Willingness to Pay for Insurance in Denmark

by

Jan V. Hansen, Rasmus H. Jacobsen and Morten I. Lau [†]

June 2012

Abstract. We estimate the maximum amount that Danish households are willing to pay for three different types of insurance: auto, home and house insurance. We use a unique combination of claims data from the largest private insurance company in Denmark, measures of individual risk attitudes and discount rates from a field experiment with a representative sample of the adult Danish population, and information on household income and wealth from registers at Statistics Denmark. We assume that households maximize expected inter-temporal utility subject to an inter-temporal budget constraint with several possible states of nature, where all uncertainty is realized in the initial period and any loss incurred by an accident is subtracted from initial wealth. The estimated willingness to pay is based on annual claims and should thus be considered as an annual premium. Since there is some uncertainty about the estimates of risk attitudes and discount rates, there is some uncertainty about the estimated willingness to pay. We use a randomized factorial design in our sensitivity analysis where each simulation involves a random draw from independent normal distributions of the estimated risk and time preferences. The results show that the willingness to pay is marginally higher than the actuarial fair value under Expected Utility Theory. However, the estimated willingness to pay is significantly higher under Rank-Dependent Utility Theory, and for some households it may be up to 600% higher than the actuarial value of the insurance claims.

[†] Danish Insurance Association (Hansen); Department of Economics, Copenhagen Business School, Denmark (Jacobsen and Lau); and Department of Accounting and Finance, Durham Business School, Durham University, United Kingdom (Lau). E-mail contacts: JVH.@FORSIKRINGOGPENSION.DK, RHJ.CEBR@CBS.DK, and M.I.LAU@DURHAM.AC.UK. We thank the Danish Social Science Research Council for research support under project #24-02-0124 and #275-08-0289, and the Danish Insurance Association and Tryg A/S for the provision of household data on insurance claims.

There is no simple way to measure the economic value of insurance products because the primary use of these products deals with the control of risk. Some studies attempt to estimate the willingness to pay for insurance products using contingent valuation or stated choice methods that are based on hypothetical questions, while other studies attempt to estimate risk preferences from data on insurance claims and deductible choices (Einav and Cohen [2007]).[1] Contingent valuation and stated choice methods are based on survey questions with no real purchase or consumption consequences for the participants. These methods may thus attract a "hypothetical bias," which measured as the divergence between the real and hypothetical willingness to pay. There is widespread evidence of participants in contingent valuation studies to overstate the amount they are willing to pay for an incremental unit of private goods (Cummings, Harrison and Rutstrom [1995]; List and Gallet [2001]; Murphy, Allen, Stevens and Weatherhead [2005], and Blumenschein et al. [2008].

We estimate the willingness to pay among Danish households for three types of insurance using a unique combination of claims data from the largest Danish insurance company, Tryg A/S, register based data from Statistics Denmark, and measures of individual risk attitudes and discount rates from a field experiment with a representative sample of the adult Danish population. These field experiments were carried out under the auspices of the Danish Ministry of Economic and Business Affairs, and the incentives in these experiments are comparable to the average claims on auto, home and house insurance products that we consider in this study.

The estimated willingness to pay for insurance is based on a decision problem in which the decision maker maximizes expected inter-temporal utility subject to an inter-temporal budget constraint. The model is calibrated to claims data in 2004 from the customer database at Tryg A/S, and this data is mapped to information at Statistics Denmark on annual household income and financial wealth. Since potential insurance claims may be substantial in comparison to annual income, and the probability of filing a claim is relatively small, it is appropriate to allow for consumption smoothing over a longer time period and thereby reduce the impact of an accident on consumption in the short term.

We use experimental data from a field methodology developed by Harrison, Lau, Rutström and Sullivan [2005] to elicit both risk and time preferences from the same respondents. The experimental procedures build on the risk aversion experiments of Holt and Laury [2002] and the

[1] See Harrison and Martinez-Correa [2012] for a systematic overview of the literature on behavioural insurance.

discount rate experiments of Coller and Williams [1999] and Harrison, Lau and Williams [2002]. Data is collected in the field in Denmark in June 2003, to obtain a sample that offers a wider range of individual socio-demographic characteristics than usually found in subject pools recruited in colleges, as well as a sample that can be used to make inferences about the preferences of the adult population of Denmark. These experiments are "artefactual field experiments" in the terminology of Harrison and List [2004], since lab experiments are essentially taken to field subjects. Economists recognize that preferences can differ across individuals, but only a few attempts have been made to elicit individual preferences for representative samples of a population in a particular geographical area, region or country.[2]

We discuss the elicitation of risk and time preferences in Section 1, and the estimation of these preferences in Section 2. The demand for insurance is discussed in Section 3, along with a presentation of the claims data in Section 4, and the estimated willingness to pay for auto, home and house insurance in Section 5. We consider the effects of alternative probability weighting functions on estimated WTP in Section 6, and conclude in Section 7.

1. Eliciting Risk and Time Preferences

Information on individual risk attitudes and discount rates is obtained from Harrison, Lau, Rutström and Sullivan [2005]. The sample for the field experiments was designed to generate a representative sample of the adult Danish population between 19 and 75 years of age. A total of 664 invitations were mailed out to a stratified sample of the adult population. Everyone who gave a positive response was assigned to a session, and the recruited sample was 268, corresponding to a response rate of 40%. The experiments were conducted in June 2003, and a final sample of 253 subjects provided data.

