Measuring the Value of Plastic and Reusable Grocery Bags

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Abstract: Using data from an online survey of grocery store customers in Logan, Utah, we estimate the marginal effects on willingness to pay (WTP) for continued use of plastic grocery bags, and the marginal effects on willingness to accept (WTA) for switching to reusable grocery bags. We find both non-parametric and parametric evidence suggesting that individuals respond quite dramatically to moderate plastic-bag tax rates and reusable-bag subsidy rates. All else equal, older and lower-to-middle income individuals, as well as larger-sized households, are more likely to switch to using reusable bags exclusively when faced with a tax on plastic bags. Lower-to-middle income individuals, as well as women in general, are more likely to switch away from using plastic bags when provided with a subsidy for reusable bags. Our results help quantify the extent to which plastic bag taxation and reusable bag subsidization might induce shoppers to switch from plastic to reusable bags for their grocery trips.

Keywords: plastic grocery bags; willingness to pay; willingness to accept.

JEL Classification: Q24, Q51, Q53

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1. Introduction

Plastic grocery bags are ubiquitous. According to FMI (2012), Roach (2012), and Reusit.com (2012) anywhere from 500 billion to 1 trillion plastic bags are consumed worldwide each year, and roughly 1 to 3 percent of these bags end up in the litter stream outside of landfills.[2] In the US alone, an estimated 100 billion plastic shopping bags are consumed annually at an estimated cost to retailers of $400 million (Roth, 1985; Reusit.com, 2012). Akullian et al. (2006) estimate an associated external cost, which accounts for damages from $C0_2$ emitted during production as well as litter, landfill and improper recycling disposal costs, of roughly $0.11 per bag.

In an effort to reduce these external costs, cities in the US, as well as several countries worldwide, have implemented outright bans or per-bag taxes in an effort to reduce the demand for plastic grocery bags. To our knowledge, however, no study has yet attempted to systematically estimate determinants of welfare – at the individual level – associated with the use of plastic or reusable bags, in particular marginal effects on willingness-to-pay (WTP) for continued plastic bag use and marginal effects on willingness-to-accept (WTA) for switching to reusable bags. This stated-preference study is a first attempt at generating such welfare estimates.[3]

Plastic bag bans have been most popular in the US, while taxes have been implemented more frequently throughout the rest of the world. For example, in 2007 San Francisco became

[2] These estimates are based on a highly cited but to-date unobtainable 2001 report by the US Environmental Protection Agency (EPA).

[3] Because grocery stores in our study area (as with most areas worldwide) provide shoppers with free plastic bags, we are precluded from assessing their revealed preferences.

the first U.S. city to ban the use of plastic bags in large supermarkets and pharmacies. The Californian cities of Santa Cruz, Santa Clara, and Santa Monica have since followed suit with their own bans, as have three counties in North Carolina (Koch, 2010). More recently, Portland Oregon and Seattle, Washington have implemented plastic grocery bag bans in concert with fees of $0.05 per paper bag (Yardley, 2011; Slovic, 2011).[4]

Since the 1990s, governments in Australia, South Africa, Ireland, Canada, New Zealand, Denmark, and the Philippines have imposed taxes on plastic bags (Cherrier 2006). For example, in 2002 Ireland introduced a 15 Euro cent tax per plastic bag, which resulted in a 90% reduction in use (Convery et al 2007). A lower tax levied in South Africa in 2003 of approximately $0.06 per bag similarly resulted in an 80% reduction (Hasson et al., 2007). In the U.S., Washington D.C. introduced a $0.05 fee per plastic bag in 2009, which resulted in an estimated 87% reduction in their usage (Craig, 2010).

The estimated reductions in plastic bag usage, while indicative of aggregate responses to alternative tax rates, leave unanswered two important questions. First, at which levels (or within which intervals) might the tax/subsidy rates be set in order to nudge individuals in their private lives toward achieving what are ultimately collective reduction targets? Alternatively stated, should we expect tax rates as low as Washington D.C.'s to be a threshold above which the marginal effect on the individual's bag choice is negligible? Second, what determines response rates at the individual (or household) level, not only with respect to a tax on plastic bags, but also with respect to a subsidy for reusable bags? Local policymakers considering the

[4] Cities are not the only entities implementing plastic bag bans and taxes in the U.S. Retail giants Trader Joe's and Whole Foods Market have banned the use of plastic bags in their outlets, while Ikea charges $0.05 per plastic bag (Horovitz, 2008).

implementation of a tax or subsidy will find this type of information useful when it comes to publically promoting the efficacy of these types of market interventions, and envisioning their likely effects.

In answer to the first question, we find non-parametric evidence suggesting that individuals respond quite dramatically to moderate plastic-bag tax rates and reusable-bag subsidy rates (e.g., $0.05 per bag or higher in both cases). This evidence is manifest in the high percentage of respondents who report that they would switch to using reusable bags exclusively if faced with a $0.05 tax per plastic bag or a $0.05 subsidy per reusable bag, thus supporting existing anecdotal evidence of similarly large responses at the aggregate (i.e., community or national) level..

As discussed in greater detail in Section 3, our decision to consider solely inframarginal changes in a household's plastic and reusable bag use (e.g., shifts from using solely plastic bags to using solely reusable bags rather than shifts from using solely plastic bags to using a combination of plastic and reusable bags) is premised on two assumptions. First, we have assumed respondents have an easier time envisioning their households making a complete rather than partial switch, thereby enhancing the accuracy of their corresponding WTP and WTA responses. Second, we have assumed that this type of 'complete-shift' visualization is consistent with what policy makers believe is necessary to achieve community-wide plastic-bag reduction goals.

In answer to the second question, we find parametric evidence suggesting that, all else equal, older and lower-to-middle income individuals are more likely to switch to using reusable bags exclusively when faced with a tax on plastic bags. Larger-sized households are also more

likely to switch to reusable bags when faced with the tax. Providing reusable bags free-of-charge likewise increases the probability that shoppers will switch away from using plastic bags when faced with a tax. Lower-to-middle income individuals are similarly more likely to switch away from using plastic bags when provided with a subsidy for reusable bags. Unlike with a plastic bag tax, we find no statistical evidence suggesting that older individuals and larger-sized households will switch to reusable bags when provided with a subsidy. Interestingly, women are more likely to respond to a reusable-bag subsidy by making the switch. As with the plastic-bag tax, providing reusable bags free-of-charge increases the probability that shoppers will switch away from using plastic bags when faced with a subsidy.

