Are Some Lives More Valuable?

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Abstract

A theoretical model of the ethical preferences of individuals is tested by conducting a choice experiment on safety-enhancing road investments. The relative value of a saved life is found to decrease with age, such that the present value of a saved year of life is almost independent of age at a pure rate of time preference of a few percent, and a saved car driver is valued 17-31% lower than a pedestrian of the same age. Moreover, individuals' ethical preferences seem to be fairly homogenous.

JEL classification: D63, I18, J17

Key words: Ethics, social preferences, individual social welfare function, relative value of life, random ethical model

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1. Introduction

As a general principle, most people probably agree that all human lives have the same value. However, the meaning of this for implementation in real life decisions is less clear. Does it mean that the same amount of resources should be spent on saving the life of an elderly person as on saving the life of a child, or does it mean that the same amount should be spent per expected saved year of life, or does it mean something else, where possible corrections for responsibility, time preferences and/or the quality of life should be considered? At present, most uses of values of statistical lives in public decision-making assume a constant value for all lives saved.

There is by now a large theoretical literature on these issues in economics as well as in philosophy (for overviews see e.g. Broome 1999, Hausman and McPherson, 1996, and Williams and Cookson, 2000), but these studies rarely suggest quantifications that can be applied by policy-makers. Results from surveys on health care priorities suggest that children should be given higher priority, while people responsible for their own bad health, such as smokers and users of illicit drugs, should be given lower priority (e.g. Anand and Wailoo, 2000, Cookson and Dolan, 2000). Similarly, on choices between life-saving programmes, people prefer to reduce involuntary risks (e.g. Slovic et al., 1985, and Mendeloff and Kaplan, 1989) and risks that are difficult to avoid (e.g. Subramanian and Cropper, 1999). To our knowledge, the only studies quantifying attitudes towards saving lives at different ages are Cropper et al. (1994), and Johannesson and Johansson (1997a). In both these seminal studies, the respondents were asked to choose between different projects, targeting certain (unspecified) accidents and diseases that result in different numbers of saved people of different ages. Both studies found that the value of life decreases sharply by age.

In our survey we let people choose between different life-saving road-investment projects, which reduce the number of fatalities in specified age groups separated between car drivers and pedestrians. The latter distinction is introduced to test if responsibility and/or volition may matter. We concentrate on fatal accidents only, and thus ignore injuries. In order to obtain what we call a random ethical model (REM), we link the notion of ethical preferences, underlying individual social welfare functions (ISWFs) (e.g. Arrow 1963, Harsanyi 1955), with random utility theory (McFadden 1974) as applied in choice experiments when eliciting individuals' preferences. In a choice experiment respondents are asked to choose one of several alternatives, where each of the alternatives is described by several attributes and where each respondent makes repeated choices; see e.g. Louviere et al. (2000). In our case, the respondents are assumed to act as social planners who maximize their own ISWF when making repeated choices between pairs of road investment projects with different outcomes. This allows the *relative* values of saved lives at different ages, and between different types of road users to be calculated. Section 2 outlines the theoretical and empirical models based on REM, Section 3 presents the choice experiment followed by the econometric results in Section 4, while Section 5 concludes.

2. The Random Ethical Model

The theoretical model

REM is based on the assumption that each individual has consequentialist ethical (or social) preferences over different states of the world described by ISWFs, where the outcome of the individual herself is held fixed. A natural benchmark case, to which the empirical findings can be compared, is a discounted utilitarian ISWF based on the current population[1]

$$W_i = \int_0^{\tau_{\max}} \int_0^{T(\tilde{\tau},t)-\tau} \int_{y_{\min}(\tilde{t},\tilde{\tau})}^{y_{\max}(\tilde{t},\tilde{\tau})} \int_{\Psi_{\min}(\tilde{y},\tilde{t},\tilde{\tau})}^{\Psi_{\max}(\tilde{y},\tilde{t},\tilde{\tau})} s\big(u(\tilde{\tau}+\tilde{t},\tilde{y}),\tilde{\Psi}\big) f(\tilde{y},\tilde{\tau},\tilde{t},\tilde{\Psi}) e^{-\delta\tilde{t}} d\tilde{\Psi} d\tilde{y} d\tilde{t} d\tilde{\tau} \,, \qquad (1)$$

