Examining the income-effect in contingent valuation
-The importance of making the right choices

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Abstract

This paper focuses on three important issues in estimating the relationship between WTP and income using contingent valuation: 1) the choice of income measure; 2) the modelling choice; and 3) the social context. Addressing the first two issues, a sensitivity analysis is performed. The results show that the estimated income-elasticity of WTP is fairly sensitive to different income measures and modelling assumptions and varies between 0.07 and 0.49 for the specific models estimated. The main conclusion drawn from the analysis is that inclusion of control variables for household characteristics is important for finding a significant income-effect, when the household income measure is used. No significant difference is found between gross or net income. The results further indicate that the relevant income measure may not only be the income level per se, but also the income level relative to others. The latter result is based on an experimental valuation question, conditioning the respondents on hypothetical changes in their absolute and relative income. The conclusion is that the social context read into the valuation situation influences the responses and, therefore, the estimated welfare measure.

Keywords: *contingent valuation; income-effect; income-elasticity of WTP; income measure; social context; relative income; multiple bounded; payment card.*

JEL-Codes: C81, Q20, Q26, Q28

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1. Introduction

Contingent valuation (CV) studies typically include income as a control variable in the willingness to pay (WTP) function to validate the results. The occurrence and size of a significant income-effect is most likely a function of the studied good, the characteristics of the sample, factors controlled for, the income measure used and the functional form applied. However, no consensus has emerged in the previous literature on how to model the relationship between WTP and income. The lack of norms makes estimation of the income-effect seemingly ad-hoc.

The relationship between WTP and income has been the subject of a fundamental discussion concerning the legitimacy of CV. A first justification test of CV estimates is to check their consistency with economic theory and *a priori* expectations. The goods and services valued in CV studies are often related to environmental quality and a strong notion within the literature has been that such goods are "luxury goods", meaning that the demand for them should increase more than proportional to income. However, the income-elasticities found in the CV literature are typically below unity (Kriström and Riera, 1996; Hökby and Söderqvist, 2003). In addition, insignificant income-effects are not unusual (Schläpfer, 2006). These results have been used to undermine the reliability of CV estimates (McFadden and Leonard, 1993; Diamond and Hausman, 1993). However, Flores and Carson (1997) showed theoretically that there is a fundamental difference between the income-elasticities of demand and WTP, where the latter, estimated by CV, is conditioned on a given quantity change.[1] In the same study it was shown that, although there exists a relationship between the two elasticities, knowledge about the size of one of them cannot be used to draw conclusions about the size of the other, i.e. an income-elasticity of WTP under unity does not disqualify a good from being a luxury. Although the income-elasticity of WTP is not sufficient to classify goods as being basic or luxury goods it reveals something about the distribution of benefits and is therefore important to study in policy analysis (Kanninen and Kriström, 1992; Kriström and Riera, 1996).

Schläpfer (2006) used meta-analysis to explore determinants of the presence of a significant income-effect in a sample of 64 CV studies including 83 valuation scenarios. A significant income-effect was found in only 30 valuation scenarios. The meta-analysis was constructed as a binary logit, where the dependent variable equaled one if a significant income-effect was reported and zero otherwise. The results showed that the probability of observing a significant income-effect was a function of several factors: (1) it increased significantly with the sample size; (2) it was significantly lower for closed-ended formats and for referendum questions; and (3) it tended to be higher for tax vehicles, especially

[1] The CV question aims at measuring the welfare effect of a given change in the quantity of the good being valued. Since the quantity change is given in the constructed market scenario individuals cannot freely maximize their utility with respect to quantity. For that reason, the demand function cannot be derived through CV.

those progressive in income. Occurrence of passive use-values attached to the valued project did not seem to be important for the probability of observing a significant income-effect. The overall conclusion from the meta-analysis was that the weak income-effect found in many contingent valuation studies may be an artifact of the survey protocol.

Wipon et al. (2004) studied the sensitivity of median WTP estimates with respect to the treatment of categorical income data and functional form.[2] The categorical income data was either recoded into dummy variables or into a continuous variable consisting of the categorical numbers or the median of the categories. The empirical analysis was based on a dichotomous choice question concerning the WTP for irradiated beef. The results showed no significant sensitivity of the WTP estimate to different treatments of the income data. The choice of functional form did neither significantly influence the estimate of median WTP as long as income was included separately and not in relation to the bid offered.[3]

This paper contributes to the previous literature on the empirical relationship between WTP and income by identifying and studying three important issues: 1) the choice of income measure; 2) the modelling choice; and 3) the social context. The first two issues are important because different choices may lead to different estimates of the income-effect. This paper performs a sensitivity-analysis of the income-effect with respect to different income measures and modelling assumptions to shed light on the importance of making the "right" choices. WTP data from 2004 concerning preservation of predators in the Swedish fauna underlies the analysis. The third issue is important to study because the social context has most often been assumed away from the valuation scenario in previous CV studies. Income per se, independent of other individuals' incomes and consumption patterns, has been judged as the relevant variable to study. The social context manifested in the relative income may play an important part since it may influence individuals' perceptions about payment responsibilities, "fair-payments" and their propensity to free-ride on other tax-payers. If that is the case, the income-effect will be determined not only by an individual's income level, but also on how it compares to the income of others. To study the importance of relative income, this paper examines WTP data concerning preservation of old-growth forest in Sweden. Specifically, I analyze the answers to an experimental WTP question that conditions respondents on hypothetical income changes.