[2] Harrison, Lau and Williams [2002] elicit individual discount rates for a representative sample of the adult Danish population and find evidence of significant preference heterogeneity across socio-demographic variables. This is the first attempt to elicit individual preferences of a population in a country using controlled experiments with monetary rewards. Eckel, Johnson and Montmarquette [2005] conduct a field study of time and risk preferences. Their subjects are recruited from low income neighborhoods in Montreal, and they are given 64 "compensated" questions, one of which is chosen at random for payment. Dohmen et al. [2005] elicit individual risk attitudes and combine hypothetical surveys with experiments that involve monetary incentives. A total of 450 subjects participated in the experiment, and they were recruited from 179 randomly chosen voting districts in Germany. Andersen, Harrison, Lau and Rutström [2010] examine the strengths and weaknesses of laboratory and field experiments to detect differences in preferences over risk and time that are associated with standard, observable characteristics of the individual.

A. Risk Preferences: Measuring Risk Aversion

Harrison, Lau, Rutström and Sullivan [2005] used a multiple price list (MPL) design to elicit individual risk attitudes.[3] They use the same approach as in Holt and Laury [2002] and presented an ordered array of binary lottery choices to be made at once. The subject picked one of the two lotteries in each row of the MPL, played out the chosen lottery and received the reward. Each subject responded to four separate risk aversion tasks, each with different prizes designed so that all 16 prizes span an income interval from 50 kroner to 4500 kroner.[4] One task and one row were picked at random for payment, and each subject was given a 10% chance to actually receive the payment associated with his or her decision.[5]

We take each of the binary choices of the subject as the data, and estimate the parameters of a latent utility function that explains those choices using an appropriate error structure to account for the panel nature of the data. The data set consists of observations from 253 subjects, with 7,928 risk aversion choices.[6] Once the utility function is defined, for a candidate value of the parameters of that function, we can construct the expected utility of the two gambles, and then use a linking function to infer the likelihood of the observed choice.

B. Time Preferences: Measuring Individual Discount Rates

Individual discount rates (IDRs) were elicited by an experimental design that was introduced in Coller and Williams [1999] and expanded in Harrison, Lau and Williams [2002]. Each subjects in Harrison, Lau, Rutström and Sullivan [2005] was presented with 6 discount rate tasks with 6 different time horizons: 1 month, 4 months, 6 months, 12 months, 18 months, and 24 months. In each task subjects were provided two future income options rather than one "instant income" option

---

[3] Andersen, Harrison, Lau and Rutström [2006] examine the properties of the MPL procedure in detail, and the older literature using it. Harrison and Rutström [2008] evaluate the strengths and weaknesses of alternative elicitation procedures for risk attitudes.

[4] The four sets of prizes were as follows, with the two prizes for lottery A listed first and the two prizes for lottery B listed next: (A1: 2000 kroner, 1600 kroner; B1: 3850 kroner, 100 kroner), (A2: 2250 kroner, 1500 kroner; B2: 4000 kroner, 500 kroner), (A3: 2000 kroner, 1750 kroner; B3: 4000 kroner, 150 kroner), and (A4: 2500 kroner, 1000 kroner; B4: 4500 kroner, 50 kroner). At the time of the experiments, the exchange rate was approximately 6.55 kroner per U.S. dollar, so these prizes range from approximately $7.65 to $687.

[5] There is considerable behavioral evidence that rewarding subjects by selecting one task at random for payment does not distort choices, even though it does make the overall experiment a compound lottery. See Harrison, Lau and Rutström [2007; fn.16] for evidence on this issue for the risk aversion instrument we used here, and Harrison and Rutström [2008; §2.6] for similar evidence in comparable lottery choice tasks.

[6] Some subjects received a different number of choices than others. For example, 116 subjects received a "symmetric" risk aversion task involving 40 choices (hence there were 116×40 = 4,640 choices) and the remaining 137 subjects received an "asymmetric" risk aversion task involving 24 choices (hence there were 137×24 = 3,288 choices).

and one future income option. The early income option was 3,000 kroner and delayed by one month in all tasks. For example, they were offered 3,000 kroner in one month and 3,000 kroner + *x* kroner in 7 months, so that we interpret the revealed discount rate as applying to a time horizon of 6 months. This avoids the potential problem of the subject facing extra risk or transactions costs with the future income option, as compared to the "instant" income option.[7]

Each subject responded to all six discount rate tasks and one task and row were chosen at random for payment. Future payments to subjects were guaranteed by the Danish Ministry of Economic and Business Affairs, and made by automatic transfer from the Ministry's bank account to the subject's bank account. This payment procedure is similar to a post-dated check, and automatic transfers between bank accounts are a common procedure in Denmark. Finally, each subject was given a 10% chance to receive actual payment. Thus, each subject faced a 10% chance of receiving payment in the risk preference task as well as a 10% chance in the time preference task.

Our estimation strategy is the same as for the lottery task. We take each of the binary choices of the subject as data, and estimate the parameters with an error structure that recognizes the panel nature of the data. The data set consists of 15,180 discount rate choices.

2. Identifying Risk and Time Preferences

A. Estimation of Risk Attitudes

We begin with Expected Utility Theory (EUT) as a model for the choices over risky options and let the utility function be the constant relative risk aversion (CRRA) specification

$$U(M) = (\omega+M)^{(1-r)}/(1-r) \tag{1}$$

for $r\neq1$, where r is the CRRA coefficient and ω is background consumption. With this functional form, $r=0$ denotes risk neutral behavior, $r>0$ denotes risk aversion, and $r<0$ denotes risk loving behavior.[8]

---

[7] These transactions costs are discussed in Coller and Williams [1999], and they include simple things such as remembering to pick up the delayed payment as well as more complex things such as the credibility of the money actually being paid in the future. The payment protocol in the experiment was intended to make sure that the credibility of receiving the money in the future was high.