The next section briefly develops a theoretical framework within which WTP and WTA for inframarginal changes associated with a household's plastic and reusable bag use (as mentioned above) can be distinguished and understood in an abstract sense. Section 3 presents our survey methodology and the empirical model used to parametrically estimate marginal effects on WTP and WTA from the data. Section 4 discusses the data obtained from the survey and presents our empirical results. Section 5 concludes.

2. Theoretical Framework

As mentioned in Section 1, WTP in this model represents the maximum amount an individual would willingly pay to continue enjoying the convenience associated with solely using plastic grocery bags, and WTA represents the minimum amount the individual would willingly accept to forgo this convenience (and thereby switch to using reusable bags exclusively).To begin, WTP is represented in Figure 1 by distance *AB* on the vertical axis, which in this case is a small

enough amount relative to per-bag tax rate $t > 0$ to induce the individual to completely switch from using plastic bags (i.e., the individual's consumption of plastic bags is driven to zero in response to the imposition of t). To see this, first note that horizontal line $t = 0$ represents the individual's status quo budget constraint, where no tax has yet been levied on plastic bag consumption, and thus the individual effectively consumes the bags for free. The individual's corresponding indifference curve, I_1, is purposely drawn flat to reflect the relatively minor contributions additional plastic bags make to utility.[5] This curve becomes horizontal (and thus tangent to/coincident with budget line $t = 0$) at point C, which in turn corresponds to q_0, the individual's plastic-bag satiation level.

[INSERT FIGURE 1 HERE]

Imposition of tax rate $t > 0$ causes the individual's budget line to rotate downward (clockwise), and creates a new tangency (with indifference curve I_2) at point A, corresponding to zero plastic bag consumption. In this instance, WTP – to avoid having to pay the per-bag tax rate of t – is represented by distance AB along the vertical axis.

The story is similar for WTA. In Figure 2, WTA is represented by distance AB on the vertical axis, which in this case is a small enough amount relative to subsidy rate $s > 0$ to induce the individual to switch completely to using reusable bags (i.e., the individual's consumption of plastic bags is driven to zero, and thus his consumption of reusable bags is driven to its satiation level at q_0 in response to the provision of s). To see this, first note that line $s = 0$ represents the individual's status quo budget constraint, where no subsidy has yet been provided for reusable

[5] Note that, as drawn in Figure 1, the continuity of the indifference curve implies the existence of a continuous demand curve for plastic bags, which, in turn, implies the existence of a set of tax rates that would induce a partial, rather than complete, switch away from plastic bag consumption. As alluded to in Section 1, we effectively focus on estimating the threshold tax rate at which the household's switch becomes complete. The analogous case for reusable bags is presented in Figure 2.

bags. The line is drawn negatively sloped, reflecting the fact that reusable bags must be purchased by the individual at a positive (pro-rated) cost (in terms of an explicit price per bag and/or the (monetized) time it takes the individual to gather the bags prior to making a shopping trip). The individual's corresponding indifference curve, I_1, is again drawn flat to reflect the relatively minor contributions additional reusable bags make to utility. The curve also becomes horizontal (and tangent to/coincident with budget line $s = 0$) at point D, which in turn corresponds to q_0, the individual's reusable-bag satiation level.

[INSERT FIGURE 2 HERE]

Provision of subsidy rate $s > 0$ causes the budget line to rotate upward (counterclockwise – and drawn horizontal for graphical convenience) and creates a new tangency/coincidence with indifference curve I_2 at point C, corresponding to (satiated) q_0 reusable bags consumed, i.e., the point at which the household no longer consumes plastic bags. Corresponding WTA is represented by distance AB along the vertical axis.

3. Survey Methodology and Empirical Model

A hard copy of the survey, which was made available online to survey participants through Survey Gizmo (surveygizmo.com) during the months of October and November, 2011, is provided in Appendix A. The survey begins by providing participants with a brief summary of plastic-bag estimates for Logan, Utah, and mentions the option of switching from plastic to reusable grocery bags. The term "reusable bags" is carefully defined.[6,7] Next, a routing

[6]Links to two internet sites are also provided regarding 1) Washington DC's experience with its plastic bag tax, and 2) the pros and cons associated with using reusable vs. plastic grocery bags. Respondents voluntarily choose whether to follow one or both of the links.

question is asked regarding the respondent's prior knowledge of reusable bags. Contingent upon the respondent's answer, the respondent is routed in one of two directions – those who have previous knowledge of reusable bags and those who do not. This selection procedure is consistent with what Caplan et al. (2010a) have labeled a "between-subject survey design," where in our case respondents are asked either a WTP or WTA question, but not both.

We have implemented this design for two reasons, both of which address the overriding concerns of construct and internal validity. First, we believed that asking respondents to answer separate WTP and WTA questions within the same survey would lead to confusion and thereby compromise the accuracy of their responses. Second, we believed that individuals who had at least some experience using reusable bags would more accurately envision what the subsidy rate would need to be in order to induce a shift to using reusable bags exclusively. Similarly, those who solely used plastic bags would more accurately envision the tax rate necessary to induce a shift away from using plastic bags.

Respondents with no prior knowledge of reusable bags are first provided with a "cheap talk" reminder statement in an attempt to mitigate the incidence of hypothetical bias (Aadland and Caplan, 2006; Caplan et al., 2010b; Cummings and Taylor, 1999). The four randomized bid, or hypothetical tax values (t_i) selected for the ensuing WTP question are \$0.05, \$0.10, \$0.25, and \$0.35. These values were chosen to form a rough distribution around Akullian et al.'s (2006) previously mentioned external cost estimate of \$0.11 per bag, beginning with the level of Washington D.C.'s existing tax of \$0.05 per bag, which is among the lowest rates currently levied in the U.S. Following Champ et al. (1997) and Berrens et al. (2002), a "certainty follow-up

[7] Logan is Cache County's largest city, located in the northeast corner of Utah (see red highlighted areas in Figure 3). In 2009 Logan had a population of 46,000 people residing in 16,000 households (U.S. Census Bureau, 2010).

question" then offers a range from 0% to 100 % on how certain the respondent is of the answer provided to the WTP question.

If instead a respondent indicates prior knowledge of reusable grocery bags, s/he is routed to a separate set of questions, which focus on the respondent's knowledge and use of reusable bags. These questions ultimately route the respondent into one of two groups – those who use reusable bags for each shopping trip and those who do not. Respondents who are unsure about the extent to which they use reusable bags are routed to the WTP question for continued use of plastic bags, while those who are aware, and who use reusable bags for only some shopping trips, are asked a dichotomous-choice WTA question prefaced with cheap talk. The bid values for the WTA question, s_i, are likewise drawn from the interval ($0.05, $0.10, $0.20, $0.35). The question asks if the randomly drawn subsidy value is large enough to induce the respondent to use reusable bags for each grocery trip. A follow-up certainty question is also asked of these respondents.

