The Effect of Mail-in Utility Rebates on Willingness-to-Pay For ENERGY STAR® Certified Refrigerators[a]

Selected Paper prepared for 2014 Southern Agricultural Economics Association Meetings, February 1-4, 2014, Dallas, Texas

by

Xiaogu Li, Christopher D. Clark, Kimberly L. Jensen, and Steven T. Yen[b,c]

[a] This research was funded, in part, by a grant from the United States Environmental Protection Agency's Science to Achieve Results (STAR) grant program though grant number R832849 to the University of Tennessee. Although the research described in the article has been funded by the United States Environmental Protection Agency, it has not been subjected to the Agency's peer and policy review and therefore does not necessarily reflect the views of the Agency and no official endorsement should be inferred.

[b] Li is a Graduate Student at the University of Tennessee, Clark is an Associate Professor at the University of Tennessee and Jensen is a Professor at the University of Tennessee, and Yen a former Professor at the University of Tennessee.

[c] Corresponding author: Xiaogu Li, Department of Agricultural & Resource Economics, University of Tennessee, 321 Morgan Hall, 2621 Morgan Circle, Knoxville, Tennessee 37996 USA, email: xli41@utk.edu.

The Effect of Mail-in Utility Rebates on Willingness-to-Pay for ENERGY STAR® Certified Refrigerators

Abstract

This study examines how a $50 mail-in rebate influences consumer willingness-to-pay for an ENERGY STAR-certified refrigerator. Data collected from a 2009 U.S. online survey containing a hypothetical choice experiment. Results suggest that a rebate induces uncertainty about the quality of ENERGY STAR-certified refrigerators and, thus, could actually reduce willingness-to-pay.

JEL Codes: Q58, D12

Key Words: Choice Experiment, Eco-label, Energy Star, Generalized Multinomial Logit, Ordered Probit, Rebate, Refrigerator, Willingness-to-Pay.

The Effect of Mail-in Utility Rebates on Willingness-to-Pay for ENERGY STAR® Certified Refrigerators

Introduction

One of the most prominent US Environment Protection Agency's (USEPA) energy efficiency programs for consumers is the ENERGY STAR® (ES) labeling program. ES is a voluntary labeling program in which products meeting established energy efficiency standards are awarded a "label". Another approach to promoting energy efficiency is to subsidize the purchase of energy efficient appliances. The U.S. State Energy Efficient Appliance Rebate Program (SEEARP), provided U.S. states and territories with $300 million to fund rebates for energy efficient appliances (MacRae et al., 2010; USDOE, 2010). Little is known about the joint effects of, or interactions between these programs (ES and rebates). Thus, this study examines the effects of offering a $50 mail in rebate on WTP for an ES-certified refrigerator.

Literature Review

One potential driver of preference for ES products is the potential for energy cost savings (McNeil, 2010; Revelt and Train, 1998; Wallander, 2008; Ward et al., 2011). Consumers may also be motivated by the potential environmental benefits reductions (e.g. GHG emissions) (Amacher et al., 2004; Banerjee and Solomon, 2003; Bjørner et al., 2004; Cason and Gangadharan, 2002; Loureiro et al., 2001; Ward et al., 2011). Consumer purchase of energy efficient appliances may also be influenced by offering a rebate. Providing monetary incentives is a common practice in a variety of markets (Aydin and Porteus, 2009; Silk and Janiszewski, 2008; Soman and Gourville, 2005; Tat, 1994). In general, though, consumers react favorably to the lower (net) prices associated with rebates. For example, Datta and Gulati (2010) used state-level revealed preference data on ES-certified appliance purchases to estimate that $1 worth of utility rebates on clothes washers increased market share of ES-certified clothes washers by about 0.3%. However, they also found that utility rebates of $25 or $50 for refrigerators and $50 or $100 for dishwashers had no significant effect on the market share of the ES-certified appliances.

Mail-in rebates offer consumers monetary reimbursements for purchasing a product (Jolson et al., 1987; Tat et al., 1988), conditional on the investment of effort necessary to obtain the rebate (Silk and Janiszewski, 2008). Delay and effort required by consumers to redeem rebates have led to dissatisfaction among consumers (Pechmann and Silk, 2013) and can result in "slippage" where consumers fail to apply for rebates (Silk and Janiszewski, 2008; Soman and Gourville, 2005).

Train and Atherton (1995) found that a utility rebate on "high efficiency" refrigerators and air conditioners made consumers more willing to choose the high efficiency appliances. They suggested consumers may feel "more comfortable that the appliances will actually deliver the promised savings if the energy company backs the appliances with the offer of the rebate" (Train and Atherton 1995, p. 60). However, using the same data, Revelt and Train (1998) found some consumers were less likely to choose the high efficiency appliance as a result of the rebate. The authors postulate that these latter consumers may view the rebate "as a sign that the appliances are too poor to sell on their own merits" (Revelt and Train 1998, p. 652).