[8] There is evidence from the lab and field that subjects are risk averse over stakes ranging between pennies and several hundred dollars. Holt and Laury [2002][2005] produced the most widely cited evidence from the lab, and they show that subjects are moderately averse to risk. Harrison, Lau and Rutström [2007] find comparable results using data from the Danish field experiments that we also apply in our analysis. The literature offers some evidence of lower estimates of relative risk aversion when the stakes in the experimental task are reduced significantly, which may cause one to question our use of the restrictive CRRA function. However, Harrison, Lau and Rutström [2007] find that CRRA holds locally over the domain of stakes in the Danish experiments, and we therefore adopt this popular specification.

We can write out the likelihood function for the choices that the subjects made and estimate the risk parameter r.[9] Probabilities for each outcome M_j, $p_j(M_j)$, are those that are induced by the experimenter, so expected utility is simply the probability weighted utility of each outcome in each lottery. Since there were two outcomes in each lottery, the EU for lottery i is

$$EU_i = \sum_{j=1,J} [\ p_j(M_j) \times U(\omega+M_j)\ ]. \qquad (2)$$

Conditional on EUT and CRRA specifications being true the likelihood of the risk aversion responses depends on the estimates of r and the observed choices. We follow Andersen, Harrison, Lau and Rutström [2008a] and assume that income from the risk aversion and discount rate tasks is integrated with daily background consumption, which was equal to 118 kroner for the average Dane in 2003. We use this value of ω in our estimations.

Table 1 displays the results from maximum likelihood estimation of elicited risk attitudes. The results show that the average Dane is risk averse with a CRRA coefficient of 0.73 and a standard error of 0.045. This coefficient is significantly different from 0 and marginally higher than the estimate of 0.67 which is reported in Harrison, Lau and Rutström [2007] for the same data set but with background consumption ω=0.

We also report total effects of key demographic variables, i.e. we condition the CRRA coefficient on one demographic characteristic at a time. The coefficients from the maximum likelihood estimations are displayed in Table 1 and show some variation in risk attitudes across the demographic characteristics. Women are more risk averse than men. The CRRA coefficient is 0.76 for women and 0.69 for men, and the difference of 0.07 is statistically significant with a *p*-value of 0.016. We find some variation across age groups, but there is no general tendency for younger age groups to be more or less risk averse than older age groups. Finally, we do not observe significant differences in risk attitudes between singles and those who live with a spouse or partner.[10]

---

[9] The statistical specification allows for the possibility of correlation between responses by the same subject. The use of clustering to allow for "panel effects" from unobserved individual effects is common in the statistical survey literature. Clustering commonly arises in national field surveys from the fact that physically proximate households are often sampled to save time and money, but it can also arise from more homely sampling procedures. For example, Williams [2000; p.645] notes that it could arise from dental studies that "collect data on each tooth surface for each of several teeth from a set of patients" or "repeated measurements or recurrent events observed on the same person." The procedures for allowing for clustering allow heteroskedasticity between and within clusters, as well as autocorrelation within clusters. They are closely related to the "generalized estimating equations" approach to panel estimation in epidemiology (see Liang and Zeger [1986]), and generalize the "robust standard errors" approach popular in econometrics (see Rogers [1993]). Wooldridge [2003] reviews some issues in the use of clustering for panel effects, in particular noting that significant inferential problems may arise with small numbers of panels.

[10] Harrison, Lau and Rutstrom [2007] find evidence of sample selection into the experiment, and the mean estimate of relative risk aversion is reduced by this correction. However, the marginal effects of individual characteristics are similar

B. Rank-Dependent Utility Theory

One route of departure from EUT has been to allow preferences to depend on the rank of the final outcome through probability weighting. The idea that one could use non-linear transformations of the probabilities of a lottery when weighting outcomes, *instead* of non-linear transformations of the outcome into utility, was most sharply presented by Yaari [1987]. To illustrate the point, he assumed a linear utility function, in effect ruling out any risk aversion or risk seeking from the shape of the utility function. Instead, concave (convex) probability weighting functions imply risk seeking (risk aversion). It is possible for a decision maker to have a probability weighting function with both concave and convex components, and the conventional wisdom is that the function is concave for smaller probabilities and convex for larger probabilities.

Quiggin [1982] formally presented the general case of rank-dependent preferences for choice over lotteries in which one allowed for subjective probability weighting and non-linear utility functions. This model has become known as Rank-Dependent Utility (RDU). The Yaari [1987] model can be seen as an important special case, and can be called the Rank-Dependent Expected Value model.

Formally, to calculate decision weights under RDU one replaces expected utility in equation (2) with RDU

$$RDU_i = \sum_{j=1,J} [\, w_j \times u_j \,] \tag{3}$$

where

$$w_j = \omega(p_j + \ldots + p_n) - \omega(p_{j+1} + \ldots + p_n) \tag{4}$$

for $j=1,\ldots, n-1$, and $w_j = \omega(p_j)$ for $j=n$. The subscript indicates outcomes ranked from worst to best, and where $\omega(p)$ is some probability weighting function.

Picking the right probability weighting function is obviously important for the RDU specification. A weighting function proposed by Tversky and Kahneman [1992] has been widely used. It is assumed to have well-behaved endpoints such that $\omega(0)=0$ and $\omega(1)=1$ and is given by

$$\omega(p) = p^\gamma / [\, p^\gamma + (1-p)^\gamma \,]^{1/\gamma} \tag{5}$$

for $0<p<1$. The normal assumption, backed by a substantial amount of evidence reviewed by Gonzalez and Wu [1999], is that $0<\gamma<1$. This gives the weighting function an "inverse S-shape," characterized by a concave section signifying the overweighting of small probabilities up to a crossover-point where $\omega(p)=p$, beyond which there is a convex section signifying underweighting.

across specifications with and without correction for sample selection.

