Overheating Willingness to Pay: Who Gets Warm Glow and What It Means for Valuation

Matthew G. Interis and Timothy C. Haab

In traditional contingent valuation, the researcher seeks the amount a respondent is willing, *ceteris paribus*, to pay to obtain something. But if a respondent receives a "warm glow" from a yes response, *ceteris* is not *paribus*. In estimating willingness to pay (WTP) to reduce environmental impacts from consumption of transportation fuel, we find that respondents who were relatively less environmentally focused in the past receive greater warm-glow benefits from a "yes" response and have greater "warm" WTP (WTP that includes warm-glow benefits). Yet respondents who were relatively more environmentally focused in the past have greater "cold" WTP (WTP excluding warm-glow benefits).

Key Words: contingent valuation, warm glow, willingness to pay

In Andreoni's (1990) theory of warm-glow giving, individuals receive two benefits from contributing to a public good: the utility associated with the change in the public good and an additional "warm glow" private benefit from the act of giving that is independent of the public good to which they contribute. Consider a stylized dichotomous-choice contingent valuation (CV) question: "Would you be willing to pay $X to receive public good Y?" The warm-glow benefit of a "yes" response to that question poses a challenge for researchers who generally want to calculate willingness to pay (WTP) for a public good when *everything else remains the same*. The presumed motivation for a yes response is that the individual is willing to give up money and will receive only the change (increase) in the public good in return. Nunes and Schokkaert (2003) referred to this WTP as "cold WTP;" "warm" WTP refers to the amount an individual is willing to pay for the improvement in the public good given that the individual also receives a "warm glow" from giving in addition to the value of the change in the public good. If a CV survey exactly mimics how a public good improvement would be provided in reality—specifically, that survey respondents would receive (not receive) the same warm glow from answering the survey question as they would (would not) from contributing to the good in reality—then, assuming for the moment that everything else in the measurement of costs and benefits is correct, there would be no risk of making an inefficient decision about whether to provide the public good. If, on the

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other hand, there is a difference in the effect of warm glow between a survey response and reality, researchers may end up using warm WTP estimates when they should be using cold WTP estimates or vice versa, potentially resulting in an inefficient decision about the good's provision.

While the theoretical concerns regarding warm glow have been well-documented, estimation of the effects of warm glow in survey settings has proven difficult. At best, respondents can, through debriefing questions following the valuation exercise, provide a guess or rough indication of whether their responses were the result solely of the value of the public good change or were motivated by warm glow. At worst, respondents cannot explain their motivations for responding, leaving the researcher to make personal judgments about others' motivations.

The literature on warm glow and other private benefits from the act of giving has focused either on the theory and implications of the presence of warm glow (e.g., Andreoni 1990, Mayo and Tinsley 2009, Conley and Kung 2010) or on empirically checking for evidence of its effects (e.g., Ribar and Wilhelm 2002, Menges, Schroedner, and Traub 2005, Crumpler and Grossman 2008, Konow 2010). We know of only one study, Nunes and Schokkaert (2003),[1] that has attempted to estimate both warm and cold WTP values. They used a series of attitudinal questions to separate motives for paying for an environmental improvement into three categories, indicated by respective factor scores, for each individual: use value, nonuse value, and warm glow. They estimated the parameters of a random WTP model and calculated warm WTP using standard methods. Then, to calculate cold WTP, they performed the same calculation using the original parameter values but replacing the respondents' factor scores with the lowest possible factor score for warm glow; that is, they calculated what the respondents' WTP values *would be if* they were not motivated by warm glow.

We use a survey of consumer preferences for policies aimed at diversifying the United States' mix of fuel sources and consequently reducing the impacts of consumption of fuel on the environment, human health, and natural resources.