Respondents who use reusable bags for each grocery trip are instead routed to a qualitative question that asks about any known compensation they receive from their grocer as a result of using reusable bags. These respondents are then routed to a set of demographic questions – questions each respondent, regardless of how they have been routed, is asked to answer in the final section of the survey.

Before the survey was administered to the public it went through three rounds of pre-testing. Pre-testing, in the form of having various focus groups participate in and evaluate the survey instrument, was used to mitigate any confusion associated with the question format. Each group consisted of between three and five individuals and included environmental

consultants, academicians, and college students. The groups included individuals who had no prior knowledge of using reusable bags for grocery shopping, as well as those who currently use reusable bags for some or all of their shopping trips.

As mentioned above, the survey was published online through Survey Gizmo. To recruit participants, 1400 postcards were distributed including instructions on how to login to the survey at surveygizmo.com (see Appendix B). As an incentive to participate in the survey, each postcard included a unique alphanumeric code for the respondent to type in upon completion of the survey. Respondents were instructed to visit a separate website on a prearranged date at the conclusion of the survey (November 7, 2011) in order to see if their code number was chosen at random for a $100 gift card to a local merchant (paid for by the study's authors).

Participants were solicited in two different ways. First, 700 of the 1400 postcards were randomly delivered door-to-door to households located in the two primary zip-code areas of the city during October, 2011. Second, the remaining 700 postcards were handed out to customers in front of two large grocery stores (350 postcards each) – Lee's Marketplace and Fresh Market – during the weekends of October 8th and 22nd, 2011. These two stores were geospatially selected in order to recruit participants from different areas of the city. Approximately 3.8% of the 700 shoppers approached in front of the two grocery stores refused to accept the postcards, indicating that an overwhelming of those approached had the opportunity to participate in the survey. Overall, 216 surveys were completed, for a total response rate of 15.4 %.[8]

[8] This response rate is roughly half the average rate reported by Cook et al. (2000) based on their meta-analysis of a wide range of web-based surveys. According to Lindhjem, H. and Navrud, S. (2011), response rates for online, stated preference (SP) surveys tend to be more variable than those for online surveys in general. For instance, the

For the parametric analysis, interval regression analysis is used to calculate dollar-denominated marginal effects for continuing to use plastic bags, as well as for switching to reusable bags (Wooldridge, 2002). Accordingly, based on his response to a given bid value, a respondent's latent WTP is placed in one of two regions: $(-\infty, t_i)$ in the event of answering "no" to the WTP question, and (t_i, ∞) in the event of answering "yes."[9] WTP for individual j (in its reduced form, as a solution to a standard random utility model) is assumed linear in both its deterministic and random components,

$$WTP_j = \mathbf{X_j}\boldsymbol{\beta} + \varepsilon_j, \quad (1)$$

where $\mathbf{X_j}$ represents a vector of explanatory variables, i.e., individual j's demographic characteristics, and $\boldsymbol{\beta}$ is a vector of corresponding (constant) coefficients to be estimated. An *i.i.d* error term, ε_j, is appended in order to account for unexplained variation in the respondent's estimated WTP.

For estimation purposes, a binary choice variable, $accept\_WTP_j$, is defined, which equals one if the respondent accepts t_i and zero if not. Thus, $accept\_WTP_j = 1$ responses imply $WTP_j > t_i$ and $accept\_WTP_j = 0$ implies $WTP_j \leq t_i$ (Caplan et al, 2010). Using equation (1), the probability that respondent j accepts bid t_i is,

$$P_j = Pr[accept\_WTP_j = 1] = Pr[WTP_j > t_i] = Pr[\varepsilon_j > t_i - \mathbf{X_j}\boldsymbol{\beta}] = \Phi(\mathbf{X_j}\boldsymbol{\beta} - t_i) \quad (2)$$

where $\Phi(\cdot)$ is the standard normal cumulative distribution function, with the last equality following from $\Phi(\cdot)$'s symmetry. Using (2), the associated log likelihood function defined over all individuals $j = 1,...,N$, is,

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authors cite several published studies based on web-based SP surveys with response rates as low as 5% and as high as 40%.

[9] We refer only to WTP in our discussion of the interval regression model for expository convenience. The same model is used for calculating mean WTA, with subsidy s_i duly substituted for tax t_i.

$$\text{Log L} = \sum_{j=1}^{N} [\text{accept\_WTP}_j \left(ln(P_j) \right) + (1 - \text{accept\_WTP}_j) \left(ln(1 - P_j) \right)], \quad (3)$$

where, again, Log L is estimated as an interval regression model (Wooldridge, 2002).

4. Data and Empirical Results

Definitions and associated descriptive statistics for those variables ultimately used in the econometric analyses performed in this study are presented in Table 1. Comparing the statistics in Table 1 (as well as statistics for some of the variables not ultimately included in the econometric analyses) with corresponding U.S. census data helps to identify characteristics of our sample that both align with and diverge from associated characteristics in Logan's general population. For example, the average household size for respondents included in our overall sample of 163 observations is 3.13.[10] In 2010, the average family size in Logan city was 3.24 (U.S. Census Bureau 2010). In our sample, 88.55% of the respondents identify themselves as "white," while the U.S. census reports 83.9 % (U.S. Census Bureau 2010).

[INSERT TABLE 1 HERE]

The percentage of male respondents in our sample is 29%, while the U.S. census reports 49%. However, a recent survey estimates that nationwide women are responsible for approximately 64% of their households' shopping trips (Goodman, 2008). This suggests that the lower percentage of males in our survey aligns more closely with what one would suspect based on national data concerning the allocation of grocery shopping responsibilities within the

[10] Of the 216 completed surveys, 17 included "unsure" responses to the WTP and WTA questions. These observations were removed from the sample for the estimation of the dichotomous-choice model (i.e., equation 3), but included in the sample for the estimation of the ordered-probit model (see footnote 11). An additional 36 surveys were deemed sufficiently incomplete and also removed from the samples for both the dichotomous-choice and ordered-probit models.

typical household. With respect to education level, 93% of our total respondents are high school graduates, compared to U.S. census information suggesting that 90.9% of Logan residents are high school graduates. In our sample, 31% report household incomes between $25,000 and $75,000 per year. Between the years 2005 and 2009 the median income for Logan was estimated to be $34,466 (US Census Bureau 2010). Overall, it therefore appears that our sample compares quite favorably with U.S. census data.