[2] The authors claim to have calculated the average WTP for all models estimated. According to the equations presented in their paper, it is the median that has been calculated. The median are typically found to be more robust with respect to the functional form compared to the mean, as also is found in their study.

[3] The diverging model was estimated using the log of net income ratio, i.e. $\ln\left(\frac{income - bid}{income}\right)$.

When planning a CV study the researcher needs to decide what income measures to collect. If the valuation question is directed to households, then household income seems like the reasonable measure, but this may not be the case when the question is directed to individuals. If the individuals only have control over their own personal income, then that may be the relevant income measure. The reported or registered individual or household incomes are most often "fuzzy" variables, aggregated over different income sources (e.g. work, capital and public transfers). More uncertainty is added to the analysis when the relationship between WTP and income is studied. Some households consist of several working adults and the aggregated income may not be shared equally between the household members. In such case the household income will poorly explain a specific individual's WTP. Other people may report WTP amounts that are inconsistent with their current income. For example, students and unemployed may base their WTP on expected income rather than their current income. Third, in welfare states like Sweden the reported or registered income may include all kinds of public transfers, e.g. child-support and living-support. The inclusion of transfers in the measure of income is problematic since transfers typically are assigned to cover certain expenditures, e.g. the wellbeing of children or paying the rent. By including specific control variables in the analysis some of the "fuzziness" involved in estimating the relationship between WTP and income may be reduced.

2. Modelling the relationship between WTP and income

Besides adding practical problems to the analysis, including income in the WTP function may also contribute to methodological problems. Given a continuous WTP variable (elicited from an open-ended WTP question) it is straight-forward to include income as an independent variable in the WTP regression to estimate the income-effect. If the WTP data are elicited from a dichotomous choice or a payment card question it is not as straight-forward. A common approach to handling discrete data is to set up a simple random utility model which assumes utility is linear in income (Hanemann, 1984). The linear model has great appeal since its parameters can easily be interpreted, e.g. the negative of the bid coefficient is interpreted as the marginal utility of income. Although the linear-in-income assumption is made in many studies (implying that WTP is independent of income), it is not unusual to see income in the WTP function, meaning that the theoretical model is not consistent with the model estimated.

Hanemann and Kanninen (1999) showed how income-effects can be incorporated in the random utility framework by using a Box-Cox utility function. This function is used to determine the curvature of the relationship between income and WTP. However, adoption of the Box-Cox utility function implies that income will enter the model as the difference between income and WTP, which may be problematic. Haab and McConnell (2002) argue that is not reasonable to assume that an individual's marginal utility of money varies with her own income when the project valued has a low cost. It is therefore not justifiable to model income non-linearly in form of income-WTP. Instead it is more

reasonable to assume that the marginal utility of money varies across individuals with different incomes. They suggest that income-dummies should be included in the linear random utility model to study differences in WTP between different income groups.

This paper does not aim at deriving a theoretically stringent utility model for the relationship between WTP and income. Instead the focus is on the empirical relationship. The theoretical foundation of the analysis is based on the assumption that individuals derive utility from consumption of private goods, $\boldsymbol{q}$, and an environmental public good, z. Individuals are assumed to possess a positive WTP for an increase of the public good from its initial level z^0 to the increased level z^1. Individuals are assumed to be heterogeneous with respect to some characteristics, $\boldsymbol{X}$, and income, Y. Furthermore they are assumed to maximize their utility, u, given income and commodity prices.

The empirical analysis in Section 5 is restricted to "goods", i.e. it does not consider the case of negative WTP. To address this restriction it is assumed that WTP is an exponential function of a linear combination of observable characteristics and an additive stochastic term, ε, with zero mean and standard deviation, σ.[4]

The income variable can be modeled in several ways leading to different expressions for the income-elasticity. Three common specifications for the income variable based on the exponential function are given by equations (1.a.)-(1.c.): Linear (1.a.); quadratic (1.b.); linear in logarithms (1.c.).

$$WTP_i = e^{\mathbf{BX_i}+\gamma Y_i+\varepsilon_i} \tag{1.a.}$$

$$WTP_i = e^{\mathbf{BX_i}+\tilde{\gamma} Y_i+\varphi Y_i^2+\varepsilon_i} \tag{1.b.}$$

$$WTP_i = e^{\mathbf{BX_i}+\tilde{\gamma} \ln(Y_i)+\varepsilon_i} \tag{1.c.}$$

The income point-elasticity of WTP is given by:

$$I.E = \frac{dWTP}{dY} \cdot \frac{Y}{WTP} \tag{2}$$

[4] The exponential WTP model suggests that the distribution of WTP is skewed to the right. This model was popularized by Cameron and James (1986).

Taking the derivative of Eq. (1.a.) with respect to income and applying it to Eq. (2) gives:

$$I.E_{1.a} = \gamma Y \qquad (3.a.)$$

where γ is the income parameter.

A non-linear relationship between WTP and the income-elasticity is derived by adding a quadratic term in the WTP function, as in Eq. (1.b.). The corresponding expression for the income-elasticity is:

$$I.E_{1.b} = \left(\breve{\gamma} + 2\varphi Y\right) \cdot Y \qquad (3.b.)$$

where φ is the parameter for the quadratic term.

Taking the logarithm of Eq. (1.c.) and then taking the derivative gives an expression for the income-elasticity, assuming that it is constant over different income levels:

$$I.E_{1.c} = \frac{d\ln(WTP)}{d\ln Y} = \tilde{\gamma} \qquad (3.c.)$$

where $\tilde{\gamma}$ is the parameter for log-income.