where $f(\tilde{y},\tilde{\tau},\tilde{t},\tilde{\Psi})$ is the population size of people with income *y*, age τ, personal characteristics given by the vector Ψ, at calendar time *t* (from now). $T(\tau,t)-\tau$ is the expected remaining life time for people at age τ in time *t*, $u(\tau+t,y)$ is the utility, measuring individual well-being, for an individual who is $\tau+t$ years at time *t* with income *y*, and δ is the (constant) utility discount rate. The social-preference function *s* can hence at this stage be interpreted quite broadly to include anything an individual considers to be of moral significance, and does not need to be limited to individual well-being *u* (cf. Hammond, 2002). In order to estimate the relative value of saving the life of a person belonging to group *j*, compared to a person belonging to group *k*, we can calculate the corresponding ethical marginal rate of substitution (*EMRS*) from equation (1) such as

$$EMRS_i^{jk} = \frac{dW_i / df(y^j,\tau^j,\Psi^j)}{dW_i / df(y^k,\tau^k,\Psi^k)} = \frac{\int_0^{T(\tau^j,t)-\tau^j} s(u(\tau^j+t,y^j),\psi^j) e^{-\delta t} dt}{\int_0^{T(\tau^k,t)-\tau^k} s(u(\tau^k+t,y^k),\Psi^k) e^{-\delta t} dt} \,. \qquad (2)$$

The relative value in equation (2) equals the ratio between the present values of the expected remaining value of the sub-social-preference function *s*. Given that people's social preferences are welfaristic, i.e. they depend solely on utility information (Sen 1979), we can simplify equation (2) to

[1] It is of course implicit in this formulation that individuals can make interpersonal comparisons of utility, corresponding to what Sen (1970) denoted a social welfare *functional*.

$$EMRS_i^{jk} = \frac{dW_i / df(y^j, \tau^j, \Psi^j)}{dW_i / df(y^k, \tau^k, \Psi^k)} = \frac{\int_0^{T(\tau^j, t) - \tau^j} u(\tau^j + t, y^j) e^{-\delta t} dt}{\int_0^{T(\tau^k, t) - \tau^k} u(\tau^k + t, y^k) e^{-\delta t} dt}, \quad (3)$$

which is equal to the ratio of the present values of the expected remaining utilities. However, one can question whether people will value saving a rich person more than a poor person,[2] or take into account the fact that the expected lifetime increases with more recent born generations. If they do not, equation (3) can be simplified as follows

$$EMRS_i^{jk} = \frac{\int_0^{T(\tau^j) - \tau^j} u(\tau^j + t) e^{-\delta t} dt}{\int_0^{T(\tau^k) - \tau^k} u(\tau^k + t) e^{-\delta t} dt}. \quad (4)$$

Moreover, many economists as well as philosophers have argued against using a positive utility discount rate (pure rate of time preference), such as Ramsey (1928) and Harrod (1948). It is also possible that some individuals find it ethically dubious to correct for a varying quality of life (utility) as a function of age. We can then simplify equation (3) further and re-write the relative value of life as

$$EMRS_i^{jk} = \frac{T(\tau^j) - \tau^j}{T(\tau^k) - \tau^k}, \quad (5)$$

i.e. as the ratio between the expected remaining lifetimes.

