% and 1% levels, respectively.

Table 3-6. Estimated WTP for Product Attributes

Attributes only				
Attribute	Conditional Logit		Random Parameter Logit	
	Mean Estimate	Std. Error.	Mean Estimate	Std. Error.
<i>CLPLabel</i>	70.256***	9.368	66.155***	10.878
<i>Capacity</i>	9.484*	5.406	8.765*	5.813
<i>Frenchdoor</i>	5.278	8.165	-20.581	32.519
<i>LG</i>	-34.789**	11.770	-36.521**	12.646
<i>GE</i>	-25.570**	11.961	-30.652**	12.777
<i>Kenmore</i>	-2.198	11.539	-4.171	13.372
<i>Ice</i>	107.320***	14.131	86.418***	15.786
<i>Water</i>	75.641***	13.723	48.213***	12.182
<i>IandW</i>	229.123***	20.897	183.529***	31.371

All Factors				
Attribute	Conditional Logit		Random Parameter Logit	
	Mean Estimate	Std. Error.	Mean Estimate	Std. Error.
<i>CLPLabel</i>	209.079***	48.261	65.478***	71.401
<i>Capacity</i>	11.214**	5.698	3.937	5.989
<i>Frenchdoor</i>	4.707	8.636	-55.689	44.814
<i>LG</i>	-31.530**	12.161	-32.375**	13.603
<i>GE</i>	-24.606*	12.281	-29.432**	14.272
<i>Kenmore</i>	-3.183	12.231	-4.772	13.614
<i>Ice</i>	109.751***	14.659	83.723***	17.846
<i>Water</i>	77.235***	14.470	43.057**	13.548
<i>IandW</i>	240.021***	22.491	213.850***	34.313

Note: *, **, and *** indicate significance at 10%, 5% and 1% levels, respectively.

Chapter 4: Conclusion

Conclusion

In this study we investigated two types of environmental information provision programs, i.e. the explicit eco-label, the ENERGY STAR, and the voluntary environmental program and agreement, the Climate Leaders program. To examine how these programs affect consumer preferences, WTP for these labels were estimated, based on econometric models using only product attributes and both product attributes and demographic information and other factors. We can draw several concluding remarks from the results of this study.

For both analyses, we found WTP estimates for the ENERGY STAR label and the CLP participation to be positive and significant, indicating that consumers are willing to pay a premium for environmentally friendly products equivalent to a significant portion of the purchase prices, regardless of whether the environmental benefits occur in the consumption or production process. WTP for the ENERGY STAR label ranges from \$81.683 to \$394.276, depending on the econometric model used, which is higher than the range of WTPs for the Climate Leaders program of \$65.478 to \$209.079.

We examined the impacts of monetary incentives such as a mail-in rebate on consumer preferences for the ENERGY STAR label. When only product attributes were included in the models, we found that WTP for the ENERGY STAR label without rebate is higher than WTP for the ENERGY STAR label with rebate, while the findings for models incorporating both product attributes and demographic characteristics are the opposite. The differences may be because of several reasons, such as consumers are more concerned with the product quality when a rebate is provided, or consumers hold different perspectives towards a rebate because of heterogeneous preferences.

The effects of demographic characteristics, such as age, income, education, gender and race, as well as household characteristics and location of residence, on preferences for the “labeled” products, were also examined. In general, we found that for both the ENERGY STAR label and the Climate Leaders programs, younger consumers with higher incomes and higher levels of educational attainment may be more likely to engage in “green” purchases. Females are found to be more likely to purchase ENERGY STAR labeled products, while males are found to be more likely to purchase Climate Leaders program products.

Last but not least, our analyses provided further evidence that environmental attitudes and concerns, as well as perceived consumer effectiveness, have positive and significant effects on consumer purchases of environmentally friendly products.

Our findings could provide information to government agencies that are considering environmental information provision programs, in the form of either an eco-label or a voluntary environmental agreement as they suggest that either can be effective as a policy tool in environmental regulation. To home appliance manufacturers, such findings may help them in determining the market benefits they can receive by conforming to higher environmental standards in terms of product attributes or the manufacturing process. Yet our findings are limited to the studies based on environmentally friendly refrigerators, and might not reflect the effects of environmental information provision programs on other products. Hence future researchers may want to extend this investigation to other products.

Vita

Xiaogu Li was born in Suining, Sichuan Province, China, on April 20, 1986 to Mr. Henggui Li and Ms. Feng Liao. He graduated from Suining City High School in 2004. He received a B.A. in Economics in 2008 from Peking University. He matriculated The University of Tennessee, Knoxville in 2009 and received a M.S. in Agricultural Economics in May 2011.