

The value of mortality risk reductions. Pure altruism – a confounder?

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Abstract

This paper examines public valuations of mortality risk reductions. We set up a theoretical framework that allows for altruistic preferences, and subsequently test theoretical predictions through the design of a discrete choice experiment. By varying the tax scenario (uniform versus individual tax), the experimental design allows us to verify whether pure altruistic preferences are present and the underlying causes. We find evidence of negative pure altruism. Under a coercive uniform tax system respondents lower their willingness to pay possibly to ensure that they are not forcing others to pay at a level that corresponds to their own – higher – valuations. This hypothesis is supported by the observation that respondents perceive other individuals' valuations to be lower than their own. Our results suggest that public valuations of mortality risk reductions may underestimate the true societal value because respondents are considering other individuals' welfare, and wrongfully perceive other people's valuations to be low.

Keywords: Altruism, Risk reduction, Willingness to pay, Stated preferences, Value of statistical life

JEL Classification D6, D7, I1

1. Introduction

The contingent valuation method was initially developed in the US, and has been increasingly used since the late 1960s. Fundamentally, the underlying reason for the rise of stated preference methods has been the acknowledgement that substantial portions of utility were not reflected in the observed market prices of (in the first instance) environmental goods. Stated preference methods (SP) have since developed considerably and are now used for valuing other types of goods such as transport, food and health, but the method remains widely debated (Diamond and Hausman, 1994; Jones-Lee, 1989; Lindhjem et al., 2011).

In the present SP study we focus on one specific issue that has been raised in the literature; the question of whether pure altruism is included in the general public's valuations of changes in public safety, more specifically mortality risk reductions. The concept of sympathetic preferences (Smith, 1975), empathetic preferences (Harsanyi, 1977) and altruism (Andreoni et al., 2003) has been dealt with at large in the literature. That individuals may have a non-selfish concern for others has been long acknowledged, but the implications that such empathetic preferences may have on stated preference structures, have not been analysed in much detail. Of core interest for this paper, is the observation that altruistic preferences may take many forms and can be divided into several types according to which components of the others' utility enter into the individual's utility function; *paternalistic* altruism or *pure* altruism (Jones-Lee 1991; 1992). Paternalistic altruism may be safety-focused or wealth-focused¹. In the former case, individuals only value the added safety obtained by others and not other factors entering into others' utility function. In the latter case, the only factor of interest is others' wealth. Pure altruism is present when individuals are instead concerned with the general welfare of others, and respect their preferences. In contrast to safety-focused altruism which

¹ In the case where the utility function is assumed to comprise only of the survival probability and wealth (income)

one may assume cannot be negative for positive increments in safety, pure altruism can take either a positive or a negative net-value (Johannesson et al., 1996). For instance, in the case of tax based public initiatives, an individual may be concerned about coercing others into having to pay for the public initiative, if she believes that others value it less than she does. This may imply that the individual will state a lower willingness to pay (WTP) than when the risk reduction is of a private nature². Alternatively, a pure altruistic individual may express a higher WTP for allowing others access to the good, if she believes that others value it higher than she does. The inclusion of pure altruistic preferences in SP studies with uniform coercive payments can be problematic if there is imperfect knowledge of others' benefits, and if costs to others are not (or only partly) considered in the valuation.

The aim of this paper is to examine the public valuation of increased safety by setting up a theoretical framework and subsequently testing predictions via a stated preference experiment. We base the study on traffic safety, but the conclusions are generalisable to other contexts such as health and the environment. We test whether marginal rates of substitution of income for mortality risk (i.e. marginal WTP) include elements of pure altruism. Furthermore, we test whether the net impact of pure altruistic preference can be explained by individuals' *perceptions* of others' WTP for improved traffic safety. To investigate the potential comparability of our survey results with previous findings in the literature, we also test whether we can replicate the finding that public valuations are less than or equal to private valuations in the context of traffic safety using the same methodology that has been applied in the literature to date.

Our motivation for conducting this study is that WTP for own risk reductions often generates higher valuations than WTP for own and others' risk reductions via taxes (Johannesson et al.,

² An individual may also state a lower WTP if she is wealth-focused altruist and believes that others ought not to pay more in tax irrespective of their preferences for safety