Table 1 also shows that the great majority of respondents who were asked whether they would continue using plastic grocery bags in the face of a tax indicate that they would not (*accept_WTP* = 0.143). Likewise, a great majority of respondents asked whether they would switch to using reusable bags if provided with a subsidy indicate that they would (*accept_WTA* = 0.843).[11] Interestingly, both groups of respondents are relatively certain of their WTP and WTA responses (*certtax* = 0.817 and *certsub* = 0.834, respectively). Similarly large percentages of respondents report that they would use reusable bags more often if they were free (*rbfree* = 0.806) and believe increased use of reusable bags decreases the need for larger landfill size (*rblandf* = 0.903).

In Table 2, the results for *accept_WTP* and *accept_WTA* are categorized by bid level. These non-parametric results suggest that a relatively small tax on plastic bags or a relatively small subsidy for using reusable bags is necessary to induce a relatively large proportion of shoppers to switch to using reusable bags. In particular, a plastic bag tax of $0.05 per bag results in roughly 74% of the respondents who answered the WTP question (n = 61) saying they would

[11] In cases where a respondent knows, or believes, s/he is already receiving a subsidy from the grocery store for using reusable bags, the subsidy described in this study can be thought of as being in addition to the pre-existing one.

switch to using reusable bags. This percentage increases to between 88% and 94% as the tax rate rises toward $0.35 per bag. Likewise, a reusable bag subsidy of $0.05 per bag induces approximately 94% of the respondents who answered the WTA question (n = 102) to say they would switch to using reusable bags.

[INSERT TABLE 2 HERE]

Table 3 presents our parametric results for the marginal effects on WTP, obtained by estimating equation (3) using the sub-sample of respondents who currently do not use reusable bags.[12] The first section of the table reports the marginal effects associated with a set of explanatory variables taken from Table 1 to explain variation in the probability that the typical respondent will accept the (average) bid.[13] As indicated, older and lower-to-middle income individuals are, all else equal, more likely to switch to reusable bags when faced with a tax on plastic bags. Larger-sized households are also more likely to switch to reusable bags when faced with the tax. Providing reusable bags free-of-charge also increases the probability that shoppers will switch away from using plastic bags when faced with a tax.

[INSERT TABLE 3 HERE]

The second section of Table 3 presents associated goodness-of-fit measures and summary statistics for the overall model. The X^2 statistic is significant at the 1% level of significance, indicating that the estimated marginal effects are not simultaneously equal to zero. The model

[12] For this model, 17 respondents who answered "unsure" to the WTP question were removed from the sample. However, an ordered probit model was estimated with these 17 respondents included to compare results, where *accept_WTP=0* indicates a "no" response, *accept_WTP=1* indicates an "unsure" response, and *accept_WTP=2* indicates a "yes" response (an ordered probit model was similarly estimated for the WTA model). The results from these respective ordered probit models, which are qualitatively similar to those for WTP and WTA estimated via equation (3), are provided in Appendix C. Stata IC/11.0 for Windows (32 bit) was used to estimate the data.

[13] Additional versions of the WTP model (and of the WTA model presented in Table 4) were run with various variables listed in Table 1. Results from these model runs are available upon request from the authors. The results presented in Table 3 are generated from what the authors believe to be the best fitting model.

also predicts *accept_WTP*=0 responses much more accurately than *accept_WTP*=1 responses. This reflects the fact that the great majority of respondents rejected their randomized bid offers, thus inducing the model to over-predict rejected bids.

The third section of Table 3 presents mean WTP estimates based on three different runs of the model. The first WTP estimate (denoted WTP^1) is based on the dataset as is, i.e., the dataset in its pristine form. The second and third estimates (WTP^2 and WTP^3, respectively) use re-coded data along the lines of Champ et al. (1997) and Berrens et al. (2002). For WTP^2, we re-code respondents who have accepted the randomized bid value (i.e., $accept\_WTP_j = 1$), yet have reported a certainty level less than 50% (i.e., *certtax* < 0.5), to $accept\_WTP_j = 0$. For WTP^3 we instead re-code respondents who have rejected the randomized bid value (i.e., $accept\_WTP_j = 0$), yet have reported a certainty level less than 50% (i.e., *certtax* < 0.5), to $accept\_WTP_j = 1$.

Typically, only recoding akin to WTP^2 is undertaken. This is because of a slight, yet significant-enough nuance associated with the extent to which the setting in which the WTP question is asked is "all-or-nothing." In the typical situation, the respondent answers the WTP question in a strict all-or-nothing setting, i.e., a "yes" answer means the respondent obtains the environmental good in question, while a "no" answer means the good is unobtainable. In our case, a "yes" answer means the respondent continues using plastic bags, while a "no" means the respondent switches to using reusable bags. Either way, the respondent continues to go grocery shopping. Thus, we are compelled to derive conservative WTP estimates a lá Champ et al. (1997) and Berrens et al. (2002) in both directions. With respect to WTP^2, we presume that uncertain respondents (i.e., those who are less than 50% certain of their "yes" responses) will in fact not accept their respective bids and thus switch to using reusable bags. With respect to

WTP^3, we presume the opposite, i.e., those who are less than 50% certain of their "no" responses will in fact accept the bid and thus continue using plastic bags.

As indicated in Table 3, recoding has no effect on the statistical significance of the WTP estimate, i.e., WTP^1, WTP^2 and WTP^3 are each statistically indistinguishable from zero. This result reflects the fact that the average respondent was roughly 82% certain of his/her response to the WTP question, with a relatively small standard deviation of 18% (Table 1). Few respondents' certainty levels therefore fell beneath the respective 50% thresholds necessary for recoding, as described above for WTP^2 and WTP^3.

It is important to note that we report these mean WTP estimates with a great degree of caution because, as shown in Table 2, the great majority of respondents rejected their respective bids at each bid level. As a result, the interval regression model estimates a *negative* point estimate of WTP with extremely wide confidence bounds. Only in concert with our parametric evidence in Table 2, therefore, can we infer that the average household's WTP for continued plastic bag use is statistically indistinguishable from zero. For the same reason, it is no surprise that the estimated *taxbid* coefficient in Table 3 is also not statistically different from zero.

Table 4 presents our results for the WTA model. The qualitative implications of our WTP model are similar to the WTA model. In particular, our model suggests that even a very low subsidy would have a large behavioral effect. We also find, as mentioned in the Section 1, that lower-to-middle income individuals are more likely to switch away from using plastic bags when provided with a subsidy for reusable bags. Unlike with a plastic bag tax, we find no statistical evidence suggesting that older individuals and larger-sized households will switch to reusable

bags when provided with a subsidy. However, women are more likely to respond to a reusable-bag subsidy by making the switch. As with the plastic-bag tax, providing reusable bags free-of-charge increases the probability that shoppers will switch away from using plastic bags when faced with a subsidy.