To circumvent some of the difficulties associated with estimating warm-glow effects, we adopt a new approach. Instead of simply asking respondents to explain the motivations behind their responses or trying to tease out those motivations through follow-up questions, we develop a proxy for warm glow using contributions made to a second public good (carbon offsets) by the respondent and a hypothetical other person and the respondents' environmental image ratings of themselves and the hypothetical other persons. It is assumed that respondents who make different contributions have different images and that one can improve one's environmental image by contributing to the public good. The change in image is the private benefit of contributing—warm glow. Our approach differs from that of Nunes and Schokkaert (2003). We use the more general random utility model and back out cold WTP from estimates of warm WTP using the theoretical definition of each. Also, we use responses to an unrelated part of the survey that occurred after the dichotomous choice question of interest to proxy for the warm glow respondents would receive from a yes response to the dichotomous choice question.

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[1] Nunes, de Blaeij, and van den Bergh (2009) used the same technique as Nunes and Schokkaert (2003) to separate the warm-glow component of WTP.

Being able to distinguish between warm and cold WTP values is important for efficient design and accurate analysis of public policies, especially when the hypothetical payment mechanism in a CV study does not exactly mimic the payment mechanism in reality, thereby inducing payment-vehicle dependence for the valuation scenario, or when there is any discrepancy (for whatever reason) between warm glow received from a hypothetical contribution in a stated preference study and warm glow received from an actual contribution.

We find that receiving a warm glow raises the probability of being willing to pay for the lower fuel index but also that only respondents who were relatively *less* environmentally focused in the past benefit from warm glow. We interpret this result as indicative of diminishing marginal utility of warm-glow activities. We estimate both warm and cold WTP and find that respondents who had been less environmentally focused are willing to pay almost 250 percent (\$0.99) more than those who were more environmentally focused. On the other hand, the respondents who had been relatively *more* environmentally focused do not appear to benefit from warm glow when agreeing to contribute; their warm and cold WTP values are similar. Despite the lack of warm glow, however, the more environmentally focused respondents' cold WTP is estimated to be 35 percent (\$0.14) greater than the cold WTP of respondents who were less environmentally focused.

The Model

Survey respondents were asked to pay for environmental improvements via a higher per-gallon price for gasoline. To maintain consistency with the payment vehicle in our application, we present the model in terms of a price increase, although an analogous model involving a lump payment out of income could be used.

Let indirect utility for person i, v_i, be a function of the price of the relevant commodity (p_i), the level of environmental quality or public good provided (g), and person i's warm glow (w), which we assume is affected by past environmental contributions or attitudes.

$$v_i = v(p_i, g, w_i)$$

In this case, v_i is increasing in g and w_i and decreasing in p_i. Responding yes to a CV question is assumed to (weakly) increase warm glow because the respondent is making an additional environmental contribution.

Cold WTP, WTP^c, is the price premium on the commodity (gasoline) that, if added to the original price, gives the individual the same level of utility with the environmental improvement as before the environmental improvement with the original price, *ceteris paribus*. WTP^c is implicitly defined as

$$v(p_i^0 + WTP_i^c, g^1, w_i^0) \equiv v(p_i^0, g^0, w_i^0). \tag{1}$$

A superscript 0 depicts the original state and a superscript 1 depicts the state after payment; that is, g^1 is the improved environmental state and g^0 is the original environmental state. Researchers have traditionally estimated cold WTP.

When respondents receive positive warm glow from contributing, they receive two benefits: better environmental quality and private warm glow.

In that case, it is difficult to disentangle their WTP solely for the environmental improvement. More formally, let us define warm WTP, WTP^w, as a respondent's maximum WTP for the environmental improvement given that the respondent receives a warm glow from contributing:

$$v(p_i^0 + WTP_i^w, g^1, w_i^1(WTP_i^w)) \equiv v(p_i^0, g^0, w_i^0). \tag{2}$$

In this case, w^1 is greater than w^0 and is a function of the individual's contribution.