As discussed in the previous section the income-effect and the income-elasticity may be functions of a social context, e.g. a function of the income distribution. In such cases the expressions for WTP will be more complex and involve additional parameters. The magnitude of the income-effect will be contingent not only on the absolute income, but also on the relative income. In the empirical analysis in Section 5 of this paper a simple spilt-sample approach is adopted to find out whether the social context given in the valuation scenario matters to the respondents.

3. The survey and descriptive statistics

Predator data

Several hypotheses regarding alternative income measures and WTP can be tested utilizing this dataset, which is based on a mail-survey from 2004. The basic purpose with the survey was to gather information about attitudes toward the four large predators in the Swedish fauna. The survey was mailed to 4,050 randomly selected individuals in ages 18-84 and approximately 61 percent had

returned their answers after two reminders. To ensure that individuals living in regions of specific interest would be selected, stratification was used. In addition to studying attitudes toward the predators the survey also included a two-stage willingness to pay question regarding implementation of the predator policy package. First, the respondents were asked: *"imagine that the predator policy package is important for securing survival of the Swedish predators in the long run. Implementation of the policy costs money. Would you be willing to contribute financially to such a project?"* Those who answered yes to the question were asked to answer a polychotomous-choice question formulated as: "*below are levels of an annual tax that you will have to pay for the next five years for implementation of the predator policy package, which covers wolves, bears, lynx and wolverines. Mark for each amount how certain you are about paying that amount*." Nine amounts ranging from SEK 10 to SEK 5,000 and five uncertainty levels were presented (see Figure 1).

Even if preference uncertainty is out of the scope of this study it should be dealt with since it is inherent in the MB data used. The data are recoded such that "definitely yes" and "probably yes" means "yes" and the other answers mean "no" (Welsh and Poe, 1998; Broberg and Brännlund, 2007a; 2007b). Following the approach in Broberg and Brännlund (2007b) each respondent's WTP is bounded from below by the highest amount they definitely would pay and from above by the lowest amount they are unsure about paying.[5]

Previous research on individuals' attitudes toward the predators, such as the wolf, has shown that some people perceive them as "goods" while others perceive them as "bads" (Broberg and Brännlund, 2007a; McMillan et al., 2001; Boman and Bostedt, 1999; Ericsson and Heberlein, 2003). However, this paper focuses on the relationship between income and the size of WTP and, therefore, only considers those who perceive the predators as "goods". Table 1 summarizes the answers to the first WTP question and shows that 49 percent of the Swedish population are in favour of implementation of the predator policy.

I am willing to pay as an annual tax	Definitely Pay	Probably pay	Unsure	Probably not pay	Definitely not pay
SEK 10					
…….					
SEK 5,000					

Figure 1: Multiple bounded matrix

[5] This recoding can to some degree be justified by the finding in Groothuis and Whitehead (2002), in which individuals unsure about paying a specific amount tended to answer "no" if they were pushed to give a definite answer. Welsh and Poe (1998) found that treating both "definitely yes" and "probably yes" as "yes" yields similar results as those elicited from an ordinary payment card question. However, that may not be the case in general.

The empirical analysis is carried out on the 872 respondents who stated a positive WTP and responded consistently. Table 2 presents descriptive statistics for the whole sample and the sub-sample analyzed in this paper. The income measures are individual gross and net income (including capital income) and the household disposable income (net income including capital income and social benefits).[6]

Table 1. WTP or no WTP for implementation of the predator policy package, frequencies.

	Frequency strat. sample	Percent strat. sample	Frequency population	Percent population
Yes	890	38.7	3 099, 839	49.0
No	1,408	61.3	3 223, 177	51.0
Total	2,298	100.0	6 323, 016	100.0
Missing	144		383,986	
Total	2,442		6 720, 381	

Table 2: Descriptive statistics on whole sample and sub-sample WTP>0. Mean values (Standard deviations).

Variable	Mean sub-sample WTP>0	Mean whole sample
Age	44.84 (15.25)	51 (16.78)
Male (Yes=1)	0.46 (0.5)	0.51 (0.5)
Number of children in household	0.63 (0.94)	0.53 (0.94)
Number of adults in household	1.86 (0.81)	1.88 (0.77)
Member of green NGO (Yes=1)	0.15 (0.36)	0.08 (0.28)
Owner of dog (Yes=1)	0.27 (0.44)	0.22 (0.41)
Individual gross income (SEK)	214,61 (161,70)	205,30 (154,88)
Individual net income (SEK)	145,74 (88,18)	140,31 (83,62)
Household disposable income (SEK)	304, 42 (174,87)	285 351 (166,48)
NOBS	872	2,442

[6] All income variables are from 2003. The individuals' net income was derived from the raw-data information including gross income, municipality tax-rate, progressive state tax and the tax-reduction scheme. One approximation made in the calculations regarded capital gains, which were taxed as regular income in the study. The actual tax on capital gains is 30 percent, while the income tax in different municipalities varied between 28.90 and 33.72 percent in 2004, the year of the survey study.