Under the RDU assumption about how these *probability* weights get converted into *decision* weights, $\gamma<1$ implies *over*weighting of extreme outcomes. Thus the probability associated with an outcome does not directly inform one about the decision weight of that outcome. If $\gamma>1$ the function takes the less conventional "S-shape," with convexity for smaller probabilities and concavity for larger probabilities. Under RDU $\gamma>1$ implies *under*weighting of extreme outcomes.

We again assume the CRRA functional form for utility. The parameter r determines the concavity of the utility function but is no longer the sole determinant of risk attitudes since probabilities are also transformed. The remainder of the econometric specification is the same as for the EUT model.

The effects of allowing for probability weighting are displayed in Table 2, and we find some evidence of probability weighting. The mean estimate of γ for the entire sample is 0.61 with a standard error of 0.041. The hypothesis that $\gamma=1$, that there is no probability weighting, has a *p*-value of less than 0.001 using a Wald test. The estimate of the curvature of the utility function, given by the CRRA coefficient, is smaller than the estimate of that parameter under EUT in the comparable specification. The effect of allowing for probability weighting is therefore to reduce estimates of the curvature of the utility function – we should be careful here not to *conceptually* associate curvature of the utility function with risk aversion.

Figure 1 displays the probability weighting function and decision weights assuming a value of $\gamma = 0.61$. For illustrative purposes, the decision weights are shown for a lottery with five outcomes using values of p = 0.90 for the no-claims category and p = 0.025 for each of the four other categories with positive insurance claims. The rank-dependent specification assigns a weight of 71.2 % to the no-claims category, a weight of 3.6% to the second-best outcome, 4.5% to the third-best outcome, 6.2% to the fourth-best outcome, and a weight 14.5% to the worst outcome. Hence, we see that the decision weight is reduced significantly for the best outcome and increased for all other outcomes, with a dramatic increase from 2.5% to 14.5% for the worst outcome. These biases in the decision weights have significant effects on the estimated willingness to pay for the three insurance products.

The results in Table 2 show some variation in probability weighting across the demographic characteristics. Subjects between 30 and 40 years of age do not have a systematic bias in their perception of probabilities and the γ-parameter for this age group is 1.01 with a standard error of 0.130. The γ-parameter is less than 1 for all other demographic characteristics, and we can reject the hypothesis of no probability weighting at conventional statistical significance levels for each of these demographic variables. We also find more variation in the CRRA coefficients compared to the EUT model. There is no longer a significant difference in risk attitudes between men and women. However, we now find that people younger than 30 years of age are significantly more risk averse than people older than 40 years of age.

C. Estimation of Discount Rates

Consider next the joint estimation of risk and time preferences. Our statistical specification relies on a special case of the model in Andersen, Harrison, Lau and Rutström [2008a], which is based on the dual-self representation of latent risk and time preferences by Fudenberg and Levine [2006]. We assume that income earned from the risk and the discount rate tasks is integrated with the same level of daily background consumption.

Specifically, if we assume that Expected Utility Theory (EUT) holds for the choices over risky alternatives and that discounting is exponential then the subject is indifferent between two income options M_t and $M_{t+\tau}$ if and only if

$$U(\omega+M_t) + (1/(1+\delta)^{\tau})\ U(\omega) = U(\omega) + (1/(1+\delta)^{\tau})\ U(\omega+M_{t+\tau}) \quad (6)$$

where $U(\omega+M_t)$ is the utility of monetary outcome M_t for delivery at time t plus some measure of background consumption ω, δ is the discount rate, τ is the horizon for delivery of the later monetary outcome at time $t+\tau$, and the utility function U is separable and stationary over time.[11] The left hand side of equation (1) is the sum of the discounted utilities of receiving the monetary outcome M_t at time t (in addition to background consumption) and receiving nothing extra at time $t+\tau$, and the right hand side is the sum of the discounted utilities of receiving nothing over background consumption at time t and the outcome $M_{t+\tau}$ (plus background consumption) at time $t+\tau$. Thus (8) is an indifference condition and δ is the discount rate that equalizes the present value of the utility of the two monetary outcomes M_t and $M_{t+\tau}$, after integration with an appropriate level of background consumption ω.

We can write out the likelihood function for the choices that our subjects made and estimate the risk parameter r and the discount rate δ. Instead of specifying the expected utility of option A

11 Andersen, Harrison, Lau and Rutström [2008b] use panel data from these Danish experiments and find some variation in risk attitudes over time, but there is no general tendency for risk aversion to increase or decrease over the 17-months time span that they consider.

and B, equation (2) is replaced by the discounted utility of each of the two options, conditional on some assumed discount rate.

Table 3 displays the results from joint maximum likelihood estimation of elicited discount rates and risk attitudes. The results show that the average Dane has an estimated discount rate of 10.1% with a standard error of 0.85%. This estimate is similar to the reported value in Andersen, Harrison, Lau and Rutström [2008a]. We find a small and insignificant difference in discount rates between men and women. Men have a discount rate of 10.3% and the estimated coefficient for women is 9.9%. The results indicate a systematic variation in discount rates across age groups, and we find that younger people have lower discount rates than older people. Discount rates vary between 9.0% for people younger than 30 years of age to 12.1% for those older than 60 years of age. Finally, there is some variation in discount rates between singles and those living with a partner or spouse.

The mean estimate of the CRRA coefficient is the same as before, but we find less variation in the estimated coefficients across demographic variables compared to the values reported in Table 1. For example, the difference in risk aversion between men and women is smaller and no longer statistically significant.