In contingent valuation studies, respondents typically are asked to answer dichotomous choice yes-or-no questions—would they be willing to pay a specified amount to obtain an environmental improvement. Warm glow affects estimates of WTP in that, if respondents receive a warm glow from yes responses, they (theoretically) decide whether they are in favor of the proposal by comparing the utilities (with the proposed price of the improvement in place of *WTP*) on either side of the equivalence sign in equation 2 rather than comparing the utilities on either side of the equivalence sign in equation 1, as is traditionally supposed. Does this matter? Maybe.

Since the additional benefit of warm glow increases one's willingness to pay, WTP^w is greater than WTP^c, and using measures of warm WTP will tend to favor implementation of the project relative to using measures of cold WTP. If the project is implemented and funded in such a way that people actually receive a warm glow that is consistent with the one elicited in the value-elicitation exercise, all is well. But if implementation of the actual project results in either no warm glow or a level of it that is different from that of the survey (for example, due to differences in funding vehicles[2]), there is a risk of implementing a project for which the costs outweigh the benefits. And the reverse is true if one uses cold WTP estimates when warm WTP estimates are appropriate.

One of the most basic questions one can ask is whether warm and cold WTP differ from each other; otherwise, the entire discussion of the two is pointless. If we set the lefthand sides of equations 1 and 2 equal to each other and take the differential with respect to WTP^w and WTP^c, we note that

$$\partial WTP^c \,/\, \partial WTP^w = 1 + \frac{v_w}{v_p}\frac{\partial w^1}{\partial WTP^w}. \tag{3}$$

The subscripts on v denote partial derivatives. If WTP^w and WTP^c are indeed identical, the righthand side of equation 3 must equal one. Under the natural assumption that warm glow, w, is increasing in WTP^w, the marginal utility of warm glow, v_w, must be zero if equation 3 is to equal one. Given a measure of warm glow, we can test this condition once we estimate the parameters of the random utility model.

Hypothesis: $WTP^w = WTP^c$*, which is rejected if* $v_w \neq 0$.

If we have a measure of how much warm glow one receives from a yes response, we can, depending on the functional form of utility and warm glow, estimate values for both warm and cold WTP. For example, assume a linear-in-

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[2] For example, it is reasonable that people would receive more warm glow from paying a new one-time tax than, say, from existing tax revenue to which they have already contributed.

parameters indirect utility function with constant marginal utility of (i) price ($\alpha_p < 0$), (ii) environmental quality ($\alpha_g > 0$), and (iii) warm glow ($\alpha_w > 0$):

$$v_i = \alpha_0 + \alpha_p p_i + \alpha_g g + \alpha_w w_i + \boldsymbol{\alpha}_{\mathbf{z}}{}'\mathbf{z_i} \tag{4}$$

where α_0 is a constant, $\mathbf{z_i}$ is a vector of demographic and other control variables, and $\boldsymbol{\alpha}_{\mathbf{z}}$ is its corresponding vector of parameters. By substituting equation 4 into equation 1, we can solve for cold WTP:

$$WTP_i^c = -\frac{(\alpha_0^1 - \alpha_0^0)}{\alpha_p} - \frac{\alpha_g}{\alpha_p}(g^1 - g^0) - \frac{(\boldsymbol{\alpha}_z^1 - \boldsymbol{\alpha}_z^0)'}{\alpha_p}\mathbf{z_i}. \tag{5}$$

Equation 5 is the standard WTP formula derived from a linear utility function.