[INSERT TABLE 4 HERE]

Also, as indicated in the second section of Table 4, the X^2 statistic is significant at the 1% level of significance. Unlike the WTP model, the WTA model predicts *accept_WTA*=1 responses more accurately than *accept_WTA*=0 responses. This reflects the fact that a majority of respondents accepted their randomized bid offers for using reusable bags. Because the number of *accept_WTA=1* responses relative to *accept_WTA*=0 is not as large as the corresponding number of *accept_WTP*=0 relative to *accept_WTP*=1 responses, the WTA model nevertheless accurately predicts a relatively large percent (60%) of the *accept_WTA*=0 responses.

As with the WTP model, recoding has no effect on the statistical significance of the mean WTA estimate, i.e., WTA^1, WTA^2 and WTA^3 are each statistically indistinguishable from zero. This result reflects the fact that the average respondent was over 83% certain of his/her response to the WTA question, with a relatively small standard deviation of 20% (Table 1). Few respondents' certainty levels therefore fell beneath the respective 50% thresholds necessary for recoding.

Similar to the WTP model, we report these mean WTA estimates with a great degree of caution. As shown in Table 2, a large majority of respondents accepted their respective bids at each bid level. As a result, the interval regression model estimates a *negative* point estimate of WTA with extremely wide confidence bounds. Therefore, only in concert with our parametric

evidence in Table 2 can we infer that the average household's WTA for discontinuing plastic bag use is statistically indistinguishable from zero. Unlike the WTP model, however, the estimated bid coefficient for WTA in Table 3, *subbid*, is (weakly) statistically positive, indicating that, all else equal, the average household is more likely to switch to using recyclable bags exclusively as the per-bag subsidy increases.

5. Conclusions

This study reports results from an online survey of customers at two grocery stores located in Logan, Utah used to estimate marginal effects on willingness to pay (WTP) for continued use of plastic grocery bags, and marginal effects on willingness to accept (WTA) for switching to reusable grocery bags. We find both parametric and non-parametric evidence that individuals respond quite dramatically to moderate plastic-bag tax rates and reusable-bag subsidy rates. All else equal, older and lower-to-middle income individuals, as well as larger-sized households, are more likely to switch to reusable bags when faced with a tax on plastic bags. Lower-to-middle income individuals, as well as women in general, are more likely to switch away from using plastic bags when provided with a subsidy for reusable bags.

These results therefore provide at least initial answers to the two questions originally posed in Section 1 concerning (1) what might be the threshold tax/subsidy rates that nudge individuals in their private lives toward achieving what are ultimately collective reduction targets, and (2) what determines individual responses to plastic-bag taxes and reusable-bag subsidies. Particularly with respect to question (1), our evidence suggests that the threshold plastic-bag tax may be less than the $0.05 rate currently in effect in Washington, D.C.

Two limitations of this study are apparent. First, our online survey was self-administered and based on a convenience sample of shoppers. Although several of our sample's mean demographic characteristics compare favorably with U.S. census data, its relatively low sample size and response rate draw into question its generalizability beyond the local area in which the survey was conducted. Second, setting the lower bound on our interval of randomized bids at $0.05 per bag has precluded us from directly measuring consumer responses to even lower bid levels, e.g., at $0.03 or $0.01 per bag. As a result, we can only conjecture what actual threshold tax and subsidy rates might be. Overcoming these shortcomings are obvious starting points for future research.

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Figure 1. WTP for continued use of plastic bags.

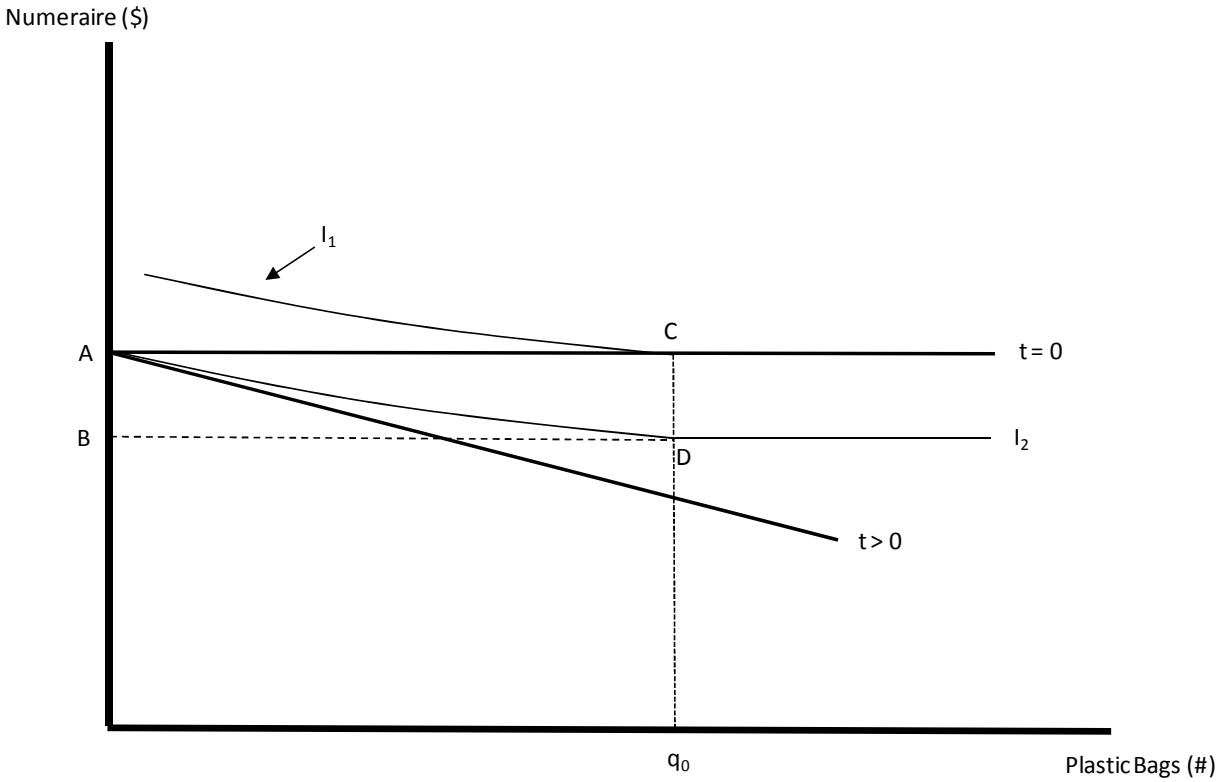

Figure 2. WTA for switching to reusable bags.