The empirical model

To test whether eqs (1-5) constitute good descriptions of the respondents' social preferences, we start with a general ISWF as follow

$$W_i = w_i\left(S^1, ..., S^n, \Omega\right), \quad (6)$$

[2] In addition, some researcher (e.g. Easterlin 1995) find that happiness appears to depend only on relative income. Johansson-Stenman et al. (2002) and Solnick and Hemenway (1996), on the other hand, find that both absolute and relative income matter.

where S^k is the number of people alive in group *k* (characterized by their personal characteristics including age), and where Ω is a vector describing other aspects of the state of the world. We can then write the ISWF as a function of changes in the number of people alive in each group. As long as the changes are small, it follows that

$$W_i = \hat{W}_i + \frac{\partial w_i}{\partial S^1} s^1 + ... + \frac{\partial w_i}{\partial S^n} s^n \equiv \hat{W}_i + b_i^1 s^1 + ... + b_i^n s^n \tag{7}$$

where $\hat{W}_i$ is social welfare at status quo, b_i is a vector of coefficients and s^j is the saved number of people in group *j*. We assume, perfectly analogous to the random utility approach, that the true ISWF is not perfectly observable and thus that the ISWF consists of a systematic observable part and a stochastic non-observable part. Furthermore, let us assume that the heterogeneity of preferences between respondents can be expressed by interaction terms between the respondent's observable personal characteristics, x_i, and the characteristics of the saved individuals. This together with an error term ϕ_i reflecting unobservable characteristics and noise (e.g. due to cognitive limitations), imply that we can re-write equation (7) as

$$W_i = \hat{W}_i + b^1 s^1 + ... + b^n s^n + \sum_{j=1}^{n} c^j x_i s^j + \phi_i, \tag{8}$$

where c is a vector of the coefficients to be estimated. An ISWF-maximizing respondent *i* would then prefer project *A* over project B if $W_i(A) > W_i(B)$. Based on the observable information we can then model the *probability* that *A* is chosen as follows

$$\Pr(A \text{ is chosen}) = \Pr(W_i(A) > W_i(B)) = \Pr\left(b^1 \Delta s^1 + ... + b^n \Delta s^n + \sum_{j=1}^{n} c^j x_i \Delta s^j > \varepsilon_i\right) \tag{9}$$

where $\Delta s^k = s^k(A) - s^k(B)$ and $\varepsilon_i = \phi_i(A) - \phi_i(B)$. Given that ε_i is standard normal, equation (9) can be estimated by a standard Probit regression (without an intercept since the constant $\hat{W}_i$ cancels out). The estimated relative value of saving a life belonging to group *j* compared to group *k* for an individual *i* is than given by

$$EMRS_i^{jk} = \frac{b^j + c^j x_i}{b^k + c^k x_i}, \qquad (10)$$

which can be compared to the different theoretical predictions from equations (2)-(5).

3. The choice experiment

Designing a choice experiment necessarily includes the identification of attributes, i.e. the factors that will be affected by the project. In our case these include the number of saved individuals and the personal characteristics of the saved individuals. Suitable levels must then be assigned to each of the attributes. Moreover, we must combine these attribute levels into projects and choice sets, and create a credible scenario that in a short and understandable way describes the task that the respondents are required to do. The questionnaire was first pre-tested in focus groups, and then tested in a pilot study on a small random sample of Swedes. These revealed that, in addition to the number of individuals saved, the age of the saved individuals and the type of road user were considered important in the choices between projects, as opposed to other personal characteristics such as income, gender and social class. To explain how a certain road investment can target a specific group of recipients, we used an example of building a pedestrian bridge near a school where the road investment would primarily save children. We also stated that it is possible, based on accident and population statistics, to express the effects of different investments in terms of the number of individuals saved by age, and whether the saved road-users are drivers or pedestrians.