To derive an expression for warm WTP that can be estimated, we need to specify how warm glow changes when respondents pay (or state that they are willing to pay) for the improvement. We assume a simple, linear relationship:[3] $w_i^1 = w_i^0 + \gamma_i \Delta p_i$ where Δp_i is the price premium paid by respondent *i* and γ_i (which is greater than zero) can be interpreted as an increase in warm glow per dollar of contribution. Using the functional form of indirect utility (equation 4) and the fact that, in identity (equation 2), Δp_i will simply take on the value WTP_i^w, the warm WTP is

$$WTP_i^w = -\frac{(\alpha_0^1 - \alpha_0^0)}{\alpha_p + \alpha_w \gamma_i} - \frac{\alpha_g}{\alpha_p + \alpha_w \gamma_i}(g^1 - g^0) - \frac{(\boldsymbol{\alpha}_z^1 - \boldsymbol{\alpha}_z^0)'}{\alpha_p + \alpha_w \gamma_i}\mathbf{z_i} = WTP_i^c \frac{\alpha_p}{\alpha_p + \alpha_w \gamma_i} > WTP_i^c. \tag{6}$$

The inequality holds because $\alpha_w \gamma_i$ is greater than zero when assuming that $\alpha_p + \alpha_w \gamma_i$ remains negative (which otherwise would mean that WTP^w would be negative and improvements in environmental quality would be bad). Under reasonable assumptions, we expect that warm WTP will be greater than cold WTP since the former includes payment for the additional warm-glow benefit not accounted for in cold WTP.

Thus, if we can estimate either warm or cold WTP, we can back out the other, conditional on functional form assumptions, using the parameter coefficients on price and warm glow and the value for γ_i. In terms of our preceding hypothesis, if $\alpha_w = 0$, then $WTP^w = WTP^c$.

Data and Estimation

The study data come from responses to a survey conducted as part of a project funded by the National Science Foundation. The survey was conducted via the internet by a private company, Knowledge Networks, which offered the first online research panel that was representative of the entire U.S. population.

[3] As one reviewer pointed out, it may be that warm glow is a function of the existing level of the public good. In our model, warm glow depends only on the marginal contribution to the public good, not on the existing amount. This is consistent with the literature on warm glow, including Andreoni (1990). Unfortunately, we cannot test whether warm glow is affected by the existing level of the public good because that level (which would be total contributions to carbon offsetting in our context) was left unspecified for respondents. This test presents an avenue for future research.

It was administered to residents of Ohio who were age 18 or older and was available over a ten-day period in mid-March, 2009. Of the 859 individuals sampled, 537 completed the survey (62.5 percent) and 532 completed it satisfactorily based on the minimum survey requirements. The survey process was linear—respondents were not allowed to go back and change answers nor look ahead to future questions.

Respondents were told that, over time, the economywide mix of transportation fuels—the amount of ethanol, diesel, gasoline, and other fuels consumed annually—changes and that each fuel mix results in a unique set of pollution emission vectors. Because the number of pollutants involved is numerous and it is often difficult for the general public to interpret the personal meaning of various levels of emissions, respondents were asked about their WTP to lower a fuel index that was designed to capture the aggregate effect of the various levels of emissions on three broad categories: damage to the environment, strain placed on natural resources, and effects on human health. The valuation exercise was part of a larger project aimed at linking valuations to life cycle assessments of transportation fuels (see Choi, Bakshi, and Haab 2010). The fuel index represented an aggregation of the emission vectors (hundreds of pollutants) that were derived from life cycle assessments of each relevant fuel. The following nontechnical description of the fuel index was provided to the survey participants.

> Because the specific impacts of the production and consumption of all fuel mixes are numerous, scientists have developed a **Fuel Index** to summarize the environmental, natural resource, and health impacts of a fuel mix using a single number. Here is some information about the **Fuel Index**:
>
> - The **Fuel Index** can take on a value from 0 to 100.
> - The **Fuel Index** value for the current transportation fuel mix in the United States is **55**.
> - Higher numbers for the **Fuel Index** mean that:
>   - There is *more* damage to the environment.
>   - There is *increased* strain on natural resources.
>   - There is *higher* risk of harmful effects on human health.
> - Lower numbers for the **Fuel Index** mean that:
>   - There is *less* damage to the environment.
>   - There is *decreased* strain on natural resources.
>   - There is *lower* risk of harmful effects on human health.
>
> As the fuel mix changes, the fuel index changes also.