Data and Survey Methods

Data for this study were collected through an online survey from a random sample of persons 18 years and older and was hosted by Knowledge Networks® (KN) during March/April 2009 (Clark et al., 2011). Households without a computer or internet connection were provided a laptop and free monthly Internet access. Invitations were sent to a total of 2,195 panel members, and 1,395 qualified responses were collected, providing a response rate of 64%. Respondents were randomly assigned to one of four versions of the survey, this study uses responses to two of the survey versions, both of which focus on the ES label. The difference between the two versions is that in one, respondents were told that purchasers of an ES-certified refrigerator would qualify for a $50 mail-in rebate from the purchaser's utility company while there was no mention of any rebate in the other. A total of 355 respondents completed the "with rebate" (WR) version, while 349 completed the "without rebate" (WOR) version.

The survey employed a contingent choice experiment to collect data on consumer preferences. The contingent choice experiment technique (also referred to as conjoint analysis) represents an extension of the traditional contingent valuation method (Mitchell and Carson, 1989), is consistent with random utility theory (Adamowicz et al., 1998) and has been widely employed in research (Louviere, 1988). Contingent choice experiments are designed to model respondents' choices as a function of the attributes of a product or service (Vermeulen et al., 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 et al., 2008).

The survey began with a series of questions about respondent home and household characteristics, usage and knowledge of refrigerators, and acquisition of their current refrigerator. It should be noted that the refrigerator/freezer was selected because they are commonplace and operated by most members of a household, they consume more energy than many other home appliances (USFTC, 2011), and consumers are familiar with ES-certified refrigerators (USEPA, 2007), with ES-certified refrigerators holding a 58% market share by 2005 (Davis, 2010). These questions were followed by a series of “information screens” where respondents were provided basic information about each of the refrigerator attributes that appeared in the contingent choice experiment. Figure 1 shows the ES information screen for the WR version of the survey. If respondents asked for additional information, they were also provided a screen that told them that products awarded the ES deliver the same or better performance as comparable models while using less energy and reducing electricity costs. Also, this screen told them that to collect the mail-in rebate they will need to complete a form provided by their utility. Upon receipt of the form, the utility would mail them a check in about six weeks.

The contingent choice experiment followed the information screens (See choice set example in Figure 1). At the beginning of the choice experiment, respondents were asked to assume that all of the refrigerator alternatives fit in the space they had for a refrigerator, were available in the color or finish they wanted, and had both automatic defrost and a built-in icemaker. The contingent choice experiment consisted of fourteen choice tasks, each requiring respondents choose one alternative. 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, Whirpool, 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 ES-certification (yes and no). A “None” option was also available to the respondents (Vermeulen et al., 2008). Thus, a total of four choices were available to the respondents in each choice task.

Several sets of Likert-scale questions were presented to respondents following the conjoint choice experiment. These questions focused on respondent behavior, attitudes toward the environment and climate change, and perceptions of ES products, including quality. Survey response data were supplemented with individual demographic characteristics previously collected by KN.

Modeling Framework

GMNL model of refrigerator choice

The Generalized Multinomial Logit (GMNL) model is used to analyze consumer preferences for ES-certified refrigerators. Advantages of the GMNL model are that it accommodates both preference heterogeneity across individuals and preference scaling, or differences in preference certainty, across individuals or choice tasks (Greene and Hensher 2010, 2013; Fiebig et al., 2010; Hess and Rose, 2012). Preference heterogeneity implies that preferences for a particular product attribute or set of attributes vary across individuals. Preference scaling implies differences in the degree of certainty individuals have regarding their choices, accounting for the fact that some respondents are more certain about the relative utility levels associated with their choices than others. Preference certainty could be influenced by demographic factors or the choice tasks (Rose and Scarpa, 2011).

The data collected from responses to the choice tasks reflect respondent preferences for the alternatives described by the attributes. Such preferences are assumed to vary based on differences in the levels or values of the attributes defining each alternative (Adamowicz et al., 1998). A random utility function can be used to characterize consumer preferences, given price and non-price attributes (McFadden, 1974):

$$\tilde{U}_{ij} = V_{ij} + \varepsilon_{ij} / \sigma_i = -\alpha P_j + \beta' X_{ij} + \varepsilon_{ij} / \sigma_i \qquad (1)$$

where $\tilde{U}_{ij}$ is the utility individual *i* receives from choosing alternative *j* for $j \in J$, and $V_{ij} = V(P_j, X_{ij})$ is the "approximated" utility characterized by price P_j and a vector of other observable product attributes X_{ij}. The parameters *α* and *β* measure the weights placed by the individual on these attributes, and the error term ε_{ij} represents all other unobservable and unknown factors and is assumed to be extreme value distributed with scale σ_i. Utility is assumed to be strictly monotonic, homogeneous of degree zero and quasi-convex in income and prices. Individual *i* chooses alternative *j* if $U_{ij} > U_{is} \; \forall \; j, s \in J$ and $j \neq s$.