3. Estimating Willingness to Pay

We assume that households maximize expected inter-temporal utility subject to an inter-temporal budget constraint with several possible states of nature, where all uncertainty is realized in the initial period and any loss incurred by an accident is subtracted from initial wealth. Since potential insurance claims may be substantial in comparison to annual income, it is appropriate to allow for consumption smoothing over time and thereby cushion the impact of an accident on consumption in the short term.

A. Model

We first present the model without uncertainty to illustrate the inter-temporal optimization problem over a finite time period T, and then introduce uncertainty to estimate the willingness to pay for each insurance type.

The inter-temporal utility function at time t = 0 of the representative household is given by

$$U = \sum_{\{t=0,\dots T-1\}} (1+\delta)^{-t}\, u(c_t) \qquad (7)$$

where c_t is consumption in period t. The instantaneous utility function

$$u(c_t) = (c_t)^{(1-r)}/(1-r) \tag{8}$$

is stationary and similar to the CRRA specification in (1). The dynamic budget constraint is

$$W_{t+1} = (1+i)(W_t + y_t - c_t) \tag{9}$$

where i is the (constant) real interest rate, W_t is financial wealth in period t, and y_t is income in period t. Financial wealth in the terminal period cannot be negative and is specified as a fraction α of initial wealth $W_T = \alpha\, W_0$, with $\alpha \geq 0$.[12] The inter-temporal budget constraint is derived from the dynamic budget constraint (9) and the terminal constraint, and is written as

$$\textstyle\sum_{\{t=0,\dots T-1\}} (1+i)^{-t}\, c_t = \sum_{\{t=0,\dots T-1\}} (1+i)^{-t}\, y_t + (1-\alpha(1+i)^{-T})\, W_0 \tag{10}$$

This constraint implies that the net present value of inter-temporal consumption is equal to the net present value of inter-temporal income plus initial financial wealth minus the net present value of financial wealth in the final period.

Maximizing inter-temporal utility subject to the inter-temporal budget constraint gives the Euler equation, which specifies the optimal consumption profile over the finite time horizon

$$c_{t+1} = ((1+i)/(1+\delta))^{1/r}\, c_t \tag{11}$$

where 1/r is the inter-temporal elasticity of substitution. We can then derive consumption in period t as a function of consumption in the initial period and insert the expression into the inter-temporal budget constraint to find the optimal level of consumption in the initial period

$$c_0 = M \cdot \left(\textstyle\sum_{\{t=1,\dots T-1\}} (1+i)^{-t}\, y_t + (1-\alpha(1+i)^{-T})\, W_0 \right) \tag{12}$$

with

$$M = 1/\textstyle\sum_{\{t=1,\dots T-1\}} (1+i)^{-t}\, ((1+i)/(1+\delta))^{t/r}. \tag{13}$$

Hence, consumption in the initial period is determined by a multiplier times the present value of lifetime income minus net savings from the initial to the final period. The optimal level of consumption over time (c^*_t) is then derived by inserting equation (12) into equation (11). The multiplier in equation (13) is a function of the real interest rate and the individual discount rate, and we see that a higher discount rate puts more weight on present consumption by increasing the multiplier in equation (13), and less weight on future consumption by reducing the growth rate in equation (11). A higher interest rate reduces the present value of lifetime income and has a negative

[12] Strictly speaking, α should be endogenous in the model because households decide how much wealth to hold in period T. However, one would need a bequest or precautionary savings motive to obtain a positive level of wealth in the final period. Adding these motives would make it more complicated to estimate the willingness to pay. We vary the value of α in the sensitivity analysis and find that the willingness to pay is robust to variations in the value of this parameter.

income effect on consumption in the present and in the future. However, a higher interest rate reduces the price of future consumption relative to present consumption, and the substitution effect dominates the income effect if the intertemporal elasticity of consumption (1/r) is greater than 1, that is, if $r < 1$.

We now add uncertainty to the decision problem in order to calculate willingness to pay for insurance under assumptions of symmetric information and no default risk for the insurer. The representative household can end up in five possible states (s = 1,..., 5), which correspond to each of the five claims categories that are presented in Section 4. Expected inter-temporal utility is given by

$$EU = \sum_{\{s=1,\ldots,5\}} p_s \sum_{\{t=0,\ldots,T-\}} (1+\delta)^{-t} u(c^*_{s,t}) \quad (14)$$

where p_s is the probability of ending up in state s, and $c^*_{s,t}$ is the optimal level of consumption in state s at time t. The decision weights are revised under rank-dependent utility theory, which allows for subjective probability weighting.

We assume that all uncertainty is realized in the initial period, and any loss incurred by an accident is subtracted from initial wealth

$$W_{s,0} = W_0 - L_s \quad (15)$$

where $W_{s,0}$ is wealth in the initial period after realization of loss L in state s. The willingness to pay for insurance is then defined as the certain reduction in initial wealth that makes the household indifferent between paying this insurance premium and entering a lottery with five possible outcomes. The estimated willingness to pay is based on annual claims and should thus be considered as the annual premium that the household is willing to pay for insurance.