Old-growth forest

This dataset includes information that is used to investigate whether individuals' relative income is important to consider when eliciting WTP for public goods. The dataset concerns preservation of old-growth forests. Sweden's total land area is approximately 41 million hectares, with fifty percent covered by boreal forests dominated by Scots pine (*Pinus Sylvestris*) and Norway spruce (*Picea Abies*). According to the *Swedish Forestry Agency,* about 18 percent of the forest area is owned by the State. Almost all of the old-growth forests in Sweden belong to the state and are mainly concentrated in the sparsely populated sub-mountainous area in Northwestern Sweden (shaded area in Figure 2). A rather large part, 43% or 660,000 hectares, of the old-growth forests in sub-mountainous area was already protected in 2002. In 2002 the *Swedish Environmental Protection Agency* was commissioned by the government to assess the environmental value of the State's forests, with a focus on old-growth forests. The results from the forest assessment was published in 2004 and concluded that there were an additional 126,000 hectares (8 percent) of productive old-growth forest in the sub-mountainous region worthy of additional preservation.

A survey was sent out in the fall of 2005 with the main objective to study attitudes toward forest preservation among the Swedish population and ultimately to estimate the mean WTP for implementing the preservation program described above. The sample included 2,000 individuals between the ages of 18 and 84. The study relied on stratification to assure selection of individuals living in municipalities near the studied forest areas. In total the response rate was approximately 49 percent, including 2.5 percent blank survey responses. The dataset includes 922 consistent responses. [7]

Figure 2: Sub-mountainous area of Sweden

(Source: The Swedish environmental protection agency)

[7] Two weeks after the first mail-out a remainder was sent out. Non-respondents were contacted via telephone and asked for their reasons for not answering the mail survey. Laziness and time-constraints were the most common reasons.

In addition to an ordinary WTP question the respondents were also asked to state how they would change their WTP if their monthly income after tax would increase by SEK 1,000. A split-sample approach including two samples was adopted. Both groups (samples) were given the same information about the change of their personal income, but different information about the change in average income in Sweden.

One group was informed that the average net income per month increased by SEK 1,000, while the second group was told that the average net income per month increased by SEK 2,000. Hence, one group was contingent on an income increase that kept their relative income unchanged, while the second group was contingent on a higher absolute income, but a lower relative income. Throughout this paper the groups will be referred to as ”unchanged relative income” and ”decreased relative income”. By conditioning the respondents on a hypothetical income change, the paper aims to reveal information about respondents' perception about the relationship between income and WTP and whether the social context, manifested in the relative income, matters to their response. Table 3 presents descriptive statistics for variables used in the empirical analysis.

Broberg (2007) used the same dataset, as used in this study, and estimated the mean WTP for implementing the forest preservation program. The mean WTP based on estimation of a spike model, which allowed for zero WTP, was approximately SEK 300. The study found that the WTP was significantly correlated with income and environmental awareness. This paper analyzes the answer to the follow-up question concerning how the respondents would change their WTP given a hypothetical income change. The follow-up question was directed to respondents who stated a positive WTP, given their current budget constraint, and respondents who had zero WTP but said they were willing to pay if their budget allowed for it. Respondents who, for some other reason, stated a non-positive WTP were passed on to the next question.

Table 3: Descriptive statistics for the aggregated sample and specific samples. Mean values (standard deviation)

Variables	Whole sample (922 obs.)	”Unchanged relative income” (448 obs.)	“Decreased relative income” (474 obs.)
Age	52.87 (16.81)	53.08 (16.95)	52.68 (16.70)
Male (Yes=1)	0.50 (0.50)	0.50 (0.50)	0.49 (0.50)
Income (16 categories)	5.40 (3.11)	5.31 (2.92)	5.48 (3.28)
“Green”[a] (Yes=1)	0.33 (0.47)	0.34 (0.47)	0.34 (0.47)
Lower WTP bound (Given WTP>0)	569.34 (643.42)	546.19 (555.02)	590.52 (715.48)

[a]If = 1: Respondent wants the government to increase its environmental expenditures

The follow-up question was divided into three stages. First, the respondents were asked if they would pay anything at all given their new hypothetical budget constraint. The respondents who answered "yes" got to answer how they would change their WTP (stated earlier in the survey): "increase" "decrease" or "not change". Respondents indicating that they would change their WTP were asked to mark the highest change they would accept on a pre-specified payment card including 16 different amounts, ranging between SEK 10 and SEK 2,500. The experimental question proved to be difficult and 9.75 percent of the respondents did not answer it. The majority of the non-respondents stated a positive WTP given the first scenario, indicating that these respondents either paid less attention to the survey instructions or deliberately skipped the second valuation question after answering the first one. The amount of text in the survey may have bored and discouraged some respondents.

Table 4 presents descriptive statistics for the two groups studied concerning their responses to the follow-up question. As shown a high percentage of the respondents that stated a positive WTP given the first scenario answered that they would continue to have a positive WTP if their income would increase. However, the numbers of "no" responses are higher within the "decreased relative income" group. One reason why respondents "leave the market" when their relative economic status worsens could be that they believe that those getting relatively richer should pay more, i.e. individuals may feel that there is a relationship between social responsibility and relative standing such that the one getting relatively richer should pay more. More difficult to explain is the ten respondents in the "unchanged relative income" group that "leave the market" if the income of all citizens in the economy increases. Once again, perceptions about payment responsibility may matter, but also the perceptions about the relative growth of their personal income level. It is also possible that individuals protested against the hypothetical setting by giving seemingly strange answers.

Concerning the individuals that said they were not willing to pay given the first valuation question, only a small fraction of them increase their WTP given the hypothetical income increase. The fraction is smaller within the "decreased relative income" group. The result is interesting for two reasons. First, the relative income seems, again, to matter. Secondly, the majority of the respondents referring to their tight budget constraint when answering "no" to the valuation question did not change their answer when they were given a relatively large hypothetical income increase. One explanation for this may be that some people found it easier to refer to their budget constraint than to simply say "I don't care", i.e. they gave answers that were socially comfortable to them.