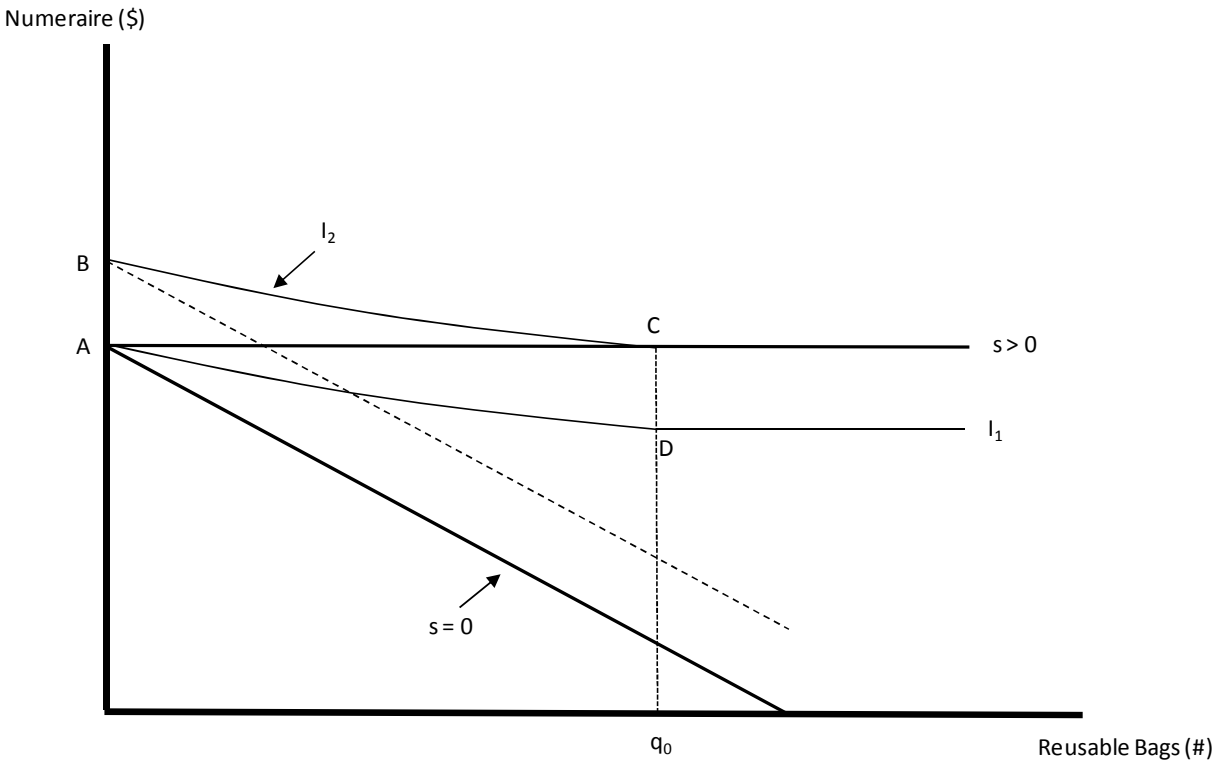

Figure 3. Locations of Cache County (left map) and Utah (right map).

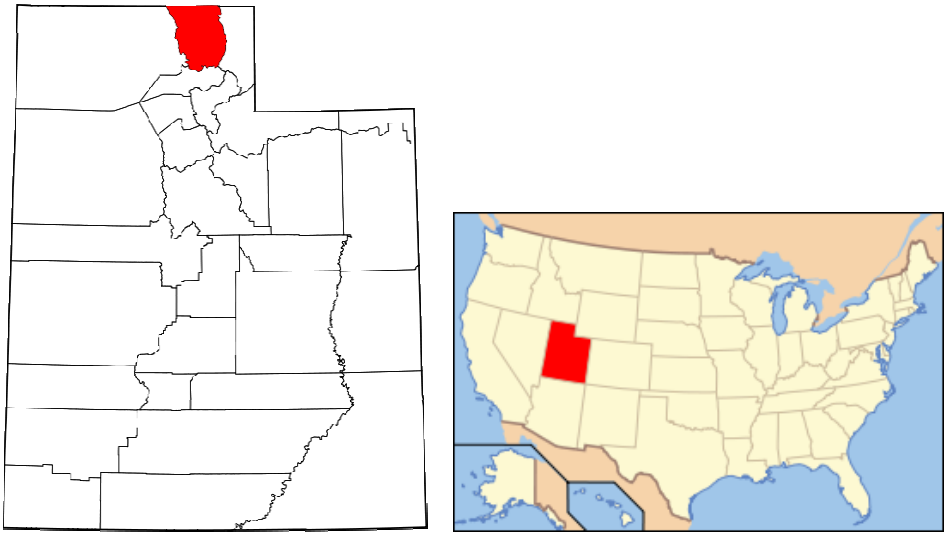

Table 1. Variable Definitions and Descriptive Statistics.

Variable	Variable Definition	Mean (SD)
accept_WTP	=1 if individual accepts t_i, 0 otherwise.	0.143 (0.353)
accept_WTA	=1 if individual accepts s_i, 0 otherwise.	0.843 (0.365)
taxbid	$t_i \in$ {\$0.05, \$0.1, \$0.2, \$0.35}	0.169 (0.119)
subbid	$s_i \in$ {\$0.05, \$0.1, \$0.2, \$0.35}	0.173 (0.105)
pbrecy	=1 if individual recycles plastic grocery bags, 0 otherwise.	0.745 (0.437)
certtax	Degree of certainty associated with answer to WTP question (%).	0.817 (0.181)
certsub	Degree of certainty associated with answer to WTA question (%).	0.834 (0.196)
rbfree	=1 if individual would use reusable bags more often if they are free, 0 otherwise.	0.806 (0.397)
rblandf	=1 if individual believes increased use of reusable bags decreases the need for larger landfill size, 0 otherwise.	0.903 (0.297)
sex	1 = male, 0 = female.	0.288 (0.454)
lowinc	=1 if household income is in interval \$0-\$25,000, 0 otherwise.	0.546 (0.500)
midinc	=1 if household income in interval \$25,001- \$75,000, 0 otherwise.	0.309 (0.464)
young	=1 if individual's age is in interval 18-32, 0 otherwise.	0.432 (0.497)
middle	=1 if individual's age is in interval 33-55, 0 otherwise.	0.346 (0.477)
totnhh	Total number of individuals living in the household.	3.131 (1.637)

Table 2. Percentages of respondents accepting randomized plastic and reusable bag bids.