Once participants had reviewed the description of the fuel index and answered a series of follow-up questions designed to ensure that they understood the index and the potential effects of changes in the fuel mix on the index, they were presented with the following choice question.

> Assuming that you will be driving the same vehicle you currently use for your day-to-day driving, if the new fuel mix were available, would you prefer the new fuel mix over the current fuel mix given that the

> Fuel Index **decreases** from **FI1** to **FI2** and fuel prices **increase x%** from $**p0** to $**p1** per gallon?

Each respondent provided the value for p0—how much that respondent was currently paying per gallon of gas—at the beginning of the survey. The values for the other elements shown in bold were provided by the researchers.[4] FI1 was the higher index value for the existing fuel mix and FI2 was the lower index value for the new, more environmentally friendly fuel mix. The percentage increase in the fuel price, *x*, was randomly assigned a value of either 5 or 10, and p1 was calculated accordingly.

Later in the survey, participants were asked several questions about their WTP for a second public good, reduced emission of carbon dioxide. It was clear from the flow of material in the survey that these questions were not related to the question about the fuel index. Specifically, we asked respondents if they would be willing to give a specified contribution to an organization that provides for carbon offsets (e.g., TerraPass) and to rate their images of themselves in terms of environmental concern on a 0–10 scale.

> We are trying to get a sense of how people view themselves in the context of environmental issues. In particular, we are interested in people's images of environmentally concerned (or responsible, or aware, or active) people.
>
> Suppose you had to rate your own environmental image on a scale from 0 to 10 with 10 being the highest possible environmental image and 0 being the lowest possible environmental image. What rating would you give yourself?

They also were asked to rate a hypothetical other person in terms of environmental image based on a specified contribution by that person to the same carbon offset organization.

> Suppose you had to rate the environmental image of someone who gives $____ on a scale from 0 to 10, with 10 being the highest possible environmental image and 0 being the lowest possible environmental image. What rating would you give this person?

The order of the two image-rating questions was randomized to test for any effect of one response on the other. We found no evidence of ordering effects in any model specification and therefore treat the responses to the questions as independent.

Support for use of a Likert-type scale is abundant in the literature on self-image congruence in sociology, psychology, and marketing.[5] We use the scale

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[4] Some respondents were randomly assigned to a treatment that asked about their willingness to accept (WTA) a higher fuel index at a lower price per gallon. Because of previously established empirical differences in estimates of WTP and WTA, we focus solely on results for WTP.

[5] Self-image congruence holds that the decision a person makes (in studies, it typically is whether to purchase a product) depends on the congruency (or, alternatively, the discrepancy) between the image associated with a behavior or product and the image or ideal image of the individual. For examples of these types of questions, see Fitzmaurice (2005), Amos et al. (1997), and Marsh et al. (2007).

responses to derive a value for the warm-glow parameter, γ, which represents an increase in warm glow per additional dollar of contribution:[6]

$$\gamma_i = (Image_{otherperson} - Image_{respondent}) \ / \ (Contribution_{otherperson} - Contribution_{respondent}).$$

Note that, under the assumption that one's environmental image increases with contribution, γ will be positive. This specification of γ should be intuitive. For example, an increase in the image of the other person (decrease in one's own image) suggests that the warm-glow benefit per additional dollar is higher (lower), *ceteris paribus*, because the respondent associates a given level of contribution with a relatively more positive (less positive) image. Similarly, if, *ceteris paribus*, one's own contribution is less, the change in warm-glow benefit is smaller. We calculate the value for $\Delta w_i = w_i^1 - w_i^0$ by multiplying γ_i by the price premium.