To estimate the willingness to pay for insurance we consider the optimal level of expected inter-temporal utility with and without insurance

$$U = \sum_{\{t=0,\ldots T-1\}} (1+\delta)^{-t} u(c^*_t) = EU \quad (16)$$

where c^*_t is the optimal level of consumption at time t with insurance. Inserting the Euler equation (11) into (16) gives the following expression

$$c^*_0 = (M \cdot EU\ (1-r))^{1/(1-r)} \quad (17)$$

Finally, we can derive the maximum insurance premium P that the household is willing to pay by inserting equation (12) into (17), assuming the premium is paid in the initial period

$$P = \sum_{\{t=1,\ldots T-1\}} (1+i)^{-t} y_t + (1-\alpha(1+i)^{-T}) W_0 - M^{r/(1-r)} (EU\ (1-r))^{1/(1-r)} \quad (18)$$

We thus need information on insurance claims, financial wealth, annual income, market interest rates, risk attitudes, and discount rates. We have access to this information in Denmark, although we cannot map the information on risk attitudes and discount rates and risk attitudes to the claims data from Tryg A/S and income and wealth data from Statistics Denmark. Since there is some uncertainty about the estimates of risk attitudes and discount rates, there is some uncertainty about the estimated willingness to pay. We use a randomized factorial design in our sensitivity analysis where each simulation involves a random draw from independent normal distributions of the estimated risk and time preferences.

4. Insurance Data

The insurance data set is kindly provided by the largest Danish general insurance company, Tryg A/S, with a market share slightly above 20 per cent. The data transfer is approved by the Danish Financial Supervisory Authority and the Danish Data Protection Agency. The data set contains 1,004,032 observations from customers who bought an auto, home or house insurance policy in 2004. We have information on insurance claims data, and use personal ID numbers to map this information with data from registers at Statistics Denmark to obtain information on annual income and financial wealth at the level of the individual and the household. The insurance policies cover the entire household, which we consider as the unit of analysis in our estimations of the willingness to pay for insurance.[13]

For each type of insurance policy we divide the households into five claims categories: (1) those with no insurance claim, (2) those with an insurance claim of 1-5,000 kroner, (3) those with a claim of 5,001-15,000 kroner, (4) those with a claim of 15,001-50,000 kroner, and finally (5) customers with a claim of 50,001 kroner or more. This gives us a discrete distribution of claims for each type of insurance.[14]

Figure 2 displays the distribution of auto insurance claims for single men, single women and couples. We have 326,426 observations on auto insurance claims in 2004, and omit the no-claims category in the figure. The probability of filing an auto insurance claim in 2004 was 9 percent for

[13] We map the estimates of individual risk and time preferences to the household insurance data using equal weights for the individual characteristics. Hence, we use a weight of 1/3 for the estimates on age, sex and marital status, respectively. For example, in the case of single men between 30 and 40 years of age, the mapping is 1/3 times the estimate for males plus 1/3 times the estimate for the age group between 30 and 40 years of age plus 1/3 times the estimate for singles. In the case of couples, the first term is replaced by 1/6 times the estimate for men and 1/6 times the estimate for women (assuming heterosexual relationships).

[14] The premium for most insurance policies in Denmark is paid on a yearly basis. In the few cases where households have filed more than one insurance claim in 2004, these claims have been pooled into a single total claim to reflect the total repayment over the year. In this way the computed willingness to pay is comparable to the insurance premiums actually paid in 2004.

single men, 10 percent for single women and 13 percent for couples. We observe that couples have a higher risk of filing an auto insurance claim than single men and women, respectively. This is presumably because many couples own one car only and drive more combined compared to single men and women. We also find that single men have a marginally higher probability of filing an auto insurance claim of more than 50,000 kroner compared to single women and couples.

The data set contains 444,748 observations on home insurance, and the distribution of claims that were filed in 2004 is displayed in Figure 3. Most insurance claims are relatively small and fall in the interval of 1-5,000 kroner, and couples are more likely to file a home insurance claim in that interval compared to single men and women. The probability of filing a home insurance claim was 8 percent for both single men and women and 12 percent for couples.

Finally, we have 232,858 observations on house insurance claims in 2004. Figure 4 shows that couples are more likely to file a house insurance claim than single men and women, like the two other types of insurance. The probability of filing a claim is marginally lower for single men and women compared to couples in each claims category, which is the general pattern we see across all insurance types and claims categories. The probability of filing a house insurance claim in 2004 was 9 percent for single men, 11 percent for single women and 13 percent for couples.

5. WTP for Auto, Home and House Insurance

The model is calibrated to the claims data from the customer database at Tryg A/S and information on annual income after tax and private financial wealth from Statistics Denmark.[15] Households are divided into five age categories, and we generally observe an inverse U-shape of income after tax and an increasing level of financial wealth as the customers get older.[16] We calculate how much each household is willing to pay for insurance using estimates of relative risk aversion and discount rates from the Danish field experiments. The insurance claims may be substantial relative to annual income, and we assume that households have a 10-year planning horizon and choose the optimal consumption profile over this timespan. Annual income is constant in the estimations and net savings over the 10-year time period is set to zero, and we use a market interest rate of 4% in the

[15] We use GAMS to estimate the WTP for insurance products. The programs and aggregate data are available from the authors on request. However, due to confidentiality issues we are not permitted to pass on insurance data at the household level to third parties.

[16] Age groups are assigned to the oldest member of the household. Table A1 and A2 in the Appendix (which is available upon request) shows the distribution of after-tax income and financial wealth for those men, women and couples who purchased auto, home and auto insurance at Tryg A/S in 2004.

baseline calculations.[17]

A. Auto Insurance

Panel A in Table 4 displays the average annual auto insurance claims for men, women and couples across different age groups. There are substantial differences in these insurance claims across households. Single men younger than 30 years of age have an average auto insurance claim of 3,197 kroner per annum, which is twice as high as the average insurance claim for single women in the same age group, and marginally higher than the average insurance claim for couples. Average annual insurance claims fall with age and there is only a marginal difference in insurance claims between single men and women who are older than 60 years of age (1,153 kroner for men and 1,137 kroner for women).