The outcome of the model can then be predicted with the probability that alternative *j* is chosen. Multiplying both sides of (1) by σ_i yields

$$U_{ij} = \sigma_i(-\alpha P_j + \beta' X_{ij}) + \varepsilon_{ij} \quad (2)$$

where $U_{it} = \sigma_i \widetilde{U}_{ij}$. The parameters σ_i, α, and β are not separately identified. Standard practice is to normalize σ_i to one. Fiebig et al. (2010) suggest accommodating scale heterogeneity by specifying σ_i using an exponential transformation as

$$\sigma_i = \exp(\overline{\sigma} + \theta' Z_i + \tau \varepsilon_{0i}) \quad (3)$$

where $\varepsilon_{0i} \sim N(0,1)$ and Z_i is a vector of individual characteristics (we use familiarity with the ES program, *Familiar*), with $\overline{\sigma}$ set at $-\tau^2/2$ so that $E(\sigma_i) = 1$ when $\theta = 0$. *Familiar* was chosen as a scaling term as it outperformed a variety of different individual-specific variables and combinations of variables in terms of Log Likelihood score and statistical significance. In (3), as the parameter τ increases, the degree of scale heterogeneity increases.

Hensher and Greene (2011) note that the GMNL model can accommodate with scale heterogeneity issue while also nests the preference and WTP space models. As can be seen from (2) and (3), GMNL reduces to a preference space model when $\tau = \theta = 0$. Substituting σ_i in (3) into (2) yields

$$U_{ij} = \exp(\overline{\sigma} + \theta' Z_i + \tau \varepsilon_{0i})(-\alpha P_j + \beta' X_{ij}) + \varepsilon_{ij}\,. \quad (4)$$

If we let WTP for an attribute be $\gamma_i = \beta_i / \alpha$ for all *i* and substitute it into (4), utility becomes

$$U_{ij} = \alpha\left\{\exp(\bar{\sigma} + \theta' Z_i + \tau\varepsilon_{0i})(-P_j + \gamma' X_{ij})\right\} + \varepsilon_{ij}. \quad (5)$$

If $\alpha = 1,$ utility reduces to

$$U_{ij} = \left\{\exp(\bar{\sigma} + \theta' Z_i + \tau\varepsilon_{0i})(-P_j + \beta' X_{ij})\right\} + \varepsilon_{ij}. \quad (6)$$

Equation (6), in WTP space, is used to find estimates in this study. WTP space models have the advantage of avoiding WTP estimates as ratios of coefficients with dubious statistical properties (Hensher and Greene, 2011). When the model is in WTP space, estimates for β are estimates of WTP for the attributes in X_{ij} (Train and Weeks, 2005); thus, WTP for the ES label (*Label)* is an element of β, denoted β_{Label}.

Respondent specific variables can be incorporated into the model by interacting them with *Label*. This action amounts to specifying the coefficient of *Label* as a linear function of a vector of respondent specific variables, in our case, quality perceptions about ES products (H_i), for individual *i*:

$$\beta_{Label} = H_i' \eta \quad (7)$$

where η is a vector of parameters containing coefficients of the *Label*-interacted terms. This specification is flexible in that the coefficient of *Label*, which is also WTP for the ES label, is allowed to vary across individuals. The parameters include $\theta, \tau, \gamma,$ and η, and the assumption of extreme value distribution for the error term ε_{ij} in (6) allows construction of multinomial probabilities which are the basis for estimation (Train, 2003). In this study, we treat part of the parameters (specifically the intercept term in η and part of γ; see discussion below) as random. The means and standard deviations of the parameters treated as random and the coefficients of the parameters treated as fixed can be estimated by maximum simulated likelihood (Fiebig et al., 2010; Train, 2003).

Upon estimation of the model parameters, mean WTP for *Label* can be calculated as $\bar{H}'\hat{\eta}$ following (7), where $\bar{H}$ is a vector of sample means for *H* and $\hat{\eta}$ is the maximum-simulated likelihood estimate of η with covariance matrix $V(\hat{\eta})$. The standard error for mean WTP can be calculated as $[\bar{H}'V(\hat{\eta})\bar{H}]^{1/2}$. Because WTP is a linear function of demographic variables H_i, the sample mean of WTP is the same as WTP evaluated at the sample mean $\bar{H}$.

Ordered probit model of respondent perceptions of the quality of ES-certified products

For this analysis, the dependent variable(*Quality*) reflects the extent to which respondents agree with the statement "*When I buy a product with the ES label, I can always be sure it's high quality*" on an ordinal scale of one to five, where one represents strongly disagree and five represents strongly agree. Respondent perceptions of *Quality* are modeled with the ordered probit model (Greene, 2012) using the maximum likelihood method.

Variables and Model Specification

Variable names, definitions and descriptions, along with sample statistics, are presented in Table 1. The product attribute variables included in the GMNL models are price, capacity, three binary variables for brands, one binary variable for configuration, three binary variables for the design of external dispensers, and the binary variable for the ES certification (*Label*). An alternative specific constant (*ASC*) was created to indicate the "None" option. All product attributes were randomized in the GMNL models. The scaling variable is respondent perception of the extent of his or her familiarity with the ES program prior to the survey (*Familiar).*

As shown in Table 1, explanatory variables in the ordered probit model include continuous age and income. Ordinal variables attitudinal variables include consumers buy ES products to save on their electricity bill, and attitudes about purchasing products that help the environment. Binary explanatory variables included in the model are whether the survey version is the WR version, education level, metro area residence, region of residence, region's interaction with *Metro*, and whether respondent serves as the household's primary decision maker for buying appliances.