1996, Hultkrantz et al., 2006; Andersson and Lindberg, 2009; Svensson and Johansson, 2010; de Blaeij et al., 2003). The observation is based on a small empirical literature that involves testing for differences in marginal valuations of mortality risk reductions in the context of traffic, which ideally only differ with respect to the payment vehicle applied: income tax levies for public investments (used for investing in roads, traffic lights, signage etc.) or out-of-pocket payments for safety devices for the individual (such as air bags, more sophisticated seat belts etc.). Out-of-pocket payments for such items will elicit private value only, whereas income tax levies will disclose citizen's preferences, i.e. individual preferences that potentially involve altruism. Henceforth we refer to private and public valuations, respectively. In contrast, Arana and Leon, (2002) and Pedersen et al., (2011) found that public valuations for risk reductions obtained via health programs were higher than private valuations. These findings together with survey results in Viscusi et al., (1988) suggest that public valuations may include a positive value associated with altruistic preferences, but that this positive value in some cases may be overshadowed partly by attitudes towards public and private provision of risk reducing interventions (an explanatory factor identified in Svensson and Johansson, (2010)). We propose that an additional explanation could be the prevalence of a negative altruistic component in public valuations. Given that the value of safety *per se* is only equal to or greater than zero (ruling out any type of envy and resentment), altruism with a negative sign can only be present if respondents not only care about the safety of other, but also about other consequences that factor into the utility function, such as coercive payments.

Although stated preference methods which apply tax as a payment vehicle seldom explicitly state that the tax is uniform and coercive, respondents are likely to interpret the vehicle in this way since in most countries tax is not voluntary nor based on individuals' WTP. Theoretical models in this field have analyzed altruism under a tax-regime in which every individual pays according to their WTP and as such are not coerced into paying (Jones-Lee 1991;1992;

Johansson, 1994). In this paper, we will extend these models to analyse altruism empirically within the realm of a theoretical model where the tax rate is uniform and in effect coercive.

Additionally, our study is different to those previously conducted in the field on two counts. First, in our study we specifically ensure that the public and private good are identically described. It is a challenge to present a public and a private good holding all other characteristics constant in order to avoid affective reactions. Prior studies, which have attempted to hold all things equal in order to isolate the altruistic component, may have succeeded to different degrees. For example, in the paper by Svensson and Johansson, (2010) the private good on offer was a “safety device” whilst the public good was a “public road safety investment”. These are essentially very different goods. Public road safety may involve longer travel time if it involves stricter speed limits, and a safety device may not avoid an accident, but merely alleviate the health consequences. Second, our study specifically explores respondents’ view on others’ WTP for safety, in order to verify whether the net impact of potential pure altruistic preferences under a uniform tax-regime may be driven by respondents’ perception of others’ valuations. To this end we apply a question format equivalent to that of the inferred valuation approach (Lusk and Norwood, 2009), where individuals are asked to express the valuations of the average citizen.

In the remainder of the paper, we initially present the theoretical foundation of our empirical approach. This is followed by a description of the survey that was conducted, and our analytical strategy. Results are then presented and discussed.

2. Theoretical foundation

Using income tax levies may often be the only realistic and relevant payment vehicle to apply

in a stated preference task if the safety intervention is a public good. This payment vehicle may generate valuations that include altruistic preferences. According to the philosopher Thomas Nagel (1970), altruism constitutes a willingness to act in the consideration of the interests of other persons, without the need of ulterior motives. As explained by Andreoni et al., (2003) it may or may not imply sacrifice on one's own part, but it does require that the consequences for someone else affect one's own choice.

Individual preferences for a public good may include altruism, and this altruism may be characterised as being *pure* or *paternalistic*. In his seminal papers, Jones-Lee (1991; 1992) derives the marginal valuation of a change in mortality risk in the presence of different kinds of altruism and under a tax-regime in which every individual pays according to her WTP. We follow the terminology from Jones-Lee, (1991) and distinguish between: a) pure selfishness (the assumption in standard economic models); b) safety-focused altruism (in which altruism relates only to other people's safety); and c) pure altruism (where people in addition to their own well-being are concerned about other people's utility)³. If an individual is a pure altruist, her public valuation (individual preferences inclusive of altruism) could be higher/lower than her private valuation depending on her *predictions* of other individuals' net benefit (i.e. the net impact of an increase in the probability of avoiding a fatality and the costs). In contrast, the presence of safety-focused preferences can only impact positively on valuations of public programmes that increase safety. Based on Jones-Lee, (1991; 1992) and Johansson, (1994) a more formal development of these thoughts is depicted as follows:

Consider a society of n individuals and suppose there is a policy proposal increasing the probability (p) of avoiding a fatal incident from p^{i0} to p^{i1} for individual $i = 1, \dots, n$. The with-project utility for individual i is defined V^{i1} whereas the without-project utility is defined V^{i0} .

³ Subsequently, we also discuss "wealth-focused altruism" as defined in Jones-Lee, (1992).