The respondents were asked to choose the road investment project that they would prefer from a choice of two projects in seven different pair-wise choices. To reduce the potential problems of learning and order effects, the respondents were encouraged to go back and change earlier choices. The exact wording of the scenario is presented in the Appendix. Each project was described by the number of saved individuals, which could take any integer number from 1 to 10, the age group that the recipients belongs to, where the levels are either 5-15, 25-35, 45-55 or 65-75 years[3], and finally whether the recipients were car drivers or pedestrians, where the youngest age group of course only consists of pedestrians. In order to reduce the number of combinations to a manageable level, we followed the optimal design approach by Zwerina et al. (1996) and generated nine different combinations of seven choice sets. Individuals were randomly assigned to one of the nine versions depending on postal code, ensuring geographic spread of the choice sets. The survey was mailed to 2500 randomly selected individuals aged 18-65 in Sweden, during Spring 2001; the response rate was 62%. After omitting those who did not complete the choice experiment, and non-responses on other variables used, the number of respondents included in the analysis was 1382, i.e. 55% of the total selected sample.

4. Econometric analysis

The econometric model presented in equation (9) includes both the difference between the attribute levels in a choice set, Δs^k, as well as this difference interacted with the personal characteristics of the respondents, $x_i \Delta s^j$, in order to allow for heterogeneity. We consider the following personal characteristics of the respondents: gender, family status (married or not, having children or not), level of education

[3] We chose to present saved lives in groups spanning a range of ages rather than of a specific age, in order to make it more realistic.

(university degree, A-level degree and lower education), area of residence (living in a big city, a medium sized town, a small town or living in the countryside), age groups (18-39, 40-56, and 57-65 years), and finally the driving distance (> 35000 km/year or not). We begin by estimating a model without interaction terms, presented in Table 1, columns 2-4. The estimated coefficients are all positive, as expected[4], and decrease with age indicating that the value of a saved life decreases as the age of the saved person increases; similarly, saved pedestrians are consistently valued higher than saved drivers.

>>> Table 1

To decide which interaction terms to include in the final analysis in order to control for heterogeneity we start with a model without interaction terms. Then we include each interaction term separately and run the regression. The interaction term with the highest likelihood function is added to the model. This procedure is repeated until none of the remaining interaction terms are significant at the 5% level. The final model from the forward stepwise procedure is shown in Table 1, column 4-7.

Table 2 presents the estimated relative value of life figures, compared to a 70 year old driver for the whole sample and for some of the significant personal characteristics of respondents as identified from the forward selection procedure. By using bootstrap technique, we generate the confidence interval for these relative values of life by using the percentile method based on 2500 bootstraps.[5] The obtained

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[4] As can be seen from equation (9), if the number of individuals saved in project A increases (or decreases in project B) then the probability of choosing project A increases if the coefficients are positive.

[5] From the bootstrapped distribution, we calculate the 95 percent confidence interval by setting the lower bound at the number ranked at the 2.5^{th} percentile and the upper bound at the number ranked at the 97.5^{th} percentile of the distribution.

EMRS confirms the importance of age and type of road user as already presented in Table 1.

Moreover, we find that older respondents do value older saved lives higher than younger respondents do, contrary to the findings by Cropper et al. (1994) and Johannesson and Johansson (1997a), but the differences are still relatively minor. For example, respondents over 57 years old value the saved life of a 30 year old pedestrian 2.88 times more than the saved life of a 70 year old driver, whereas the same ratio for respondents younger than 57 years old is 2.22, and the effect is opposite for saving 10 year old pedestrians. Furthermore, we find that respondents with children (<18 years) tend to value the saved lives of a 10 year old pedestrian significantly higher at a ratio of 5.60 times the value of the saved life of a 70 year old driver. Otherwise there are rather small differences between the sub-samples identified by the forward selection process.

>>> Table 2

Moreover, it is also shown that all sub-samples consistently give a lower value to car drivers when compared with pedestrians (17-31%) in Table 3. Additionally, using separate bootstrap simulations for these ratios we find that the differences are significantly different from zero at the 5% level, which seems to reject the hypothesis of consequentialist ethical preferences.