Bid Levels ($)	*% accept_WTP = 1*	*% accept_WTA = 1*
0.05	26.32	94.44
0.10	6.67	68.75
0.20	7.69	87.01
0.35	12.50	95.24

Table 3. Results for the WTP model (Dependent Variable = *accept_WTP*).

Explanatory Variable	Coefficient Value[a]
taxbid	-0.050 (0.101)
rbfree	-0.371** (0.243)
pbrecy	-0.001 (0.009)
young	-0.006 (0.014)
middle	0.413** (0.315)
sex	0.005 (0.015)
totnhh	-0.013** (0.026)
lowinc	-0.241*** (0.187)
midinc	-0.018** (0.033)
Summary Statistic	**Value**
N	59[c]
Log Likelihood	-10.150
$X^2(9)$	22.68***
Pseudo R^2	0.528
%Correct(*accept_WTP=0*)[b]	98
%Correct(*accept_WTP=1*)[b]	14
Mean WTP	**Value[d]**
WTP^1	-0.33 (-3.45, 2.39)
WTP^2	-0.76 (-7.62, 7.60)
WTP^3	-2.20 (-7.88, 8.51)

[a]Standard errors are in parentheses. [b]The model correctly predicted *accept_WTP=0(1)* responses for predicted values less(greater) than 0.5. [c]Two observations from the original 61 were dropped due to missing variable values. [d]Krinsky and Robb (1986) 95% confidence intervals are in the parentheses. ***Significant at the 1% level, **Significant at the 5% level, *Significant at the 10% level.

Table 4. Results for the WTA model (Dependent Variable = *accept_WTA*).

Explanatory Variable	Coefficient Value[a]
subbid	0.729* (0.327)
rbfree	0.269*** (0.116)
pbrecy	0.070 (0.085)
young	-0.131 (0.123)
middle	-0.210 (0.159)
sex	-0.168** (0.092)
totnhh	0.017 (0.019)
lowinc	0.134* (0.082)
midinc	0.117* (0.062)
Summary Statistic	**Value**
N	90[c]
Log Likelihood	-28.589
$X^2(10)$	23.92***
Pseudo R^2	0.2950
%Correct(*accept_WTA=0*)[b]	60
%Correct(*accept_WTA=1*)[b]	88
Mean WTA	**Value[d]**
WTA^1	-0.11 (-1.43, 0.61)
WTA^2	-0.17 (-2.68, 2.42)
WTA^3	-0.23 (-3.10, 2.31)

[a]Standard errors are in parentheses. [b]The model correctly predicted *accept_WTA=0(1)* responses for predicted values less(greater) than 0.5. [c]Twelve observations from the original 102 were dropped due to missing variable values. [d]Krinsky and Robb (1986) 95% confidence intervals are in the parentheses. ***Significant at the 1% level, **Significant at the 5% level, *Significant at the 10% level.

Appendix A – The Online Survey Instrument

I. Introduction

Hello and welcome to the survey regarding reusable and plastic bag use in Logan, Utah. This survey should take approximately 10-20 minutes to complete, depending upon your awareness level and interest in this issue. The survey has been designed by a graduate student in the Department of Applied Economics at Utah State University (USU). The results will be analyzed in fulfillment of the student's Master's thesis. Since nowhere in the survey is your name, address, phone number, or email requested, your responses will be confidential. The information will be used solely for academic analysis at USU. We request that you be 18 years or older, and that you are the person in your household who is either responsible, or shares in the responsibility, for doing the household's grocery shopping on a regular basis.

One lucky respondent will win a $100 gift card to Lowe's Home Improvement Store just by successfully completing the survey and being randomly drawn from the survey's pool of respondents. The winner of the $100 gift card will be drawn on November 7, 2011 (the last question on this survey provides instructions on how to enter the drawing and how you can find out if your household is the lucky winner).

II. Background Information

Cache Valley businesses currently use over 100,000 plastic bags per week (personal correspondence with the Managers of Lee's Marketplace, Fresh Market, Smith's, and Wal-Mart during the summer of 2011). According to a recent study published by Convery, et al. (2006), plastic bags are a major source of litter in cities across the US and throughout the world. In response to this problem, there have recently been programs implemented in places such as Washington DC and Ireland that have applied a per-bag fee to try and discourage their use. Other programs have been proposed in Oregon and California (Koch, 2010). A plastic bag fee is applied at the time groceries are purchased on a per bag basis.

An alternative to charging a fee per bag has been for grocers to promote the increased use of reusable bags by giving customers per-bag credits for using their own reusable grocery bags for grocery shopping. Reusable bags are defined as bags meant for multiple use that are made of canvas, cloth, or some other washable fabric. The average cost of a reusable shopping bag in Cache Valley is around $1.25 per bag. A reusable bag credit or subsidy is currently occurring at local grocers such as Fresh Market, Lee's Marketplace, and Smith's here in Cache Valley.
If you are interested in learning more about existing plastic bag ordinances, here is a link discussing the pros/cons of reusable bag use:
http://plasticvpaper.weebly.com/reusable---pros--cons.html
Here is a link explaining the Washington DC plastic bag policy:
http://abcnews.go.com/Politics/washington-dc-charge-disposable-bag-fee/story?id=9456761

III. The Survey

We begin the survey by asking you questions regarding your household's current use of reusable bags at the grocery store. Again, by "reusable bags" we mean only bags that are designed and manufactured for multiple reuse, and made of fiber, cloth, or another machine-washable fabric.

0. Before participating in this survey, had you ever heard of using reusable bags for grocery shopping?

- Yes
- No
- Unsure

If question number #0 is answered "No" or "Unsure."

The next question asks you about your household's willingness to switch from using plastic bags to using reusable grocery bags instead. As you consider your answer to this question, please keep in mind that sometimes what people say their households are willing to do in a hypothetical survey like this one differs from what they actually do when given the opportunity to do it in a real situation. Therefore, as you read the next question, please imagine your household actually facing the situation described in the question.

N1. If your grocer begins charging you t_i per plastic bag used at the checkout to bag your groceries, would you switch to using reusable bags brought with you from home in future trips to the grocery store?

- No, my household would pay the t_i per plastic bag.
- Yes, my household would switch to reusable bags.
- Unsure

N2. On a scale from 0% to 100% (with 0% indicating "completely unsure" and 100% indicating "completely sure") how sure are you of the answer you have provided to the previous question? (Please provide a whole number i.e. 35,50, 75, etc.)

If question #0 is answered "Yes."

Y1. Have you or anyone in your household ever used, or are currently using, reusable shopping bags for grocery shopping?

- Yes
- No
- Unsure

If question Y1 is answered "No" or "Unsure" the respondent is routed to question N1.