The cost of the intervention is in this development uniform and denoted t for all individuals. For this development, tax t is assumed to be uniform for simplification, but could in principle be generalized to $t_j \neq \text{WTP}_j$. The important difference to the theoretical models by Jones-Lee (1991; 1992) and Johansson (1994) is that $t_j = \text{WTP}_j$ no longer holds. For simplicity we assume that the utility function consists of two components; the survival probability (p) and income (y). The with-project utility for individual i for each of three types of individuals is therefore given by:

The selfish individual who is only concerned about own utility:

$$V_{selfish}^{i1} = V^i(p^{i1}, y^i - t), \quad (1)$$

The safety-focused altruistic individual who is concerned about others' safety:

$$V_{safety}^{i1} = V^i(p^{i1}, y^i - t, p^{j1}, \dots, p^{n1}), \quad i \neq j \quad (2)$$

The pure altruistic individual who is concerned about others' utility:

$$V_{pure}^{i1} = V^i(p^{i1}, y^i - t, V^{j1}(p^{j1}, y^j - t), \dots, V^{n1}(p^{n1}, y^n - t)), i \neq j \quad (3)$$

Eq 3 presupposes that i is well informed about j 's preferences (an assumption which will be discussed later). In all cases individual i will accept the proposal if the above utility level is at least as high as the without-project utility ($V^{i1} \geq V^{i0}$). A safety-focused individual would only be interested in how other individuals' safety is affected, and thus her utility function would include p^{j1} for at least one $j \neq i$. Since $\frac{dV^i}{dp^j} > 0$ public valuations that include safety-focused altruism should always be greater than private valuations amongst safety-focused altruistic individuals.

For the pure altruist i in Eq 3, there are three possible outcomes depending on how well-

informed i is about j ; 1) the pure altruist i (wrongly) ignores the fact that j will have to pay for safety (or predicts that $\frac{\partial V^j}{\partial p^j}(p^{j1} - p^{j0}) > -\frac{\partial V^j}{\partial y^j}t$) and hence i expresses $WTP_{\text{public}} > WTP_{\text{private}}$; 2) the pure altruist i cares for e.g. a low-income earner j and realises that j will have to pay t and predicts that $\frac{\partial V^j}{\partial p^j}(p^{j1} - p^{j0}) < -\frac{\partial V^j}{\partial y^j}t$. Hence i states $WTP_{\text{public}} < WTP_{\text{private}}$; 3) the pure altruist i is told that j will have to pay exactly what the safety improvement is worth to j ($t_j = WTP_j$). Since net-benefit to j is zero for all j , i expresses $WTP_{\text{public}} = WTP_{\text{private}}$.

In effect, the purely altruistic individual i is (in addition to her own self-interest) steered by the net impact of p and t on other individuals that she cares for i.e. the predicted sign of $\sum_{j=1}^n k_j (\widehat{V^{j1}} - V^{j0})$, $\sum_{j=1}^n k_j = 1 \forall k_j \geq 0$.

The role of pure altruism and safety-focused altruism in valuations of public goods has been debated at length in the literature. Jones-Lee, (1991; 1992) and Bergstrom, (2006) have demonstrated that one should take full account of people's WTP for the safety of others *if and only if* altruism is exclusively safety-focused and incorporate these values in the cost-benefit analysis. Conversely, WTP based on pure altruistic motivations should be excluded from the valuation. However, this conclusion has been based on theoretical models where $t_j = WTP_j$. If such a tax system were in place, pure altruistic individuals would only express $WTP_{\text{public}} \neq WTP_{\text{private}}$ if they failed to consider the potential costs to others when asked to perform valuation tasks, and such valuations would therefore represent biased valuations (so-called double counting) since only $\frac{\partial V^j}{\partial p^j}(p^{j1} - p^{j0})$ and not $-\frac{\partial V^j}{\partial y^j}t$ will enter into the valuation. Alternatively, if $t_j \neq WTP_j$ and individual i does consider the costs to others then WTP for a pure altruist could legitimately differ from a self-interested individual. Still, even if individuals do consider the costs to others, individual i 's perception of other individuals' net benefits ($\widehat{V^{j1}} - V^{j0}$) may be wrong, since individual i does not necessarily have perfect information on

the utility function of individual j . Nor does individual i have perfect knowledge of the level of t . Note that imperfect knowledge may therefore lead to biased valuations under a coercive tax-system.

As suggested in Johansson, (1994), a way of testing whether individuals exhibit negative pure altruistic preferences and whether individuals include the net benefit to others in their valuation of public tax financed programmes is to elicit valuations with and without the following statement: “*All other individuals will be asked to pay an amount corresponding to exactly the value they themselves attach to the initiative.*” This sentence allows individual i to express her WTP under the condition that $\sum_{j=1}^n k_j (V^{j1} - \widehat{V}^{j0}) = 0, \sum_{j=1}^n k_j = 1 \forall k_j \geq 0$.

We randomise respondents to WTP questions that exclude and include this phrase in order to test for the presence of pure altruism, and to decipher whether the elimination of this component of the utility function increases or decreases the marginal valuation of a risk reduction. If the impact of allowing everybody to pay according to their WTP increases (decreases) the valuation, this is an indication that costs to others are indeed considered, and that suppression of WTP may be generated by wealth-focused altruism (others ought not to pay more in tax) and/or pure altruism (others ought not to pay more in tax *than they prefer*).