Results

Sample means for the variables used in the GMNL models are reported in Table 1. Estimation results for the GMNL model of refrigerator choice with and without the rebate are presented in columns (a) and (b) of Table 2. Likelihood-ratio (LR) test results suggest that the GMNL specification was preferred to conditional and mixed logit specifications for both survey versions.

The estimated coefficients for *Label, Capacity, Ice, Water, and IandW* are positive and significant in the models indicating that consumers prefer ES-certified refrigerators, larger size, with external ice and/or water dispensers. The estimated mean parameter for coefficient of *FrenchDoor* is negative and significant only in the WR model. The estimated mean parameter for *LG* is negative in both models, while the estimated mean parameter for *GE* is negative and significant in the WOR model only. These results suggest that *Whirlpool* refrigerators are strongly preferred to *LG* and weakly preferred to *GE*. In both models, the estimate for τ is significant at the 1% level, indicating that the GMNL model nests both the utility space and WTP space models. The positive sign on *Familiar* in the models suggests that familiarity with the ES program prior to completing the survey, increases certainty about choice of refrigerator.

Estimated WTP

The estimates on *Label* from the GMNL models reported in Table 2, suggest that WTP for ES-certified refrigerators is significant. However, estimated WTP for an ES-certified refrigerator is lower for the WR survey version ($208.03) than for the WOR version ($238.39). A t-test (unequal variances) was used to compare the mean WTP across the WR and WOR groups ($208.03, $238.39), and the results indicate no statistically significant difference between the two (t = 1.04) at the 95% confidence level. Also, the mean of individual WOR WTP is $259.56 and mean of individual WR WTP is $248.67. These means were also not statistically different across WR and WOR. Hence, the offer of a $50 mail-in rebate had no statistically significant influence on WTP. The rebate would be expected to be discounted by the value of redemption costs, time delay in receiving the rebate, and uncertainty about receiving the rebate. However, it is perhaps surprising to find that this discounting fully offsets the rebate benefits.

Estimated WTP and Quality

Statistical testing was conducted on demographic variables to ensure that the WTP estimates were not being confounded by demographic differences between the two samples, (t-tests of means for continuous variables such as age and Chi-square tests of association for categorical variables). No significant differences or associations for demographics were found between the WR and WOR groups. Similarly, cross-sample comparisons of mean values for the opinion variables were conducted. Respondents were asked to indicate their level of agreement with statements about the concern for the environment, saving on electricity bills, government environmental regulation, and quality of ES products. Notably, the mean agreement rating for "*When I buy a product with the ENERGY STAR label, I can always be sure it's high quality*" was statistically higher for the WOR version than for the WR version. No other differences between the mean opinion ratings across the WR and WOR versions were significant. Thus, the WR respondents may have been less certain of the quality of ES-certified refrigerators than the WOR respondents.

The ordered probit analysis of the *Quality* variable is presented in Table 3.The negative coefficient for *Rebate* suggests that respondents offered the rebate were less likely to believe ES-certified appliances were of high quality. This suggests that respondents offered the rebate seemed to be assuming an implicit tradeoff between the utility rebate and product quality. Those who consider environmental impacts of products when making purchase decisions, and those who believed that purchasers of ES products are motivated by electricity costs savings were more likely to associate ES-certification with high product quality. Respondents with higher educational attainment and those who were their household's primary decision maker were less likely to associate the ES label with high product quality.

Given the above results, *Quality*Label* was in the incorporated into GMNL models. The results are presented in columns (c) and (d) of Table 2. With the interaction term, the estimated coefficient on *Label* decreases in magnitude for both models (results in (c) and (d) compared with (a) and (b) in Table 2). The estimated coefficient for *Label* in the WR model is significant, however, the interaction term between *Quality*Label* is not. Conversely, the estimated coefficient for *Label* in the WOR model is not significantly different from zero, but the interaction term is positive and significant. Hence, WTP for an ES-certified refrigerator is positively influenced by quality perceptions of ES-certified appliances for WOR respondents but not the WR version. When the *Quality*Label* interaction is included, the estimated mean WTP for *Label* from the WOR model is $127.18 while the estimated mean WTP for *Label* from the WR model is $212.25, over an $85 difference. A t-test (unequal variances) between the WR and

WOR groups showed a statistical difference (*t* = -2.05) at the 95% confidence level. Hence, once quality perceptions of ES are incorporated into the model, the rebate has a positive influence on WTP. The mean of individual estimates of WTP reflect a similar result. Mean WTP WOR for *Label* at $85.10 was statistically lower than mean WTP WR at $270.79 (t=-10.50).

Conclusions and Implications

Results suggest that consumers place a premium on ES-certified refrigerators relative to uncertified refrigerators. Additional analysis suggests that the preference for ES-certified refrigerators was, to some extent, motivated by an association of ES-certification with high production quality for respondents who had not been informed of the rebate, but not for those who had. Findings suggest that the offer of the rebate may have reduced the extent to which respondents associate ES certification with high product quality product. This reduction may have adversely affected WTP. Respondents to the WOR survey had a higher quality rating of ES products than WR respondents. An ordered probit of ES quality perceptions reflected a similar result, with a negative sign on *Rebate*. Further, inclusion of a *Quality*Label* interaction term in the WTP models, revealed that WTP for ES-certification was positively correlated with perceptions of ES-certified quality for WOR respondents but not for WR. Taken together, these results suggest although consumers generally associate ES with high quality, presence of a mail-in rebate has the potential to erode confidence in ES quality and reduce WTP.