Panel B shows the estimated annual willingness to pay for auto insurance assuming EUT. Since there is some uncertainty about the estimates of risk attitudes and discount rates, there is some uncertainty about the estimated willingness to pay. We use a randomized factorial design in our sensitivity analysis and undertake 10,000 perturbations (Harrison and Vinod, [1992]). Each simulation involves a random draw from independent normal distributions of the CRRA parameter and the individual discount rate for each type of household. We report the mean values and standard deviations of these simulations, and the results show that the willingness to pay is marginally higher than the average insurance claims for the various household types. For example, the willingness to pay for men younger than 30 years of age is 3,307 kroner compared to the average insurance claim of 3,197 kroner, which gives a difference of 110 kroner. The standard deviation of the estimated WTP is small and less than 5 kroner across all types of households. Hence, there is little variation in the estimated WTP when we consider the uncertainty of the elicited risk attitudes and discount rates and assume that the households behave according to EUT.

This pattern is different when we look at the willingness to pay under RDU. Panel C in Table 4 shows that the willingness to pay for auto insurance increases significantly when we allow for probability weighting and adjust the weights for each category of claims. For example, the mean estimate of the willingness to pay for men younger than 30 years of age is 14,766 kroner with the rank-dependent specification, which is significantly higher than the mean estimate of 3,303 kroner

[17] These assumptions imply that the present discounted value of consumption is equal to the present discounted value of income over the 10-year time period, and the consumption profile is declining over time because $i<\delta$. We do not find significant differences in the estimated willingness to pay when the market interest rate is increased to 10%.

under EUT. We also observe that the standard deviation of the estimated WTP increases considerably and is 1,597 kroner for men younger than 30 years of age. These effects are similar for other types of households, and we find that the estimated WTP increases between 300% and 600% for the RDU specification compared to the EUT assumption.

B. Home Insurance

We next present the results for the home insurance product. Table 5 shows that the average home insurance claims vary between 358 kroner for women older than 60 years of age to 1,257 kroner for couples younger than 30 years of age. These average claims are lower than those for auto insurance. This is not because the risk of filing a home insurance claim is lower than the risk of having a car accident, but the claims are generally lower for home insurance. The estimated WTP for home insurance is marginally higher than the average insurance claims for all types of household using the EUT specification, and we find again a significant increase in the estimated WTP for the rank-dependent specification compared to the EUT assumption. For example, the estimated WTP for home insurance is 3,186 kroner for women older than 60 years, which is nine times higher than the mean estimate of 352 kroner under the EUT assumption.

C. House Insurance

Finally, we present the results for house insurance. Table 6 shows the expected claims and WTP for this type of insurance. We find that the average claims vary between 888 kroner for men older than 60 years of age to 2,680 kroner for couples between 30 and 40 years of age. Couples have higher claims than single men and women, and the likely reason is that they have larger homes than single men and women. The results show that the risk premium is small under the EUT specification and it increases significantly under the RDU specification.

D. Sensitivity Analysis

To examine how sensitive the estimates are to our choice of parameters, we also vary the planning horizon, the level of net savings over this horizon, and the market interest rate.[18] We find that the estimated WTP increases generally when the planning horizon is reduced. For example, the willingness to pay for auto insurance for men younger than 30 years of age increases from 3,303

[18] The estimates are displayed in Table A3 for the EUT model and Table A4 for the RDU model.

kroner to 5,539 kroner when the time horizon is reduced from 10 years to 1 year, using the EUT specification. The results are similar for the RDU specification when we reduce the time horizon. A shorter planning horizon reduces the present value of income, and the insurance claims will therefore have a greater relative impact on income. The greater variation in income leads to an increase in the estimated WTP for all three types of insurance.

There is no significant effect on the estimated WTP when financial wealth in the final period is equal to 0. We observe only a marginal reduction in estimated WTP compared to the model where net savings is zero. The results also suggest that the level of the market interest rate has a marginal effect on the estimated WTP, and increasing the market rate to 10% raises the estimates for the three insurance produces across all types of households. The results thus show that the estimated WTP for insurance is sensitive to the time horizon, but is robust to changes in market interest rate and net savings over the time horizon.

6. Probability Weighting

The results indicate that the effects of risk aversion under expected utility theory on the willingness to pay for insurance are rather small, whereas the assumption of rank-dependent expected utility may have a substantial effect on estimated WTP for the three types of insurance. There are some well-known limitations of the Tversky-Kahneman probability weighting function in equation (5). It does not allow independent specification of location and curvature; it has a crossover-point at $p=1/e=0.37$ for $\gamma<1$ and at $p=1-0.37=0.63$ for $\gamma>1$; and it is not increasing in p for small values of γ. Prelec [1998] and Rieger and Wang [2006] offer two-parameter probability weighting functions that exhibits more flexibility than (5).[19] The Prelec function is written as

$$w(p) = \exp\{-\eta(-\ln p)^{\varphi}\} \tag{19}$$

and is defined for $0<p<1$, $\eta>0$ and $0<\varphi<1$. Numerical problems may arise when $\varphi\rightarrow 0$, and when $\varphi=0$ this function is reduced to the Power function:

$$w(p) = p^{\eta} \tag{20}$$

One solution to the numerical instability is to further generalize the function, and estimate a three-parameter version that Andersen, Harrison, Lau and Rutström [2011] refer to as the Power-Prelec probability weighting function:

$$w(p) = [\ \exp\{-\eta(-\ln p)^{\varphi}\}\ ]^{\gamma} \tag{21}$$

[19] Harrison, Humphrey and Verschoor [2010] explore the applied use of these more flexible functional forms.

Figure 5 displays the estimated Power-Prelec probability weighting function across sex, age groups and marital status. We generally observe that subjects have an inverse s-shaped function, except subjects between 30 and 40 years of age who have a strictly convex probability weighting function. Converting the convex probability weighting function into decision weights implies that the no-claims outcome is under-weighted and the four other outcomes with positive claims are over-weighted, just like the Tversky-Kahneman function in equation (5). Hence, we observe that all households place a lower weight on the no-claims outcome and higher weights on outcomes with positive claims.