As an indicator of whether preferences are mainly steered by pure altruism, we ask a different sample of respondents to predict other individuals’ choices. Respondents are presented with a similar discrete choice experiment, but are in each choice task asked to indicate which alternative they believe *the average citizen* would choose. We expect respondents’ prediction of other individuals’ preferences to be directly related to the sign and magnitude of pure altruism, since these choices indicate individual i ’s predicted value of t . One explanation for the exhibition of negative pure altruistic preferences could be that the individual expects other individuals to place a lower value on the risk reduction (thus lowering WTP in order to avoid

forcing others into paying for something of less value to them). To support the notion of negative pure altruistic preferences we would therefore expect the average individual to *predict* other citizen's valuation of the good to be lower than her own valuation (i.e. $WTP_{\text{predicted_public}} < WTP_{\text{public}}$).

3. Methods and materials

A discrete choice experiment (DCE) was conducted in May 2013 using an Internet panel. The survey was tested in an online pilot study (n=200) in the autumn 2012. One purpose of the pilot study was to test different levels and intervals of the price attribute in the discrete choice experiment. The design was amended afterwards based on the results of the pilot study.

The final questionnaire was in an interactive web-designed format where respondents were initially asked some introductory warm-up questions related to their own traffic behaviour. Respondents were then informed about the baseline traffic mortality risk i.e. that in recent years, 240 Danes have died in traffic accidents every year. This was followed by a more detailed explanation of the risk stating that since there are 5.5 million people in Denmark, every year 4 individuals out of 100,000 will die in a traffic accident. That is, on average every Danish citizen has an annual risk of 4 in 100,000 of dying in a traffic accident. It has been suggested that in a stated preference survey a verbal probability analogy is a good supplement to numerical probabilities (see Corso et al., 2001, Hammitt and Graham, 1999). Therefore, to put the numbers into perspective, the respondents were also told that 100,000 represents the number of people living in Aalborg (the fourth largest city in Denmark) and that this means that every year on average four people will die in the traffic in Aalborg. The respondents were also given the information that 100,000 is twice the number of seats in "Parken" (the national football stadium in Copenhagen).

Subsequently, respondents were presented with the DCE with each respondent receiving 10 choice sets consisting of two alternatives and an opt-out (“no intervention”). The DCE comprised two attributes only: 1) the annual mortality risk reduction including information about the equivalent number of lives saved (in selected scenarios); and 2) a price attribute. The attributes and corresponding levels are shown in Table 1 below. The respondents were asked to consider the value of a 10-year traffic safety intervention. The risk reduction was an annual risk reduction, which would be in place for a period of a decade. The minimum payment period was also 10 years. The 10-year time horizon was introduced to reflect realism, and to promote more serious judgments when valuing the traffic intervention. That the intervention is binding for a period of 10 years makes the budget impact more long term and the choice more permanent.

Table 1 about here

A D-efficient Bayesian design was conducted using Ngene software with priors from the pilot study (ChoiceMetric, 2009)⁴. This led to a final design with a total of 10 choice sets consisting of two hypothetical alternatives and one opt-out (i.e. no intervention). Respondents were randomised into a total of six survey splits. The same experimental design was used for all three variations of the survey and included the attributes levels listed in Table 1. In addition, the Appendix provides example of choice sets and text extracts from the questionnaire. Survey split A and D are included as examples. To test whether the valuation includes elements of pure

⁴ A pilot with 50 respondents was used to collect information on the priors (DCE split A). Fixed prior was used for the price attribute (linear) whereas priors for risk reduction (effects coded) were given a uniform distribution. D-error = 0.030854 and S-estimate = 32 (fixed)/226 (Bayesian median)

altruism, respondents were randomised to one of three survey splits (A to C). Table 2 presents the variations applied across formats A to C.

Table 2 about here

The additional text in the public setting in Split B is shown in Box 1. This was included in order to highlight the fact that all individuals pay according to their own valuation excluding any negative effect of enforcing others into paying. Respondents facing other splits than B were provided with no specific details about how the tax scheme was constructed.⁵

Box 1. Phrasing of the public intervention excluding negative pure altruism (split B)

“All other households will be asked to pay an amount corresponding to exactly the value they themselves attach to the initiative.”

The predicted valuation⁶ in Split C was phrased as shown in Box 2.

Box 2. Phrasing of the predicted valuation (split C)

“Imagine that 1000 randomly selected Danes were presented with this question, and asked to indicate which initiative they would prefer. Which initiative do you think the majority would choose?”

In addition we wanted to test whether we could replicate the prior observation in the literature that public valuations are lower than private valuations. To test for whether the private

⁵ It is seldom to provide more specific details about the tax scheme in a stated preference survey and hence we follow the standard approach.