Others have modeled image in decision-making and connected changes in image to warm glow. Andreoni (1989), for example, allowed that "people get some private goods benefit from their gift per se, like a warm glow" (p. 1448) but offered no guidance on how to conceptualize this warm glow. Several papers in the economic literature have involved models in which individuals care about their images (e.g., Akerlof and Kranton 2000, Johansson-Stenman and Martinsson 2006, Ariely, Bracha, and Meier 2009) and some have suggested image as a specific manifestation of warm glow (e.g., Brekke, Kverndokk, and Nyborg 2003, Bruvoll and Nyborg 2004, Bénabou and Tirole 2006, Andreoni and Bernheim 2009). Our use of a change in image as a proxy for warm glow stems from our need for a measure of the γ parameter to estimate both warm and cold WTP. Of the various warm-glow-type private benefits that can be gained from giving to a public good suggested in the economic literature (others include reputation, self-esteem, and avoidance of shame), image is most prevalent in the psychological literature as an operationalized concept (see, for example, Grubb and Grathwohl (1967), Sirgy et al. (1997), Mehta (1999), Spreng and Page (2003), and Fitzmaurice (2005)).

We acknowledge some flaws in our measure of γ. In particular, it assumes that people rate others using the same criteria with which they rate themselves and it comes in a different context (carbon offsets versus lowering a fuel index, although they are related). But it represents one way to measure increases in warm glow per dollar of contribution that matches the requirements of the model. Future research could investigate the merits of alternative measures.

The survey asked several questions[7] about respondents' predispositions toward environmental giving—whether they were members of an environmental organization, whether they had recently contributed money to such a group, whether they had participated in any environmental stewardship activities, and whether they regularly recycle. Each yes response was given a value of 1. The survey also asked whether they believed that humans are contributing to global warming and whether they were concerned about global warming.[8] We used a linear sum of the responses to those six questions (scores

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[6] The contribution in this case is a survey response indicating WTP a price premium on gasoline, not a direct monetary contribution. In our case, therefore, we assume that warm glow results from a yes response to the survey question.

[7] The exact wording of the questions is provided in an appendix. The appendix and the full survey are available from the authors upon request.

[8] This question involved an intensity scale of 1 through 4 in which 1 indicated no concern and

Table 1. Summary Statistics

Variable	Mean	Std. Deviation	Min.	Max.
Price premium (Δp)	0.14	0.05	0.05	0.30
Change in fuel index (Δg)	–8.65	3.86	–13.75	–4.50
Change in warm glow (Δw)	0.02	0.02	0.00	0.10
Change in warm glow per dollar (γ)	0.11	0.13	0.00[a]	0.94
Assessment of change in fuel index (Δg)	3.72	0.75	2[b]	5
Politically conservative	4.28	1.41	1	7
Environmental indicator	3.12	1.33	0	6

[a] While it is possible for γ to be less than zero in a broader context in which warm glow is a function of other environmentally oriented activities besides one's contribution to carbon offsets, here the respondents have information only on the hypothetical other person's contribution. Therefore, it is unreasonable in this context, where the only activities are carbon-offset contributions, that γ would be less than zero and we drop the 56 respondents for whom this was true.

[b] Nine respondents gave an assessment of 2 ("bad") even though the fuel index decreased, which is an unambiguous improvement.

Notes: $N = 194$; 108 respondents answered yes and 86 responded no to the CV question.

ranging from 0 to 6) as an indicator of how environmentally focused each respondent was. In addition, the survey asked for a subjective assessment of how "good" or "bad" the proposed change in the fuel index would be on a scale of 1 through 5 (1 being "very bad" to 5 being "very good") and a self-reported identification of their political ideology on a scale of 1 through 7 (1 being highly liberal to 7 being highly conservative).

The survey collected demographic data, including the number of children in the household, the household head's education level and age, and the household's income, that were insignificant and were not included in the final model.

Results

Table 1 provides summary statistics for the variables of interest. Recall that $w_i^1 = w_i^0 + \gamma_i \Delta p_i$. The change in warm glow, Δw_i, is therefore equal to γ_i multiplied by the price premium, Δp_i. In our sample, there appears to be roughly the same number of self-reported liberals as conservatives. The average respondent was asked to pay \$0.14 more per gallon of gasoline for a decrease in the fuel index of 8.65.