Implications of the results are that regulatory agencies and other policy makers should incorporate marketing and communications strategies to offset the possibility that mail-in rebates may erode quality perceptions. In this case, policymakers may want to emphasize the extent to which increased energy efficiency is being, or can be, achieved without sacrificing other product attributes or overall product quality in materials promoting these subsidies to consumers.

References

Adamowicz, W., P. Boxall, M. Williams, and J. Louviere. "Stated Preference Approaches for Measuring Passive Use Values: Choice Experiments and Contingent Valuation." *American Journal of Agricultural Economics* 80,1(1998): 64-75.

Amacher, G., E. Koskela, and M. Ollikanen. "Environmental Quality Competition and Eco-labeling." Journal of Environmental Economics and Management 47 (2004): 284-306.

Aydin, G., and E. Porteus. "Manufacturer-to-retailer Versus Manufacturer-to-Consumer Rebates in a Supply Chain." *Retail Supply Chain Management: International Series in Operations Research & Management Science* 122(2009): 1-34.

Banerjee, A., and B. Solomon. "Eco-labeling for Energy Efficiency and Sustainability: A Meta Evaluation of U.S. Programs." *Energy Policy* 31, 2 (2003):109-123.

Bjørner, T., L. Hansen, and C. Russell. "Environmental Labeling and Consumers' Choice - An Empirical Analysis of the Effect of the Nordic Swan." *J Env Econ Mgmt* 47,3(2004): 411-434.

Cason, T., and L. Gangadharan. "Environmental Labeling and Incomplete Consumer Information in Laboratory Markets." *Journal of Environmental Economics and Management* 43, 1 (2002): 113-134.

Clark, C., K. Jensen, C. Russell, and S. Yen. *Environmental Labeling and Motivation Crowding-Out: Final Report*. Department of Agricultural & Resource Economics, University of Tennessee, 2011.

Davis, L. *Evaluating the Slow Adoption of Energy Efficient Investments: are Renters Less Likely to Have Energy Efficient Appliances?* NBER Working Paper 16114. National Bureau of Economic Research, Cambridge, MA, 2010.

Datta, S., and S. Gulati. *Utility Rebates for Energy Star Appliances: are They Effective?* Working Paper, University of British Columbia, Vancouver, Canada, 2010.

Fiebig, D. G., M. Keane, J. Louviere, and N. Wasi "The Generalized Multinomial Logit Model: Accounting for Scale and Coefficient Heterogeneity." *Marketing Science* 29, 3 (2010): 393-421.

Greene, W.H. *Econometric Analysis*, 7th edn. Upper Saddle River, NJ: Prentice Hall, 2012.

Greene,W.H., and D.A. Hensher."Does Scale Heterogeneity Across Individuals Matter? An Empirical Assessment of Alternative Logit Models." *Transportation* 37 (2010): 413-428.

Greene W.H, and D.A. Hensher. "Revealing Additional Dimensions of Preference Heterogeneity in a Latent Class Mixed Multinomial Logit Model." *Applied Econometrics* 45,14(2013): 1897–1902.

Hensher D.A., and W.H.Greene.“Valuation of Travel Time Savings in WTP and Preference Space in the Presence of Taste and Scale Heterogeneity”. *Journal of Transport Economics and Policy* 45,3(2011): 505–525.

Hess, S., and J.M. Rose. “Can Scale and Coefficient Heterogeneity be Separated in Random Coefficient Models?” *Transportation* 39,6 (2012):1225–1239.

Jolson M., J. Wiener, and R. Rosecky. “Correlates of Rebate Proneness.” *Journal of Advertising Research* (February – March 1987): 33-43.

Loureiro, M., J. McCluskey, and R. Mittelhammer. “Assessing Consumer Preferences for Organic, Eco-Labeled, and Regular Apples." *Journal of Agricultural and Resource Economics* 26,2(2001): 404-416.

Louviere, J. “Conjoint Analysis Modeling of Stated Preferences: a Review of Theory, Methods, Recent Developments and External Validity.” *Journal of Transport Economics and Policy* 22, 1(1988): 93-119.

MacRae L., E. Jacobsohn and C. Cloutier. “The State Energy Efficient Appliance Rebate Program: an Assessment.” *2010 ACEE Summer Study on Energy Efficiency in Buildings*, 2010. http://eec.ucdavis.edu/ACEEE/2010/data/papers/2210.pdf. (Last Accessed August 19, 2012)

McFadden, D. “Conditional Logit Analysis of Qualitative Choice Analysis.” In: Zarembka P (ed.) *Frontiers in Econometrics*. New York: Academic Press, 1974.

McNeil, M. *Progress Towards Managing Residential Electricity Demand: Impacts of Standards and Labeling for Refrigerators and Air Conditioners in India*. LBNL Paper LBNL-2322E, Lawrence Berkeley National Laboratory, Berkeley, CA, 2010. http://escholarship.org/uc/item/6cd588t4.pdf. (Last Accessed August 1, 2012).