Table 4: WTP>0 if income change?
Responses for the aggregated sample and the two separate samples.

	All	"Unchanged relative income"	"Decreased relative income"
Sample size	2,000	1,000	1,000
Responses	922	448	474
Respondents with positive WTP given the initial scenario			
"Yes"	315	156	159
"No"	39	10	29
Missing	59	30	29
Total	413	196	217
Respondents with Zero WTP given the initial scenario			
"Yes"	33	20	13
"No"	228	113	120
Missing	8	6	2
Total	279	139	135

Table 5: Change in WTP in case of an increased income level.
Number of observations.

	All	"Unchanged relative income"	"Decreased relative income"
Increase	128	78	50
Decrease	13	2	11
Not change	176	73	103
Missing	31	23	8
Total	348	176	172

Table 6: Lower bound of the change in WTP contingent on an increased income level.
Mean values (standard deviations).

	All	"Unchanged relative income"	"Decreased relative income"
Increase	428.33 (435.94)	442.50 (427.82)	406.80 (451.53)
Decrease	326.15 (340.14)	440.00 (268.70)	305.45 (358.54)
Total	157.87 (364.83)	216.89 (382.66)	103.54 (339.78)
Missing	2	2	0

In Table 5 we see that many respondents would increase their WTP if their income was about to increase as described in the valuation scenario. However, a larger fraction of the respondents within the ”decreased relative income” group stated that they would leave their WTP unchanged, or even decrease it, compared to the ”unchanged relative income” group. Table 5 further indicates that respondents do react on changes in their relative standing.

Table 6 presents descriptive statistics for the payment card question concerning the highest change in WTP that the respondents would accept given the income increase. The value presented is the mean of the lower bound of the indicated change-categories. A comparison of the two groups further indicates that relative income matters to the respondents. The average increase is smaller within the ”decreased relative income” group compared to the “relative unchanged group”.

4. The econometric model

WTP model

Following Cameron and Huppert (1989) the double-bounded payment card data is analyzed by modelling the interval in which each respondent's WTP resides. If the respondent's true WTP is known to lie within an interval defined by lower and upper thresholds A_{Li} and $A_{Ui,}$ then (ln WTP_i) will lie between ($ln\ A_{Li}$) and $(ln\ A_{Ui})$, Normalizing the WTP function given in Eq. (1.a) with the unknown standard deviation (σ), the probability that ($ln\ WTP_i$) lies between the bounds can be written as:

$$\Pr(WTP_i \subseteq (\mathrm{A_{Li}}, \mathrm{A_{Ui}})) = \Pr\left[\left(\beta \cdot \ln(\mathrm{A_{Li}}) - \boldsymbol{\delta} X_{\mathbf{i}} - \lambda Y_i\right) < \eta_i < \left(\beta \cdot \ln(\mathrm{A_{U\,i}}) - \boldsymbol{\delta} X_{\mathbf{i}} - \lambda Y\right)\right] \quad (4)$$

where $\eta_i = \frac{\varepsilon_i}{\sigma}$, $\boldsymbol{\delta} = \frac{\mathbf{B}}{\sigma}$, $\lambda = \frac{\gamma}{\sigma}$ and $\beta = \frac{1}{\sigma}$.

If we let F(η) denote the cumulative density function, then for any given observation Eq. (4) can be rewritten as:

$$\Pr(WTP_i \subseteq (\mathrm{A_{Li}}, \mathrm{A_{Ui}})) = F(\eta_{Ui}) - F(\eta_{Li}) \quad (5)$$

The log-likelihood function is:

$$L = \sum_{i=1}^{N} \ln\left[F(\eta_{Ui}) - F(\eta_{Li})\right] \quad (6)$$

Estimation of Eq. (6) assuming a specific distribution for F(η) gives estimates of the parameters $\boldsymbol{\delta}$ and β which can be used to calculate the mean WTP.

Modelling change of WTP

To analyze the change in WTP following the hypothetical income change, a similar interval estimation approach is applied. The change in WTP is modelled as a linear combination of personal characteristics, a dummy for the hypothetical change in average income, DY_A (equals one if respondents belong to the "decreased relative income" group and zero otherwise) and an additive stochastic term, υ^c:

$$\Delta \mathrm{WTP_i}\,|_{\Delta Y_i} = \alpha_c + \theta \cdot X_i + \mu \cdot DY_A + \upsilon_i^c \qquad (7)$$

An individual will reject a tax increase (ΔA_i) if it is larger than the change in WTP following the change in income. Hence;

$$\Pr(\Delta \mathrm{WTP_i}\,|_{\Delta Y_i} < \Delta \mathrm{A_i}) = \Pr(\alpha_c + \theta \cdot X_i + \mu \cdot DY_A + \upsilon^c{}_i < \Delta \mathrm{A_i}) \qquad (8)$$

Denoting the cumulative distribution of the change in WTP with $F(\upsilon^c)$, Eq.(8) can be written as:

$$\Pr(\Delta \mathrm{WTP_i}\,|_{\Delta Y_i} < \Delta \mathrm{A_i}) = \mathrm{F}(\upsilon_i^c) \qquad (9)$$

Hence, the probability of accepting a tax change is $1 - \mathrm{F}(\upsilon_i^c)$. The probability that ($\Delta WTP_i|_{\Delta Yi}$) lies between the bounds given by the double-bounded data (ΔA_{Li} and ΔA_{Lu}) can be written as:

$$\Pr(\Delta WTP_i\,|_{\Delta Y i} \subseteq (\Delta \mathrm{A_{Li}}, \Delta \mathrm{A_{Ui}})) = F(\eta_{Ui}^c) - F(\eta_{Li}^c) \qquad (10)$$

where η^c is the standarized error term (υ^c/σ^c).