We estimate a standard probit model (see Haab and McConnell (2002) for estimation details). The parameter estimates are shown in Table 2, and their signs indicate the direction of the effect of a marginal change in the righthand-side variable on the probability of a yes response. Four of the estimated parameters are statistically significant. In the face of a greater price premium, people are less likely to be willing to pay for a decrease in the fuel index while a smaller decrease in the fuel index makes people less likely to pay for that decrease. People who believe that an improvement in the fuel index is relatively better are more likely to be willing to pay for the decrease in the fuel index.

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2 through 4 denoted varying degrees of concern. For the environmental indicator, we assigned a value of 0 to no concern and 1 to the other responses.

Table 2. Probit Model Parameters – Parameter on Change in Warm Glow Is Not Significant

Variable	Parameter	Standard Error
Intercept	–0.84	0.67
Price premium (Δp)	–3.06 *	1.86
Change in fuel index (Δg)	–0.05 **	0.02
Change in warm glow (Δw)	3.93	5.39
Assessment of change in fuel index (Δg)	0.37 ***	0.13
Politically conservative	–0.14 **	0.07
Environmental indicator	0.06	0.07
Log-likelihood value –122.13		
Likelihood ratio chi-square (6) 22.18 ***		

Notes: $N = 194$. * indicates significance at the 10 percent level, ** indicates significance at the 5 percent level, and *** indicates significance at the 1 percent level. Percent concordant = 67.2.

And people who rate themselves as more conservative are less likely to be willing to pay for a smaller fuel index. The other independent variables and change in warm glow in particular are not significant. These results indicate that warm glow does not affect utility for the general sample and thus that an increase in warm glow does not affect the probability of being willing to pay for the lower fuel index.

The initial results appear to suggest that warm glow is not important. However, the picture becomes more complicated and interesting when we allow some heterogeneity in the parameters of the environmental indicator (responses to questions about the participants' environmental views), which could take a value between 0 and 6. We assigned each respondent to one of two groups: a *low-E* group (69 respondents) for respondents whose environmental score fell between 0 and 2 and a *high-E* group (125 respondents) for respondents whose environmental score fell between 3 and 6.[9] This distinction was motivated by the possibility that warm-glow activities exhibit diminishing marginal returns. This might be the case, for example, if people who have done more environmentally friendly activities and had more environmentally friendly attitudes in the past receive relatively less warm glow from engaging in one additional environmentally friendly activity,—in this case, saying that they would be willing to pay a higher per-gallon price of gasoline in exchange for a lower fuel index. We hypothesized that respondents with a higher environmental indicator score would be more likely to have a relatively smaller or insignificant parameter on Δw relative to respondents with lower environmental scores. We tested this hypothesis by interacting the environmental indicator dummy (which equaled 1 if the respondent was in the high-E group) with Δw. We also included a dummy variable for whether the

[9] There were relatively few observations in this study, so grouping respondents by each of the seven levels of the environmental index yielded too few per level; hence, we used the binary specification. This particular binary specification yielded the best balance of respondents compared to other threshold values for the environmental index. However, the results held (albeit less strongly statistically) when we divided the respondents into a low-value group for responses of 0–3 and a high-value group for responses of 4–6.

respondent was in the high-E group. We report the results of this analysis in Table 3.