Mitchell, R., and R. Carson.*Using Surveys to Value Public Goods: The Contingent Valuation Method*. Resources for the Future, Washington DC, 1989.

Pechmann C., and T. Silk. Policy and Research Related to Consumer Rebates: a Comprehensive Review. *Journal of Public Policy & Marketing* (January 2013): 1-65.

Revelt, D., and K. Train. “Mixed Logit with Repeated Choices: Households’ Choices of Appliance Efficiency Level.” *Review of Economics and Statistics* 80,4(1998): 647–657.

Rose J., and R. Scarpa. “The Role and Estimation of Scale Heterogeneity in Choice Models.” *AERE 2011 pre-conference workshop: recent developments in the design and implementation of discrete choice experiments*. Centre for the Study of Choice, University of Technology, Sydney, 2011.

Silk T., and C. Janiszewski. *Managing Mail-In Rebate Promotion*. Warrington College of Business Administration Working Paper Series, University of Florida, Gainesville, FL,

2008. http://warrington.ufl.edu/departments/mkt/docs/janiszewski/Rebate.pdf. (Last Accessed 01 July 2012).

Soman, D., and J. Gourville. *The Consumer Psychology of Mail-In Rebates: A Model of Anchoring and Adjustment*. In HBS Marketing Research Papers, Harvard University, Cambridge, MA, 2005. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=875658. (Last Accessed 01 July 2012).

Tat, P. "Rebate Redemption: a Motivational Perspective." *Psychology & Marketing* 11(1994): 15-26.

Tat, P., W. Cunningham III, and E. Babakus. "Consumer Perceptions of Rebates." *Journal of Advertising Research* 28(1988): 45-50.

Train, K., and T. Atherton. "Rebates, Loans, and Customers' Choice of Appliance Efficiency Level: Combining Stated- and Revealed-Preference Data." *The Energy Journal* 16 (1995):55-70.

Train K, Weeks M (2005) "Discrete Choice Models in Preference Space and Willing-to-Pay Space.: In: Scarpa R, Alberini A (ed) *Applications of Simulation Methods in Environmental and Resource Economics*. Dordrecht,The Netherlands: Springer, pp1–16.

Train, K . *Discrete Choice Methods with Simulation*. New York: Oxford University Press, 2003.

U.S. Department of Energy (U.S. DOE). *State Energy Efficient Appliance Rebate Program: an Assessment*. Washington DC, 2010. http://www.energystar.gov/ia/partners/downloads/meetings/2010/2010%20Rebate%20Success.pdf. (Last Accessed January 1, 2011).

U.S. EPA. *National Awareness of ENERGY STAR® for 2006: Analysis of 2006 CEE Household Survey Staff Report*. Washington DC, 2007.

U.S. Federal Trade Commission (USFTC). *Appliance Energy Data*, 2011. http://www.ftc.gov/bcp/conline/edcams/eande/appliances/index.htm. (Last Accessed August 1, 2012).

Vermeulen, B., P. Goos, and M.Vanderbroek . "Models and Optimal Designs for Conjoint Choice Experiments Including a No-Choice Option." *International Journal of Research in Marketing* 25,2 (2008): 94-103.

Wallander, S. "Price Impacts of the Energy Star Label: the Power of Redundant Information." *Yale Environmental Economics Seminar,* Yale University, New Haven, CT, 2008.

Ward, D., C. Clark, K. Jensen, C. Russell, and S. Yen. "Factors Influencing Willingness-to-Pay for the ENERGY STAR® Label." *Energy Policy* 39 (2011): 1450-1458.

Information Screen

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.

Some utilities offer a mail-in rebate for the purchase of an ENERGY STAR refrigerator. For the purposes of this survey, please assume that your utility is offering a $50 mail-in rebate to customers who purchase an ENERGY STAR refrigerator.

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?

- ○ Ready to proceed
- ○ Would like more information

Choice Task Screen

If you needed to buy a refrigerator and <u>these were your only options</u>, 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:

<table>
<tr><th></th><th>Alternative 1</th><th>Alternative 2</th><th>Alternative 3</th><th></th></tr>
<tr><td>Price</td><td>$929</td><td>$1,029</td><td>$929</td><td rowspan="7">NONE: I wouldn’t choose any of these
○</td></tr>
<tr><td>Brand</td><td>General Electric</td><td>Kenmore</td><td>LG</td></tr>
<tr><td>Configuration</td><td>Side-by-side</td><td>French door</td><td>Side-by-side</td></tr>
<tr><td>Capacity (cu. ft.)</td><td>23.78</td><td>25.34</td><td>24.52</td></tr>
<tr><td>Though-the-Door Dispenser</td><td>Water</td><td>Ice</td><td>Ice & Water</td></tr>
<tr><td>Energy Star</td><td>No</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Your choice</td><td>○</td><td>○</td><td>○</td></tr>
</table>