Y2. Approximately how often do does your household use reusable bags for grocery shopping?

- All shopping trips.
- More than half of shopping trips.
- Less than half of shopping trips.
- My household does not use reusable bags.
- Unsure

If anything but "All shopping Trips" is answered, continue to question Y3. Otherwise, skip to question Y8.

Y3. Do you think using reusable bags helps to reduce the amount of non-reusable bags (plastic or paper) that end up in the Logan/Cache Valley landfill?

- Yes
- No
- Unsure

Y4. If reusable bags were available free-of-charge from your local grocer or another source in town would your household use them more frequently?

- Yes
- No
- My household already uses reusable bags for all grocery transactions

Y5. Does your household currently recycle the plastic bags that are provided by your grocer at the cash register?

- Yes
- No
- Unsure
- My household does not use any plastic bags provided by the grocer.

Grocery stores such as Lee's Marketplace and Smith's offer incentives to get customers to use more reusable bags. These incentives have traditionally been small amounts (e.g., 5 cents per reusable bag) subtracted from your grocery bill. Before you answer this question, please think about 1) your household income, 2) your household's monthly grocery budget, and 3) how many reusable bags your household currently uses at the grocery store on shopping trips.

Y6. If your grocer provided a subsidy of s_i per reusable bag that you would bring from your home would your household switch to using reusable bags for all grocery shopping trips?

- Yes
- No
- Unsure

Y7. On a scale from 0% to 100% (with 0% indicating "completely unsure" and 100% indicating "completely sure") how sure are you of the answer you have provided to the previous question? (Please provide a whole number i.e. 25, 50, 75, etc.)

Y8. Local grocery stores such as Lee's Marketplace and Fresh Market provide their customers subsidies for using reusable bags in the form of either cash (e.g., a per-bag cash credit on your grocery bill) or credits (e.g., points added to a customer loyalty card). Is your household currently receiving a subsidy like these for using reusable bags?

- Yes
- No
- Unsure

Question Y9 is only asked of those respondents who originally answered "All shopping Trips" to question Y2.

Y9. Do you think using reusable bags helps to reduce the amount of non-reusable bags (plastic or paper) that end up in the Logan/Cache Valley landfill?

- Yes
- No
- Unsure

Demographic Information

We conclude this survey with a few questions about you and your household that will aid in the statistical analysis of the information you and all the other participating households have provided. You are under no obligation to answer a question that you might feel uncomfortable with. Again, all of your responses to the questions on this survey are anonymous and confidential.

1. What is your gender?

- Male
- Female

2. In what year were you born? _____

3. What is the highest level of education you or anyone else in your household has completed? (Please check only one category.)

- 0 – 8 years, no high school diploma or GED
- 9 – 12 years, no high school diploma or GED
- High school diploma or GED
- Some college, no degree yet obtained
- Associate's degree
- Bachelor's degree
- Master's degree
- Doctorate or professional degree

4. What is your household's annual income? (Please check only one category.)

- Less than or equal to $25,000 per year.
- $25,001 – $50,000 per year.
- $50,001 – $75,000 per year.
- $75,001 – $100,000 per year.
- $100,001 – $150,000 per year.
- Greater than $150,000 per year.

5. What is your marital status? (Please check only one category.)

- Single
- Living as domestic partners
- Married
- Divorced
- Widowed

6. How many people currently live in your household (including children)? _____

7. Of the people currently living in your household, how many are over the age of 18? _____

8. How do you define your ethnicity? (Please check only one category.)

- Caucasian/White
- Hispanic
- Pacific Islander
- Native American
- African American
- Other

This completes the survey. Again, thank you for your participation. If you would like to enter our drawing for the $100 Lowe's gift card, please enter your personal access code provided on the survey information page that brought you to this website (located on the bottom left of the paper). On November 7th, 2011, the randomly drawn winning code will be posted at this web address (http://usereuseableandwin.blogspot.com) with further instructions on how to claim your prize.

Appendix B – Recruitment Postcard

Want to further science and have a chance at winning a $100 gift card to Lowe's? Please fill out our survey regarding plastic and reusable bag use in Logan, Utah. Respondents should be over 18 years of age and be responsible/co-responsible for your household's grocery shopping decisions. The survey data will be used for a Utah State University graduate student's research thesis. Please take 10-15 minutes to complete a web survey at this site:

www.surveygizmo.com/xxx/

Thank you!

Appendix C – Ordered Probit Regression Results for WTP and WTA Models.

Table C1. Ordered probit results for WTP model.

Explanatory Variable	**Coefficient Value**[a]
taxbid	-1.192 (1.351)
rbfree	-0.845** (0.371)
pbrecy	-0.649* (0.359)
young	0.450 (0.566)
middle	0.664 (0.579)
sex	0.437 (0.390)
totnhh	0.057 (0.128)
lowinc	-1.411** (0.555)
midinc	-0.668 (0.482)
Summary Statistic	**Value**[b]
N	76
Log Likelihood	-48.871
$X^2(9)$	26.03***
Pseudo R^2	0.210
Cut Point 1[c]	-0.833 (0.800)
Cut Point 2[c]	0.253 (0.764)

[a,b]Standard errors are in parentheses. [c]Estimated cutpoints on latent WTP used to differentiate *accept_WTP=0* from *accept_WTP=1* (Cut Point 1) and *accept_WTP=1* from *accept_WTP=2* (Cut Point 2) when values of remaining explanatory variables are evaluated at zero. ***Significant at the 1% level, **Significant at the 5% level, *Significant at the 10% level.

Table C2. Ordered probit results for WTA model.

Explanatory Variable	Coefficient Value[a]
subbid	2.616* (1.484)
rbfree	0.731** (0.337)
pbrecy	0.410 (0.318)
young	-0.358 (0.516)
middle	-0.648 (0.517)
sex	-0.590* (0.304)
totnhh	0.145 (0.096)
lowinc	0.486 (0.382)
midinc	0.731* (0.412)
Summary Statistic	**Value[b]**
N	100
Log Likelihood	-62.424
$X^2(9)$	21.27**
Pseudo R^2	0.146
Cut Point 1[c]	0.391 (0.681)
Cut Point 2[c]	0.839 (0.684)

[a,b]Standard errors are in parentheses. [c]Estimated cutpoints on latent WTA used to differentiate *accept_WTA=0* from *accept_WTA=1* (Cut Point 1) and *accept_WTA=1* from *accept_WTA=2* (Cut Point 2) when values of remaining explanatory variables are evaluated at zero. ***Significant at the 1% level, **Significant at the 5% level, *Significant at the 10% level.