⁶ The question format is in many ways similar to that of the inferred valuation approach, where individuals are asked to express the valuations of the average citizen (Epley and Dunning, 2000; Lusk and Norwood, 2009).

valuation is less than or equal to the public valuation, respondents were randomised into three additional survey splits. Table 3 presents the variations applied across formats D to F.

Table 3 about here

The safety improvement interventions (both private and public) presented to respondents were described in a manner that was intended to reduce disutility that the respondents would associate with the intervention *per se*. For example, the mentioning of lower speed limits may initiate strong reactions among some respondents and was therefore not used as an example. The descriptions were such that the interventions would generate very little change to the mobility and comfort of road users.

Prior to the 10 choice sets, respondents were presented with a short version of a cheap talk script which not only focused on increasing the validity of the WTP response by referring to the concept of opportunity cost, but also stressed the existence of other types of risk that one could alternatively pay for.

3.1 Analytical strategy

To test whether public preferences include elements of pure altruism, we test for difference in marginal rates of substitution of income for risk (i.e. marginal WTP estimates for a risk reduction) between split A and B according to the following hypothesis:

$$H1. \quad H_0: MWTP_A = MWTP_B$$

Where $MWTP_A$ denotes the marginal rate of substitution of income for risk for intervention A, and so forth for splits A to F. The method for estimating the MWTP values is presented below under the econometric specifications section.

If H1 is rejected this will be interpreted as an indication of pure altruism in the public valuation. $MWTP_A - MWTP_B > 0$ will indicate net positive pure altruism. $MWTP_A - MWTP_B < 0$ will indicate net negative pure altruism, and will imply that individuals consider the costs to others when expressing their valuations (refer to Eq 2 and Eq 3).

To further verify the presence of pure altruism (as opposed to wealth-focused altruism), we test whether respondents' perceptions of others' preferences differ from their own preferences:

$$H2. \quad H_0: MWTP_A = MWTP_C$$

Here $MWTP_A - MWTP_C > 0$ suggests that respondents perceive/predict other individuals' valuations to be lower than their own (and opposite if $MWTP_A - MWTP_C < 0$). If $MWTP_A - MWTP_B < 0$ we expect mean $MWTP_A - MWTP_C > 0$ (and opposite if $MWTP_A - MWTP_B > 0$).

To examine the validity of our survey instrument against previous results in the field, we test whether public valuations are less than or equal to private valuation. This is done by comparing marginal WTP across splits D and E. Survey splits D and E involve different scenario descriptions (public initiative versus private safety equipment). We test whether type of intervention affects valuations using survey splits A and F (which involve holding payment vehicle constant). Note that we do not necessarily expect similar valuations when the benefits are expressed differently, hence D and E cannot be compared directly with A, B, C and F. Note also that testing for differences in marginal WTP is identical to testing for differences in Value of Statistical Life (VSL) estimates across splits, where VSL is estimated as the individual's WTP divided by the risk change, see e.g. Hammitt (2000).

3.2. Econometric specification

The DCE is based on random utility theory and probabilistic choice modelling (McFadden, 1974). Data was analysed using the error component logit specification (belonging to the family of mixed logit models) following Train, (2003). Separate models were estimated for each survey split. The utility function U for individual i of alternative n and choice set j is specified as

$$U_{inj} = V_{inj} + \varepsilon_{inj} = \alpha_{status_quo} + \beta_1 RISK_n + \beta_2 PRICE_n + \varepsilon_{int} + \mu_i E_{inj} \quad (4)$$

where α is the alternative-specific constant for the status quo (specified as choosing no intervention)⁷, β the parameters for each of the two attributes, and ε the error term assumed independent and identically distributed (IID) with type I extreme value distribution. Finally, μ is a random term with zero mean and error component E denoting the alternative specific random individual effects. By applying this model specification we account for substitution (correlation) patterns between the policy interventions introducing heteroscedasticity in its variance and allow for repeated choices by each respondent. In addition to the model outlined in Eq 4 above we run an error component model for each split in which the alternative specific constant is restricted to zero ($\alpha_{status_quo} = 0$). It is debatable whether or not to include the constant in the model and previous studies have attempted this differently (Alberini and Scasny, 2011; Carlsson et al., 2010b; Tsuge et al., 2005; Johansson-Stenman and Martinsson, 2008). Including an alternative specific constant allows for the presence (and estimation) of an

⁷ Only one constant was specified in the model implying that the constant captures the joint probability of choosing either of the two hypothetical interventions

“action effect/bias”, i.e. utility derived from *doing something* (relative to doing nothing)⁸. Finally, we test whether the risk parameter can be assumed linear in utility (by testing for equality in the size of the parameters in a non-linear effects coded model with middle risk as reference level). If this is the case this implies that respondents exhibit sensitivity to scope for risk reduction.