Figure 1. Example Information and Choice Task Screens

Table 1. Variable Descriptions and Sample Statistics

Variable	Description	Sample Means	
		WOR	WR
GMNL Models		(N=19,860)	(N=19,452)
Chosen	1 if the refrigerator alternative is chosen, 0 otherwise	0.25	0.250
Price	$879, $929, $979, or $1,029	715.879	715.915
Label	1 if ENERGY STAR (ES)-certified, 0 if not	0.384	0.383
Capacity	23.78, 24.52, 25.34, 25.83 cubic feet of interior space	18.631	18.632
FrenchDoor	1 if French door style, 0 if side-by-side	0.385	0.384
LG	1 if LG brand, 0 otherwise	0.199	0.200
GE	1 if GE brand, 0 otherwise	0.185	0.183
Kenmore	1 if Kenmore brand, 0 otherwise	0.183	0.183
Ice	1 if has external ice dispenser, 0 otherwise	0.201	0.201
Water	1 if has external water dispenser, 0 otherwise	0.184	0.183
IandW	1 if has external ice and water dispenser, 0 otherwise	0.182	0.183
ASC	1 if "None" option, 0 otherwise	0.25	0.250
Familiar	Familiarity with the ES program prior to the survey (1=not at all, 2=somewhat, and 3=very)	2.136	2.141
Ordered Probit			(N=685)
Quality	When I buy a product with the ES label, I can always be sure it's high quality (1=strongly disagree, …, 5=strongly agree)		3.267
Rebate	1 if rebate version of the survey, 0 otherwise		0.492
Age10	Age of respondent in decades		4.878
Age10Sq	Age10 squared		26.406
HsGrad	1 if high school graduate, 0 otherwise		0.331
SCollege	1 if attended some college, 0 otherwise		0.286
CollGrad	1 if college graduate, 0 otherwise		0.267
Metro	1 if reside in a metro area, 0 otherwise		0.845
MW	1 if midwest region, 0 otherwise		0.216
NE	1 if northeast region, 0 otherwise		0.194
South	1 if south region, 0 otherwise		0.368
MetroMW	Metro, MW interaction		0.175
MetroNE	Metro, NE interaction		0.172
MetroSouth	Metro, South interaction		0.295
Inc10K	Income in $10,000		6.210
Inc10KSq	Income in $10,000, squared		55.179
ShopRole	Role in buying appliances, 1 if primary decision maker, 0 otherwise		0.345
Environ	When I buy products, I consider how use of them will affect the environment (1=strongly disagree, …, 5=strongly agree)		3.267
SaveElect	People buy products that have the ES label to save money on their electricity bills (1=strongly disagree, …, 5=strongly agree)		3.942

Table 2. Estimated GMNL Models of Refrigerator Choice[a]

	No *Quality*Label* Interaction				*Quality*Label* Interaction			
	WOR (a)		WR (b)		WOR (c)		WR (d)	
Variable	Est. Coeff.	Std. Err.	Est. Coeff.	Std. Err.	Est. Coeff.	Std. Err.	Est. Coeff.	Std. Err.
Mean								
Price	1.000	----	1.000	----	1.000	----	1.000	----
*Quality*Label*	NA		NA		0.584	-0.142***	-0.037	-0.082
Label	2.384	-0.229***	2.080	-0.18***	0.518	-0.503	2.168	-0.313***
Capacity	0.112	-0.046**	0.131	-0.041***	0.123	-0.044***	0.210	-0.041***
FrenchDoor	-0.027	-0.212	-0.349	-0.14**	-0.014	-0.142	-0.153	-0.110
LG	-0.506	-0.11***	-0.337	-0.092***	-0.494	-0.108***	-0.321	-0.091***
GE	-0.206	-0.102**	0.026	-0.100	-0.23	-0.096**	0.050	-0.095
Kenmore	-0.043	-0.103	-0.019	-0.089	-0.069	-0.106	-0.026	-0.090
Ice	0.511	-0.128***	0.572	-0.117***	0.529	-0.116***	0.587	-0.109***
Water	0.307	-0.109***	0.442	-0.109***	0.338	-0.105***	0.509	-0.103***
IandW	1.884	-0.191***	1.771	-0.162***	2.147	-0.177***	1.512	-0.153***
ASC	-5.097	-1.122***	-4.525	-1.016***	-4.531	-1.119***	-2.501	-1.053**
Standard Deviation								
Label	2.279	-0.208***	1.875	-0.153***	2.449	-0.203***	1.738	-0.156***
Capacity	-0.194	-0.019***	0.133	-0.011***	0.167	-0.013***	-0.009	-0.006
FrenchDoor	2.939	-0.256***	2.654	-0.217***	2.97	-0.226***	2.722	-0.204***
LG	0.927	-0.147***	-0.637	-0.129***	-0.758	-0.119***	0.533	-0.112***
GE	-0.662	-0.196***	0.827	-0.115***	-0.473	-0.222***	-0.844	-0.115***
Kenmore	0.754	-0.155***	-0.536	-0.149***	1.014	-0.137***	0.677	-0.096***
Ice	1.513	-0.150***	1.299	-0.148***	1.579	-0.149***	1.467	-0.135***
Water	0.562	-0.164***	-1.069	-0.121***	0.690	-0.135***	1.065	-0.115***
IandW	2.399	-0.223***	2.002	-0.160***	2.307	-0.181***	2.222	-0.195***
ASC	1.946	-0.231***	2.322	-0.219***	-1.667	-0.217***	-4.909	-0.375***
θ_0	-0.510	-0.165***	-0.123	-0.166	-0.551	-0.169***	-0.071	-0.163
$\theta_{Familiar}$	0.259	-0.068***	0.150	-0.066**	0.338	-0.069***	0.157	-0.068**
τ	0.471	-0.072***	0.417	-0.083 ***	0.608	-0.069***	0.564	-0.067***
N	19,860		19,452		19,696		19,120	
LLF	4151.27		4093.50		4123.81		4015.03	
LLR(Intercept) (10 df)[b]	1920.10***		2106.96***		2923.11***		5572.31***	
LLR (CL) (12 df)	4175.63***		4045.70***		4118.37***		3924.00***	
LLR (ML)(2 df)	43.73***		49.88***		78.22***		65.32***	
Mean WTP	$238.39	$22.90***	$208.03	$18.00***	$127.18	$34.41***	$212.25	$23.24***