>>>Table 3

The results obtained can also be interpreted in terms of relative value per expected remaining life-*year*. Table 4 shows that the implied value per remaining life-year decreases as age increases. This also holds when we correct for varying quality of life by using quality-adjusted life years (QALYs) based on the results from a Swedish survey (Brooks et al., 1991).[6] This is in sharp contrast to Cropper et al. (1994) and Johannesson and Johansson (1997a), where the latter found that saving 41 70-year old individuals is equivalent to saving 1 30-year old individual,[7] implying that the value per life *year*, quality adjusted or not, decreases sharply as age increases.

The chosen Survey methodology may offer a possible explanation for the differences between our results, and those of Cropper et al (1994) and Johannesson and Johansson (1997a), since we used a choice experiment in which the respondent was asked to make seven pair-wise choices, whereas both the other studies asked just one closed-ended question. Kahneman et al. (1999) argue that the choices made under some circumstances may indicate attitudes or value expressions rather than actual tradeoffs between the projects presented. For example, if respondents strongly believe that younger individuals should be given higher priority, the opportunity to express this view in the survey should be provided. If respondents are only asked one question, for example whether one should save 10 70-year old individuals or 1 30 year old individual, they may choose the latter even if their "true" ISWF corresponds to a lower ratio. A related issue is that a single-question approach is typically more

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[6] Several approaches have been suggested in order to measure the utility for a health state and most frequently applied is QALYs, which measures health status in terms of equivalents of well life years (e.g. Sloan, 1996).

[7] In an accompanying study Johannesson and Johansson (1997b) found a very low willingness to pay (less than 1500 USD) for an extra life-year at an advanced age.

sensitive to the tradeoffs included in the experiment (compare the literature on the design of contingent valuation in e.g. Alberini, 1995). Rather general descriptions of "life-saving projects" may also have induced some respondents to assume different diseases (and associated suffering) for different age groups; for example, a person dying at the age of 30 may be interpreted to have cancer, while at the age of 70 the death may be imagined to have a natural cause.

>>> Table 4

From Table 4 it follows that we can reject the undiscounted utilitarian model corresponding to equation (5). The implicit discount rate to keep the present value per saved year of life constant is lowest for the children, which may be interpreted as an additional value due to their perceived lower responsibility and ability to protect themselves. The highest discount rate is amongst those aged around 30, which may similarly indicate a higher responsibility, since it is well known that young drivers are over-represented in the accident and speeding statistics; at the same time they have better physical possibilities to protect themselves and recover from accidents than other age groups.

5. Conclusion

This study has applied an ethical preferences approach for analysing life-saving road investment projects using a random ethical model, a modification of the random utility model, which assumes that individuals maximize their subjective perception of social welfare, instead of utility. The main result is that the relative value of a saved life decreases with age in a pattern that is consistent with a discounted utilitarian model, with a pure rate of time preference of a few percent. However, contrary to what is implied by welfare-based ethical preferences, responsibility and/or vulnerability also seem to matter for the valuation.

However, even when disregarding scientific uncertainty, we do *not* propose that this result should necessarily be applied in actual policy. Indeed, many moral philosophers and politicians would disagree with the consequentialist ethics underlying the analysis. Still, we do believe that this type of information is vital for policy makers to be able to make enlightened decisions and to allocate resources efficiently in a variety of social decision making situations. And the need to do so is no less in areas where the importance of ethical values is obvious, and where our views are backed-up with strong feelings.

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Table 1. Parameter estimates of the choice experiment.