Our estimation approach accords with previous work also using choice experiment to establish a marginal value of a risk reduction/ VSL (e.g. Alberini and Scasny, 2011; Carlsson et al., 2010b; Tsuge et al., 2005; Johansson-Stenman and Martinsson, 2008). Marginal rate of substitution between income and risk, i.e. marginal WTP for a risk reduction, is calculated as the ratio in parameters $(-\frac{\beta_1}{\beta_2})$, and standard errors are obtained using the Delta Method (Hole 2007). The hypotheses are tested using *t*-tests (Wooldridge, 2002). Data is analysed using Stata software.

4. Results

The sample was obtained from the Nielsen⁹ Company’s online database in May 2013. The panel members are all more than 15 years of age and reside in a household with Internet access. In Denmark 93% of the population has access to the Internet at home. In the present survey, we included panel members in the age group 18-80 years. The response rate in the survey was 17% resulting in a sample of 1200 equally split across the six survey splits. The completion rate was 77%. No significant pattern was found in the difference in household income, age and

⁸ In this case β_1 will capture the marginal utility of a risk reduction aside from the constant utility component. When the alternative specific constant is set to zero, β_{1_1} will subsume the two effects. Hence if α_{status_quo} is found to be negative and significant, β_{1_1} will be higher in the restricted model (than in the unrestricted model) implying a higher estimate of marginal WTP for a risk reduction.

⁹ The Nielsen Company is a global marketing research firm formerly known as ACNielsen.

gender across the six survey arms. Our sample was representative of the adult general Danish population with respect to age and gender (but not household size, income and education).

All coefficients in the regression models (the restricted as well as the unrestricted) are significant at $p < 0.01$ and with the expected signs (positive for risk reduction, negative for price, and negative for the status quo). The error component coefficient is significant in all models indicating, as expected, a higher unobserved variability in the choice of intervention treatments relative to status quo (regression results are available from authors on request).

Marginal WTP for a 1/100,000 risk reduction for each survey split (A-F) are presented in Table 4. The marginal rate of substitutions are estimated with and without the alternative specific constant fixed at zero.

Table 4 about here

Given that the average household size in our sample is 2.3 our results correspond to VSL estimates of restricted model/unrestricted model (in millions DKK) 42.1/38.6 (split A), 56.8/54.0 (split B), 20.2/13.5 (split C), 33.8/30.0 (split D), 27.3/25.8 (split E) and 43.3/40.8 (split F).

Table 5 about here

When testing for the prevalence of pure altruism (H1: A versus B) we find that respondents express a markedly lower valuation in A than in B (restricted and unrestricted model: $p < 0.001$) implying that split A is affected by a high degree of negative pure altruism, and/or wealth-

focused altruism. When testing respondents' perception of other individuals' valuations using the predicted valuation (H2: A vs C) results show that $MWTP_A > MWTP_C$ (restricted and unrestricted model: $p < 0.001$), suggesting that respondents perceive other individuals' valuations of traffic safety to be markedly lower than their own. See test results in Table 5.

Furthermore, we find that the private valuation (D) is higher than the public valuation (E), although the difference is only statistically significant for one of the two models (restricted model: $p = 0.012$; unrestricted model $p = 0.364$). This result is in accordance with other results in the literature i.e. that public valuations are less than or equal to private valuations. When testing for the impact of the type of public intervention (mandatory safety equipment (F) versus public initiative (A)) there is no difference in valuations (restricted model $p = 0.950$; unrestricted model $p = 0.937$). This suggests that the private and public interventions in the present study have been described in a manner that does not generate different degrees of affect, implying that our result (split D versus E) is not caused by the difference in interventions.

5. Discussion

Overall the valuations elicited in the present study appear robust. In all splits (A to F) respondents exhibit sensitivity to scope. Moreover, the level of VSL estimates are all within the interval observed more recently in the literature (Lindhjelm et al., 2011). A review of empirical Swedish VSL estimates (based on revealed and stated preferences) found a large spread in VSL estimates from 9 to 1121 million SEK (10-1300 million DKK) (Hultkrantz & Svensson, 2012). Since Sweden is a country, which in many ways is similar to Denmark, we focus on Swedish SP estimates and use the additional quality inclusion criteria applied in both

Lindhjelm et al., 2011 and Hultkrantz & Svensson, 2012¹⁰. Following this, the spread then reduces to an interval between 13 to 98 million SEK (15-114 million DKK), and the variation in the Swedish VSL estimates still encompasses the range of estimates found in the present study (14-57 million DKK).

Our study replicated what has been observed in the literature: that the public valuation of increased safety does not exceed private valuation. These results may be explained by the presence of either negative pure altruism or wealth-focused altruism under coercive taxation. When potential pure altruism is excluded (in split B), a significantly higher VSL estimate is produced (56.8 million). This value is markedly higher than for the standard public valuation (A), which implies that coercive tax markedly affects elicited valuations. At the same time we observe that split C generates low VSL estimates, implying that respondents perceive other individuals' valuations of risk reductions to be low. This finding suggests that one underlying motive for suppressing WTP in split A is a consideration for others' preferences, and that the difference in VSL across splits A and B to a significant degree is driven by negative pure altruism. The difference may, however, also to some extent be driven by wealth-focused altruism, since split A allows respondents to influence the level of coercive tax payment, whereas this is not possible in split B.