[a] *** indicates significance at α =.01, ** indicates significance at α =.05.

[b] Wald tests of models against those in parentheses with χ^2 distribution.

Table 3. Ordered Probit Model of Respondent Perception of Quality of ES Appliances [a]

	ML	Marginal Effects on the Probability of Quality Category:				
Variable	Estimate	1	2	3	4	5
Continuous explanatory variables						
Age10	-0.224	0.011	0.034	0.039	-0.056	-0.027
	(0.143)	(0.007)	(0.022)	(0.025)	(0.036)	(0.017)
Age10Sq	0.023	-0.001	-0.003	-0.004	0.006	0.003
	(0.014)	(0.001)	(0.002)	(0.003)	(0.004)	(0.002)
Income10K	0.0181	-0.001	-0.003	-0.003	0.006	0.002
	(0.0360)	(0.002)	(0.005)	(0.006)	(0.009)	(0.004)
Income10KSq	-0.002	0.0001	0.0003	0.0003	-0.0004	-0.0002
	(0.002)	(0.0001)	(0.0003)	(0.0003)	(0.0005)	(0.0003)
Environ	0.328***	-0.016***	-0.050***	-0.057***	0.083***	0.039***
	(0.046)	(0.003)	(0.008)	(0.010)	(0.013)	(0.007)
SaveElect	0.489***	-0.024***	-0.073***	-0.084***	0.124***	0.058***
	(0.044)	(0.005)	(0.009)	(0.012)	(0.014)	(0.008)
Binary explanatory variables (yes = 1; no = 0)						
Rebate	-0.279**	0.014**	0.042**	-0.048**	-0.071***	-0.033**
	(0.084)	(0.005)	(0.013)	(0.015)	(0.021)	(0.011)
HsGrad	-0.233	0.013	0.036	0.037	-0.059	-0.026
	(0.147)	(0.009)	(0.024)	(0.021)	(0.037)	(0.016)
SCollege	-0.325*	0.019	0.052*	0.047*	-0.082*	-0.035*
	(0.152)	(0.011)	(0.026)	(0.018)	(0.038)	(0.015)
CollGrad	-0.544***	0.036*	0.089**	0.065***	-0.136***	-0.054***
	(0.160)	(0.014)	(0.029)	(0.014)	(0.039)	(0.014)
Metro	0.609	-0.047	-0.105	-0.051***	0.150*	0.053**
	(0.319)	(0.036)	(0.060)	(0.013)	(0.072)	(0.020)
MW	0.595	-0.022*	-0.075	-0.132	0.137	0.092
	(0.369)	(0.011)	(0.039)	(0.095)	(0.072)	(0.072)
NE	0.314	-0.013	-0.043	-0.064	0.077	0.043
	(0.413)	(0.014)	(0.051)	(0.015)	(0.095)	(0.066)
South	0.574	-0.025	-0.080	-0.111	0.138	0.078
	(0.342)	(0.015)	(0.044)	(0.071)	(0.076)	(0.053)
MetroMW	-0.724	0.059	0.126	0.052**	-0.175*	-0.061*
	(0.393)	(0.049)	(0.074)	(0.020)	(0.085)	(0.024)
MetroNE	-0.165	0.009	0.026	0.025	-0.042	-0.018
	(0.435)	(0.027)	(0.071)	(0.056)	(0.110)	(0.044)
MetroSouth	-0.513	0.032	0.083	0.065*	-0.128	-0.053
	(0.361)	(0.029)	(0.062)	(0.031)	(0.087)	(0.033)

Table 3. Continued.

Variable	ML Estimate	Marginal Effects on the Probability of Quality Category: 1	2	3	4	5
ShopRole	-0.233*	0.013*	0.036*	0.037**	-0.059*	-0.026*
	(0.093)	(0.005)	(0.015)	(0.014)	(0.024)	(0.010)
Threshold (μ_1)	0.569					
	(0.501)					
μ_2	1.434**					
	(0.500)					
μ_3	2.988***					
	(0.506)					
μ_4	4.166***					
	(0.514)					
Pseudo R^2	0.138					
Log likelihood	-797.495					
χ^2 (df = 17)	254.19					
Sample size	685					
Predicted probability		0.020	0.098	0.528	0.294	0.060

[a] Asymptotic standard errors in parentheses. *** indicates significance at α =.01, ** at α =.05, and * at α =.10.