When specifying the log-likelihood function it should be considered that individuals may not want to change their WTP given the hypothetical income change and, therefore, a spike at zero WTP change is introduced that allows such answers.

The interval spike model is given by[8]:

$$L = \sum_{i=1}^{N} \left[k_i \cdot \ln\left[F(\eta_{Ui}^{c}) - F(\eta_{Li}^{c}) \right] + (1 - k_i) \cdot \ln(F(0)) \right] \qquad (11)$$

where and k_i equals one if the individual stated a positive change in WTP and zero for "no change" responses.[9]

5. Results

As mentioned above, there is no consensus in the previous literature on what income measure to use and how it should be specified in the WTP function. By estimating and comparing different models based on different income measures and modelling assumptions this paper will shed light on the variation in size of the estimated income-elasticity of WTP.[10]

Table 7 presents results based on the predator dataset. Different models based on either individual (I) or household (H) income are reported. In all the models WTP is assumed to be log-normally distributed. Model 1 is based on Eq. (1.a.) where income is included linearly, as any other variable in the exponential function, and the income-elasticity is calculated as a point-elasticity evaluated at the mean values of the variables. According to the results, the estimate of the income-elasticity based on individual income is more than twice as large as the estimate based on household income. The income-elasticity estimate based on the household income is not significantly different from zero. In Model 2, where household characteristics are controlled for and WTP is assumed to be a non-linear function of income, as in Eq. (1.b.), the pattern change. The elasticity increases for both the individual and household income, but much more in the case of the latter, which increases by more than 600 percent. Judging from the results in Table 7, using the gross or net income does not lead to significantly different estimates of the income-elasticity.

Model 3 is based on Eq. (1.c.), where it is assumed that the income-elasticity is constant over income levels. The elasticity decreases in size for both individual and household income, compared to the point-elasticity estimate given by Model 2. Model 4H is regressed on household income per household

[8] Spike models applied on WTP data allowing for zero WTP can be found in Kriström (1997) and Nahuelhual-Munoz et al. (2004). Yoo & Kwak (2002) extend the DC spike model in Kriström (1997) to the case with double bounded DC.

[9] The small number of "decrease" answers have been excluded from the analysis. This will bias the estimate of the change upwards. If the data had allowed for it, an extended spike model including such answers could have been estimated.

[10] The standard deviations for the income-elasticities were calculated using the WALD-command in LIMDEP.

member. The estimated elasticity is smaller and the data fit is worse compared to Model 2, where the number of children and adults were included as independent control variables.

To sum up the results presented so far, estimates of the income-elasticity vary over different models. The estimates range between 0.07 and 0.49. The differences between the models are almost exclusively insignificant. Judging from the t-values associated with each estimate of the income-elasticity, the non-linear point-elasticity model using household income and household characteristics performs best. The corresponding estimate is 0.49.[11] Controlling for household characteristics seems important for finding a significant income-effect, when the household income is used.

Table 7: Testing for differences between individual (I) and household (H) income and the importance of household characteristics. Parameter estimates (standard deviations).

Varibles	Model 1I Net	Model 1H	Model 2I Net	Model 2I Gross	Model 2H	Model 3I Net	Model 3H	Model 4H
Constant	4.763 (0.196)***	4.704 (0.203)***	4.963 (0.222)***	4.991 (0.230)***	4.960 (0.225)***	5.172 (0.236)***	5.118 (0.217)***	4.593 (0.216)***
Ln (bid)	-0.907 (0.025)***	-0.903 (0.025)***	-0.913 (0.025)***	-0.913 (0.025)***	-0.916 (0.025)***	-0.907 (0.026)***	-0.915 (0.025)***	-0.910 (0.025)***
Age (Not retired)	-0.003 (0.003)	-0.000 (0.003)	-0.004 (0.004)	-0.003 (0.004)	-0.003 (0.004)	-0.002 (0.004)	-0.003 (0.004)	-0.003 (0.003)
Retired	-0.503 (0.174)***	-0.374 (0.167)**	-0.554 (0.195)***	-0.543 (0.194)***	-0.502 (0.189)***	-0.516 (0.197)***	-0.519 (0.189)***	-0.521 (0.182)***
Male	0.205*** (0.076)	0.240 (0.074)***	0.202*** (0.077)	0.201*** (0.077)	0.249 (0.074)***	0.231*** (0.076)	0.252 (0.074)***	0.230 (0.074)***
Green NGO	0.597 (0.098)***	0.596 (0.099)***	0.603 (0.100)***	0.601 (0.100)***	0.596 (0.100)***	0.582 (0.103)***	0.599 (0.100)***	0.591 (0.099)***
Dog	0.249 (0.081)***	0.238 (0.081)***	0.276 (0.082)***	0.278 (0.082)***	0.283 (0.082)***	0.271 (0.083)***	0.270 (0.082)***	0.265 (0.081)***
Income	0.118 (0.042)***	0.022 (0.023)	0.238 (0.100)**	0.129 (0.046)***	0.217 (0.078)***	0.124 (0.046)***	0.303 (0.089)***	0.227 (0.092)**
Income^2			-0.020 (0.020)	-0.005 (0.004)	-0.012 (0.008)			-0.012 (0.016)
Adults			-0.088 (0.041)**	-0.091 (0.040)**	-0.271 (0.051)***	-0.087 (0.041)**	-0.237 (0.049)***	
Children			-0.017 (0.043)	-0.018 (0.043)	-0.055 (0.045)	-0.007 (0.043)	-0.046 (0.045)	
Student			-0.102 (0.142)	-0.081 (0.141)	-0.007 (0.142)	0.000 (0.000)	0.000 (0.000)	-0.062 (0.138)
Income elasticity	0.189 (0.068)***	0.073 (0.077)	0.289 (0.092)***	0.252 (0.080)***	0.487 (0.124)***	0.137 (0.050)***	0.332 (0.096)***	0.294 (0.095)***
LLI	-1,273.98	-1,276.76	-1,269.86	-1,269.84	-1,266.96	-1,247.54	-1,268.46	-1,272.06
No. Obs	872	872	872	872	872	855	872	872