The likelihood ratio test rejected the hypothesis that there was no difference in the parameters on Δw for the low-E and high-E groups at the 95 percent level. For the low-E group, the marginal effect of the change in warm glow on the probability of a yes response is positive and significant at the 95 percent level. We therefore reject the hypothesis that $WTP^c = WTP^w$ for the low-E group. For the high-E group, the marginal effect is negative but insignificant, so we fail to reject the same hypothesis for the high-E group. We interpret this result as evidence of diminishing marginal utility from warm-glow-producing activities. The other interesting point from Table 3 is that the dummy indicating whether a respondent is in the high-E group is positive and significant. This fits with our expectations—people who are relatively more environmentally focused are more likely to be willing to pay to reduce the fuel index. The striking upshot from these results is that respondents who are more environmentally focused have greater cold WTP but are less likely to receive a warm glow from contributing so their warm and cold WTP values are similar. Respondents who are less environmentally focused, on the other hand, are more likely to receive a warm glow from a yes response and therefore to have greater discrepancies in their warm and cold WTP values. It may be that individuals in the high-E group are more likely to give primarily because they are inherently inclined to do so whereas individuals in the low-E group are more likely to give primarily because they receive a warm glow from giving.

From equation 6 and Tables 1 and 3, we calculate average warm and cold WTP for the low-E and high-E groups. Warm WTP for the low-E group is $1.39. Cold WTP, which does not include any warm-glow benefit from contributing,

Table 3. Results from Allowing for Heterogeneity of Preferences according to the Environmental Indicator

Variable	Parameter	Standard Error
Intercept	–1.02	0.66
Price premium (Δp)	–3.21 *	1.88
Change in fuel index (Δg)	–0.06 **	0.02
Change in warm glow (Δw) low-E	20.90 **	9.51
Change in warm glow (Δw) high-E	–5.01	6.57
Assessment of change in fuel index (Δg)	0.41 ***	0.13
Politically conservative	–0.16 ***	0.07
Dummy (= 1 if in the high-E group)	0.46 *	0.26
Log-likelihood value –119.76		
Likelihood ratio chi-square (7) 26.93 ***		
WTP^w (low-E) $1.39		
WTP^c (low-E) $0.40		
WTP (high-E) $0.54		
WTP^c (average) $0.49		

Notes: $N = 194$. * indicates significance at the 10 percent level, ** indicates significance at the 5 percent level, and *** indicates significance at the 1 percent level. Percent concordant = 69.3.

is $0.40. For the high-E group, both warm and cold WTP is $0.54. Average cold WTP for the entire sample is $0.49.

Conclusions

In this study, we implement a new strategy for isolating the value of warm glow in responses to standard CV questions, allowing researchers to eliminate the potentially undesirable effect of warm glow from estimates of the value of provision of an environmental good. By allowing for heterogeneity of warm-glow preferences among respondents according to an indicator of their relative focus on environmental issues, we see that respondents who are less environmentally focused are more likely to receive warm glow from yes responses to a CV question and are therefore more likely to have a greater discrepancy between their warm and cold WTP values than those who are more environmentally focused. Yet, after controlling for warm-glow benefits, we find that respondents who are more environmentally focused are willing to pay 35 percent ($0.14) more to reduce a fuel index by 8.65 points than less environmentally focused respondents. The warm-glow WTP of less environmentally focused respondents is estimated to be almost 250 percent ($0.99) more than their cold WTP. On average, respondents are willing to pay $0.49 more per gallon of gas to reduce the fuel index by 8.65 points.

We do not wish to imply, in the particular situation analyzed here, that warm WTP estimates are more appropriate than cold WTP estimates. In fact, as in Chilton and Hutchinson (1999), we might conclude the opposite. Their main conclusion[10] was that welfare estimates from a voluntary payment mechanism cannot be transferred to a situation with a coercive payment mechanism. This is precisely the case in our example since the contribution to carbon offsets is voluntary while the increase in the price of gasoline to decrease the fuel index is coercive. Instead, we conclude that estimates of warm and cold WTP can differ and offer a way to distinguish between the two. A better understanding of warm glow and how it affects people's decisions about WTP a specified amount for an environmental improvement can improve the economic efficiency of decisions regarding provision of an environmental improvement.

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[10] This conclusion was a result of a model in which people did not receive warm glow from a coercive payment.

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