Variable	Coeff.	Std error	P-value	Coeff.	Std error	P-value
Main effects						
30 year old driver	0.171	0.009	0.000	0.165	0.010	0.000
50 year old driver	0.156	0.008	0.000	0.152	0.008	0.000
70 year old driver	0.068	0.007	0.000	0.055	0.008	0.000
10 year old pedestrian	0.324	0.012	0.000	0.378	0.016	0.000
30 year old pedestrian	0.207	0.010	0.000	0.204	0.010	0.000
50 year old pedestrian	0.176	0.010	0.000	0.172	0.011	0.000
70 year old pedestrian	0.099	0.010	0.000	0.076	0.014	0.000
Interaction effects (attribute × socio-economic characteristic of the respondent)						
30 year old driver× Lives in medium-sized town				0.052	0.018	0.005
50 year old driver× Age above 57				0.045	0.019	0.016
70 year old driver× Lives in big town				0.026	0.013	0.046
70 year old driver× Lives in medium-sized town				0.040	0.015	0.007
10 year old pedestrian× Age above 57 years				-0.029	0.018	0.101
10 year old pedestrian× No Child in the household				-0.077	0.015	0.000
10 year old pedestrian× Drives more 35000km/year				0.042	0.017	0.010
30 year old pedestrian× Lives in big town				0.034	0.013	0.009
50 year old pedestrian× Age above 57				0.054	0.019	0.006
70 year old pedestrian× No Child in the household				0.042	0.015	0.006

Table 2. Ethical marginal rate of substitution (EMRS) in the total sample and in sub-samples. 70-year old drivers constitute the base case; 95% confidence interval in parenthesis.

	All	Above 57	Below 57	No child	Child	City	Not city
30 year old	2.54	2.58	2.58	2.58	2.58	1.98	2.78
driver	(2.17; 3.03)	(2.19; 3.12)	(2.19; 3.12)	(2.19; 3.12)	(2.19; 3.12)	(1.55; 2.58)	(2.28; 3.52)
50 year old	2.31	2.88	2.22	2.33	2.33	1.79	2.50
driver	1.94; 2.80)	(2.27; 3.12)	(1.84; 2.75)	(1.94; 2.87)	(1.94; 2.87)	(1.40; 2.58)	(2.03; 3.19)
10 year old	4.81	4.60	5.01	4.49	5.60	3.81	5.33
pedestrian	(4.10; 5.74)	(3.81; 5.75)	(4.23; 6.11)	(3.78; 5.46)	(4.70; 6.87)	(2.99; 4.94)	(4.38; 6.73)
30 year old	3.08	3.11	3.11	3.11	3.11	2.68	3.21
pedestrian	(2.60; 3.69)	(2.62; 3.77)	(2.62; 3.78)	(2.62; 3.77)	(2.62; 3.77)	(2.10; 3.48)	(2.62; 4.07)
50 year old	2.62	3.30	2.51	2.64	2.64	2.03	2.84
pedestrian	(2.23; 3.12)	(2.62; 4.14)	(2.10; 3.03)	(2.24; 3.22)	(2.23; 3.22)	(1.59; 2.63)	(2.33; 3.58)
70 year old	1.47	1.46	1.46	1.72	1.10	1.13	1.58
pedestrian	(1.17; 1.79)	(1.16; 1.81)	(1.16; 1.81)	(1.35; 2.15)	(0.74; 1.49)	(0.84; 1.50)	(1.23; 2.02)

Note. In the calculation of EMRS we use the mean of the other covariates and only vary the covariate under consideration, e.g. whether or not the respondents are over 57 years of age.

Table 3. Ethical marginal rate of substitution (EMRS) between pedestrians and car drivers. 95% confidence interval in parenthesis.

Pedestrians/car drivers ratio	All
30 year old	0.83 (0.75; 0.91)
50 year old	0.88 (0.79; 0.98)
70 year old	0.69 (0.60; 0.85)

Table 4. Relative value per remaining life-year and QALY, respectively, and the implicit real annual discount rates that would correspond to constant relative values per remaining year of life. Based on the results for pedestrians.

Age	Expected remaining years of life	Relative value per remaining years of life	Implicit discount rate for constant relative value	Expected remaining QALYs	Relative value per remaining QALY	Implicit discount rate for constant relative value
10	72.3	0.66	1.7%	61.8	0.60	2.3%
30	52.4	0.58	3.6%	43.4	0.55	4.5%
50	32.9	0.79	3.2 %	27.7	0.73	3.8%
70	14.5	1		11.4	1	

Source: QALYs used in the calculations are from Brooks et al. (1991), and values on expected remaining years of life were obtained from SCB (2000).