That the predicted approach generates very low values, suggests that respondents wrongfully perceive that other citizens are less willing to pay for risk reductions - a result, which is in line with the literature (Johansson-Stenman and Martinsson, 2006; Carlsson et al., 2010a). Valuations of mortality risk reductions seem to be affected by negative pure altruism, which

¹⁰ The inclusion criteria applied were 1; a sample size of at least 200, 2; an explicit risk reduction and 3; representative population.

may be generated by the mistaken perception that other individuals do not value safety initiatives as highly as one-self.

Importantly, our study highlights the fact that the tax structure is fundamental to the elicitation of public valuations. Negative pure altruistic preferences may be included in valuations where payment for the public intervention is presented – or interpreted - as a coercive tax. This may explain why the literature has found private evaluations to be consistently higher than public valuations.

A coercive tax is arguably a more realistic scenario than a tax payment determined individually (according to one's own WTP) as in the original model proposed by Jones-Lee, (1991;1992) and Johansson, (1994). Hence, in stated preference tasks where respondents are faced with a hypothetical tax payment, the interpretation will most likely be that the real life payment vehicle will be coercive tax, and this – as we have shown in our theoretical model – will affect the preferences.

That we find evidence of pure altruism, and more specifically negative pure altruism, in stated preference tasks, is supported by a laboratory experiment conducted by Messer et al., 2013, which provides strong evidence of pure altruism in coercive settings involving public risks. In fact, Messer et al., (2013) find that individuals with the most to gain from a risk-reducing policy tend to shade their WTP downward: that is, in a public setting they express a maximum WTP that is significantly lower than for an equal reduction in private risk. This is in perfect accordance with our observation, that respondents express lower WTP when facing coercive payments and at the same time perceive their own valuations of the safety program to be higher than other citizens'. Respondents appear to be *lowering* their WTP to ensure that they are not

forcing other individuals to pay at a level that corresponds to their own – higher - valuations. Our research and the research of Messer et al., (2013) lends support to the Johannesson et al., (1996) conjecture that pure altruists consider the cost of a programme that might be imposed on others, when they express their preferences for public safety programmes.

6. Conclusion

We conducted a stated preference survey using identical discrete choice experiments with varying frames. We found that using a scenario which sought to eliminate potential pure altruism generated higher marginal valuations of safety. The prevalence of negative pure altruism was supported by the observation that respondents perceived other individuals' valuation to be lower than their own. Our results suggest that public valuations of mortality risk reductions (using coercive taxation as a payment vehicle) may underestimate the true societal value of such interventions because respondents are considering other individuals' welfare, and wrongfully perceive others' valuations to be low, in which case public valuation will be biased.

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TABLES

Table 1. Attributes and levels used in the discrete choice experiment

Attributes	Attribute descriptions ¹	Levels
Benefits	Annual risk reduction	1/100,000
		2/100,000
		3/100,000
	Number of fatalities avoided annually	60
		120
		180
Costs	To be paid every year for a decade	100
		500
		1200
		2000
		5000

¹ Annually over a decade

Table 2. Overview of survey splits for hypotheses testing (I)

	Split A Public (base)	Split B No pure	Split C Others
Perspective	Public preferences	Public preferences (safety-focused altruism only)	Predicted valuation
Initiative	Public interventions ¹	Public interventions ¹	Public interventions ¹
Frame	WTP per household	WTP per household	WTP per household (prediction)
Benefit	Risk reduction all citizens + lives saved	Risk reduction all citizens + lives saved	Risk reduction all citizens + lives saved
Payment vehicle ²	Tax	Tax (Others pay according to their WTP)	Tax

1. Initiatives such as more street lightening in mornings and evenings, better marking of pedestrian walkways and road lanes, better signage and initiatives to decrease the number of bicycle accidents caused by a lorry turning right when bicyclists are driving straight ahead.

2. Paid annually over a decade

Table 3. Overview of survey splits for validation (II)

	Split D ¹ Private (equip)	Split E Public (risk)	Split F Public (equip)
Perspective	Private preferences	Public Preferences	Public Preferences
Initiative	Safety Equipment ²	Public Interventions ³	Mandatory safety equipment ²
Frame	WTP per household	WTP per household	WTP per household
Benefit	Risk reduction household	Risk reduction all citizens	Risk reduction all citizens + lives saved
Payment vehicle ⁴	Rent (of equipment)	Tax	Tax

1. Inclusion criteria: respondents who have access to a car.

2. Safety equipment such as a new type of airbags, special safety belts, better bodywork etc.

3. Initiatives such as more street lightening in mornings and evenings, better marking of pedestrian walkways and road lanes, better signage and initiatives to decrease the number of bicycle accidents caused by a lorry turning right when bicyclists are driving straight ahead.