*, **, *** indicates if the estimates are significant on the 10, 5 and 1 percent level

[11] The t-values reveal the significance of the income-elasticity and since all models are regressed on a large sample, the t-values are comparable.

Perceptions about the relationship between income and WTP

So far the analysis has focused on differences in WTP due to differences in respondents' absolute income levels. The low income-elasticity indicates that the distribution of the benefits attached to preserving predators in the Swedish fauna is regressive in the sense that poor people are willing to pay more as a percentage of their income than rich people. The weak income-effect, which is also found in many other CV studies, may not only be a question of how income is measured or modelled. It may actually be that some peoples' demand for the public good are independent of their income level per se and instead may be a function of their income within a social context (e.g. income positioning or perceptions about "fair payments"). To study whether peoples' WTP are sensitive to changes in their relative income level, this paper adopts the split-sample experiment outlined in Section 3.

Table 8 presents results derived from estimation of the spike model given by Eq. (11), explaining the size of the change in WTP conditioned on the hypothetical income change. The model are regressed on all the respondents who answered the split-sample question and also separately on those who said they were willing to pay given their current income. Note that this model excludes respondents that would decrease their WTP given the new scenario.[12] To study whether different types of individuals react differently to the hypothetical change in their relative income, interaction terms are included in Model 6. For example, one covariate is the respondents' WTP (given the initial scenario) which is to some degree determined by other covariates in the model (e.g. "green" and income). However, this covariate is relevant to study because it also captures factors unobservable to the researcher, e.g. attitudes and perceptions about "fair payments".[13]

Model 5 includes only one covariate and, the relative income dummy. The results for both the whole sample and the sub-sample consisting of respondents with a positive WTP show that people react significantly to the social context presented in the valuation scenario. The relative income dummy is highly significant. Model 6 includes more covariates and interaction terms to further study the of the relative income effect on the change of WTP. Table 9 presents estimates for the change of WTP contingent on the hypothetical income change. The values reported are based on the estimates of Model 6 and are the average increase in WTP for the whole sample and for those respondents who stated a positive WTP (given the initial scenario). The increase in WTP is smaller within the "decreased relative income" group. The differences between the split-sample groups are statistically significant (on the ten percent level) only for those who had stated a positive WTP (given the initial scenario).

[12] The sample includes too few such observations to estimate a extended spike model taking them into consideration. Also some of the observations are likely protest answers, e.g. those who said they would decrease their WTP given an equal change in their personal income and the average income in Sweden.

[13] There seems not to be any co-linearity problem in the model. The highest correlation coefficient is 0.16 and concerns the correlation between the variables WTP and "green".

The results for the whole sample show that the increase in WTP is positively correlated with respondents' attitudes toward public expenditures on the environment ("green"), their income and their WTP (given the initial scenario). All interaction terms are negative. Those who stated a high WTP (given the initial scenario) also stated significantly higher increases in their WTP. The size of the interaction term indicates that this effect is smaller within the "decreased relative income" group. This supports the notion that the "unobservable characteristics of respondents", captured by the WTP variable, also covers perceptions about "fair payments". Males within the "decreased relative income" group tend to state smaller increases compared to females which would indicate that males react stronger to the social context manifested in the relative income change. The estimates of Model 6b show that the results remain stable when the same model is regressed only on those who stated a positive WTP (given the initial scenario). The only estimates that change substantially are the estimates of the income parameters. Income is insignificant within the "unchanged relative income group". The sign of the interaction parameter for personal income and the relative income dummy indicates that the increase in WTP tends to be higher for rich respondents within the "decreased relative income group". The result indicates that poor respondents tend to care more about changes in their relative standing than rich people. However, this effect is not significant.

6. Discussion and Concluding remarks

As discussed in the introduction of this paper, there is no consensus in the previous literature on how to model the relationship between WTP and income, i.e. the specifications used in previous literature are seemingly ad-hoc. This paper performs a comparison between different models based on different income measures and modelling assumptions to study the variation in size of the income-elasticity of WTP. The analysis in this paper also focuses on the relevance of considering social context aspects of the valuation scenario when studying the relationship between WTP and income. Specifically, the paper analyzes the importance of respondents' relative income level.

Survey data concerning preservation of the four large predators in the Swedish fauna are used to perform a sensitivity analysis of the estimated income-elasticity with respect to different income measures and modelling assumptions. The results from the analysis show that estimates of the income-elasticity of WTP are fairly sensitive to the choices of income measure and modelling. Overall, the estimated income-elasticity varied within the range of 0.07-0.49. Higher estimates are generally associated with a larger standard deviation and the differences between the estimates are almost exclusively insignificant. The highest point-estimates are produced assuming that WTP is a non-linear function of household income. This estimate is also the most precise. In the absence of control variables regarding household characteristics, individual income yields a higher estimate compared to household income. When the number of adults and children are controlled for the pattern is reversed.