4. Paid annually over a decade.

Table 4. Marginal WTP values (reported in DKK).

	Annual WTP [95%CI] per 1/100,000 risk reduction	
	Restricted model ¹	Unrestricted model ²
A. Public (base)	968.8 [823.9; 1113.6]	886.8 [735.0; 1038.6]
B. No pure	1307.1 [1146.6; 1467.7]	1241.1 [1076.4; 1405.6]
C. Others	465.5 [339.0; 592.0]	309.3 [245.0; 390.4]
D. Private (equip)	777.6 [638.9; 916.3]	689.5 [544.1; 834.9]
E. Public (risk)	626.8 [500.7; 752.9]	594.4 [463.9; 725.1]
F. Public (equip)	997.0 [830.8; 1163.3]	920.0 [746.1; 1094.0]

1. Model with constant = 0

2. Model with constant \neq 0

Table 5. Test results for differences in WTP (in DKK) across study arms

	Restricted model		Unrestricted model	
	Δ WTP	P-value ¹	Δ WTP	P-value ¹
H1: $MWTP_{\text{Public (A)}} - MWTP_{\text{No pure (B)}}$	-338.3	<0.001	-354.3	<0.001
H2: $MWTP_{\text{Public (A)}} - MWTP_{\text{Others (C)}}$	503.3	<0.001	577.5	<0.001

1. Probability that H_0 true

Appendix

A1. Text common to all survey splits (translated by the authors)

In recent years, around 240 Danes have died in the traffic every year. There is approximately 5.5 million people living in Denmark. This means that every year 4 individuals out of 100,000 people in Denmark will die in a traffic accident.

As a comparison, you can think about the population in Aalborg which is around 100,000. It is therefore the same as saying that every year, 4 people in Aalborg would die as a result of a traffic accident. 100.000 is also twice the population in Roskilde or Vejle. Or twice the number of seats in Parken, Copenhagen.

A2. Survey split A (public base).

Imagine that the government is considering implementing one of two potential interventions. Both will reduce the risk of dying in a traffic accident for you, your family and others over the next decade. The intervention could be one of the following;

- more street lightening in mornings and evenings
- initiatives to decrease the number of bicycle accidents caused by a lorry turning right when bicyclists are driving straight ahead
- better marking of pedestrian walkways and road lanes
- better signage

In the following 10 questions, you will be presented with a choice between two different initiatives which will deliver different reductions in the number of fatalities at different prices. The interventions will for an extra tax payment per household reduce the risk of dying in the traffic. The risk of a traffic accident with non-fatal outcomes will not be reduced by the interventions. We will ask you to choose which of the initiatives you would prefer the government to implement. You can also choose to indicate that the government shouldn't implement any initiatives.

Remember that the risk of dying in a traffic accident as you are presented for in this survey is only one form of risk you face in life. Therefore, we will also ask you to think about how important you think it is to reduce exactly this risk and how much you would be willing to pay out of your household's annual budget over the next decade.

Which initiative do you choose?

Initiative 1

60 traffic fatalities avoided each year

The corresponding yearly risk reduction is **1 in a 100,000** for all citizen

Extra tax payment per household is **100 DKK** a year

Initiative 2

180 traffic fatalities avoided each year

The corresponding yearly risk reduction is **3 in a 100,000** for all citizen

Extra tax payment **per household** is **500 DKK** a year

- Initiative 1
- Initiative 2
- None

A3. Survey split D (private equipment).

Imagine that you can choose to rent one of two potential safety equipment for a decade. The equipment could be used by you and your household and would – against rent payment - reduce the risk of dying in a traffic accident for you and your household. The initiative could be one of the following;

- safety equipment such as a new type of airbags, special safety belts
- better bodywork

In the following 10 questions, you will be presented for a choice between two different equipment which will deliver different reductions in the number of fatalities at different prices. Renting the equipment will thereby reduce the risk of dying in a traffic accident for your household. The risk of a traffic accident with non-fatal outcomes will not be reduced by the equipment. We will ask you to choose which of the equipment you would prefer to rent. You can also choose not to rent any equipment.

Remember that the risk of dying in a traffic accident as you are presented for in this survey is only one form of risk you face in life. Therefore, we will also ask you to think about how important you think it is to reduce exactly this risk and how much you would be willing to pay in rent out of your household's annual budget over the next decade

Which equipment do you choose?

Equipment 1

The gain in yearly risk reduction is **1 in a 100,000** for all household members

Your household's rent is **100 DKK** a year

Equipment 2

The gain in yearly risk reduction is **3 in a 100,000** for all household members

Your household's rent is **500 DKK** a year

- Equipment 1
- Equipment 2
- None