The results support the notion that it is important to control for the number of adults whenever the household income is used as an independent variable in the WTP function. Using household income per household member yields a lower estimate and worse data fit compared to the model where household characteristics were included as covariates.

When analyzing the decisions of individuals the household income needs to be adjusted for the number of adults (and perhaps children also) in the household before it can be compared to the income of single households. If household characteristics are not controlled for, the household income will reveal little about the income disposable to a specific household member. This conclusion is to some degree contrary to the conjecture in Kriström and Riera (1996), that inclusion of covariates in the WTP function does not change the estimated income-elasticity in any fundamental way.

To study the importance of relative income, this paper applies a split-sample approach, using survey data concerning preservation of old-growth forest in Sweden. An experimental CV question asked respondents how they would change their WTP (stated earlier in the survey) if their absolute income and the average income in Sweden were to increase by a specific amount. Two samples were compared, both conditioned on the same increase in their personal income, but on different information about the change in average income.

The results from the analysis indicate that respondents react on the social context given in the valuation scenario, with males having a stronger reaction than females. Respondents who were asked to consider a decrease in their relative income stated a lower increase in WTP (on average) compared to those whose relative income remained unchanged, all else equal. The difference is larger for respondents who reported a positive WTP given the initial scenario. The estimated models included the respondents' WTP (given the initial scenario), as a covariate. The results support the conjecture that this variable captures factors unobservable to the researcher, e.g. attitudes and perceptions about "fair payments". Respondents who stated a high WTP also stated a high increase in their WTP given that their hypothetical income increased. However, when their hypothetical *relative* income decreased, they stated a smaller increase in WTP. I can only speculate why some respondents react stronger than others to the hypothetical income change. However, the results indicate that respondents react to information (change in the average income in Sweden) which according to the conventional CV literature should be irrelevant to them.

Table 8: Spike model on the change of WTP contingent on the hypothetical income change.

Parameter estimates (standard deviations)

	WTP ≥ 0 initial scenario		**WTP > 0 initial scenario**	
Variables	Model 5a ΔWTP	Model 6a ΔWTP	Model 5b ΔWTP	Model 6b ΔWTP
Constant	-0.899 (0.135)***	-2.702 (0.583)**	-0.204 (0.170)	-2.660 (0.797)***
Age		0.009 (0.009)		0.025 (0.012)**
Male		0.399 (0.295)		0.548 (0.371)
Income		0.049 (0.052)		-0.013 (0.062)
"Green"		0.941 (0.302)***		0.635 (0.376)*
WTP		0.002 (0.000)***		0.001 (0.000)***
"Decreased relative income"	-0.605 (0.206)***	0.574 (0.851)	-0.794 (0.252)***	0.750 (1.144)
Rel.Dec·Age		-0.003 (0.014)		-0.007 (0.018)*
Rel.Dec·Male		-0.881 (0.472)*		-1.283 (0.600)**
Rel.Dec·Income		-0.013 (0.077)		0.122 (0.091)
Rel.Dec·Green		-0.736 (0.449)		-0.969 (0.563)*
Rel.Dec·WTP		-0.001 (0.000)**		-0.0015 (0.0006)***
Bid	-0.002 (0.000)***	-0.003 (0.000)***	-0.002 (0.000)***	-0.003 (0.000)***
X^2	1,265***	1,140***	883.26***	1,050***
NOBS	535	508	272	255

*, **, *** indicates if the estimates are significant on the 10, 5 and 1 percent level

Table 9: Mean ΔWTP contingent on the hypothetical income change (Standard deviations)

	ΔWTP unchanged relative income (in SEK)	**ΔWTP decreased relative income (in SEK)**
Whole sample	116 (20)	75 (14)
Part sample (WTP > 0)	233 (42)	114 (23)

Even though an individual's income level is an important determinant of WTP, it is not independent of the social context. In other words, people seem to have perceptions about who should pay for public goods, which implies that an increase in income does not necessarily imply an increase in WTP. This paper asked about WTP for a good that many respondents conceive as a genuine public good: the preservation of biodiversity within a virgin forest that provides value almost exclusively from its nonuse attributes. Many respondents stated that their main motive for valuing the preservation program was their desire to conserve virgin nature for future generations. One interpretation is that peoples' perceived obligation to pay for conserving virgin nature is a function of their *relative* income, such that, when their relative position worsens their sense of obligation weakens. This implies that the income-effect on the WTP for public goods is more complicated than suggested in the conventional CV literature. It also implies that valuation of public goods is not independent of the social context described to respondents in the valuation scenario.

The results may be flawed due to the hypothetical setting used as the foundation of the analysis. Judging from the item non-response, the second valuation question proved to be troublesome. Some respondents seem to have deliberately skipped the question after answering the first valuation question. The amount of text associated with the survey and the hypothetical setting might have discouraged some of these respondents. However, even if the results may be flawed they still indicate that the social context matter to respondents.

In the future, studies examining the income-effect on WTP should more carefully describe their choices of income measure and modelling assumptions and further study the influence of the social context, i.e. in what degree an individual's WTP is influenced by the income levels and contributions of other individuals. Also, studies experimenting with the social context, need to address design issues of CV questions and obtain a better understanding of the workings behind the responses.

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