We can repeat the WTP estimations using the alternative probability weighting functions, and the results are shown in Table 7. Panel A displays the estimated WTP for auto insurance using the Power-Prelec function, and we find the same dramatic effect as before. The estimated WTP is between 300% and 600% higher than the actuarial value of the insurance claims. We find similar effects on estimated WTP for the two other types of insurance.[20] The results thus point to a high WTP for auto, home and house insurance for all households.

We find that γ in the Power-Prelec function is significantly higher than 1 for subjects younger than 40 years of age, but the estimated coefficient is close to 1 and insignificant for all other households.[21] Hence, the probability weighting functions are similar in shape for the Prelec and Power-Prelec functions. Finally, we find that the η parameter in the Power function is significantly higher than 1 for subjects below 40 years of age, and significantly lower than 1 for those who are 60 years or older. We cannot reject the hypothesis that $\eta=1$ for men and women, and for singles and couples. A concave probability weighting function ($\eta<1$) implies that the no-claims outcome is over-weighted and outcomes with positive claims are under-weighted, and we find that the estimated WTP for auto insurance falls below the actuarial value for the highest age group.

7. Conclusions

We have shown that it is feasible to estimate the willingness to pay for insurance products. These estimates are based on claims data from the largest insurance company in Denmark, which is mapped to information at Statistics Denmark on annual household income and wealth, and nationally representative estimates of risk aversion and discount rates using controlled experiments.

[20] These estimates are provided in Table A5 for home insurance and in Table A6 for house insurance.

[21] The estimated Prelec and Power probability weighting functions are displayed in Figure A1 and A2, respectively.

The results show that the willingness to pay is marginally higher than the actuarial fair value under Expected Utility Theory. However, the estimated willingness to pay is significantly higher under Rank-Dependent Utility Theory, and for some households it may be up to 600% higher than the actuarial value of the insurance claims.

References

Andersen, Steffen; Harrison, Glenn W.; Lau, Morten I., and Rutström, E. Elisabet, "Elicitation Using Multiple Price Lists," *Experimental Economics*, 9(4), December 2006, 383-405.

Andersen, Steffen; Harrison, Glenn W.; Lau, Morten I., and Rutström, E. Elisabet, "Eliciting Risk and Time Preferences" *Econometrica*, 76(3), 2008a, 583-618.

Andersen, Steffen; Harrison, Glenn W.; Lau, Morten I.; Rutström, E. Elisabet, "Lost in State Space: Are Preferences Stable?" *International Economic Review*, 49(3), 2008b, 1091-1112.

Andersen, Steffen; Harrison, Glenn W.; Lau, Morten I.; Rutström, E. Elisabet, "Preference Heterogeneity in Experiments: Comparing the Field and Laboratory," *Journal of Economic Behavior and Organization*, 73, 2010, 209-224.

Andersen, Steffen; Harrison, Glenn W.; Lau, Morten I., and Rutström, E. Elisabet, "Discounting Behavior: A Reconsideration," *Working Paper 2011-03*, Center for the Economic Analysis of Risk, Robinson College of Business, Georgia State University, 2011.

Blumenschein, K.; Blomquist, G. C.; Johannesson, M.; Horn, N., and Freeman, P., "Eliciting Willingness to Pay without Bias: Evidence from a Field Experiment," *The Economic Journal*, 118(1), 2008, 114–137.

Cohen, Alma, and Einav, Liran, "Estimating Risk Preferences from Deductible Choice," *American Economic Review*, 97, 2007, 745-788.

Coller, Maribeth, and Williams, Melonie B., "Eliciting Individual Discount Rates," *Experimental Economics*, 2, 1999, 107-127.

Dohmen, Thomas; Falk, Armin; Huffman, David; Sunde, Uwe; Schupp, Jürgen, and Wagner, Gert G., "Individual Risk Attitudes: New Evidence From a Large Representative, Experimentally-Validated Survey," Discussion Paper 1730, Institute for the Study of Labor, Bonn, Germany, 2005.

Eckel, Catherine; Johnson, Cathleen, and Montmarquette, Claude, "Savings Decisions of the Working Poor: Short- and Long-term Horizons," in J. Carpenter, G. W. Harrison and J. A. List (eds.), Field Experiments in Economics (Greenwich, CT: JAI Press, *Research in Experimental Economics*, Volume 10, 2005).

Fudenberg, Drew, and Levine, David K., "A Dual-Self Model of Impulse Control,"*American Economic Review*, 96(5), December 2006, 1449-1476.

Gollier, Christian, *The Economics of Risk and Time* (Cambridge, MA: MIT Press, 2001).

Gonzalez, Richard, and Wu, George, "On the Shape of the Probability Weighting Function," *Cognitive Psychology*, 38, 1999, 129-166.

Harrison, Glenn W.; Harstad, Ronald M., and Rutström, E. Elisabet, "Experimental Methods and Elicitation of Values," *Experimental Economics*, 7(2), June 2004, 123-140.

Harrison, Glenn W.; Humphrey, Steven J., and Verschoor, Arjan, "Choice Under Uncertainty: Evidence from Ethiopia, India and Uganda," *Economic Journal*, 120, March 2010, 80-104.

Harrison, Glenn W.; Lau, Morten I., and Rutström, E. Elisabet, "Estimating Risk Attitudes in Denmark: A Field Experiment," *Scandinavian Journal of Economics*, 109(2), June 2007, 341-368.

Harrison, Glenn W.; Lau, Morten I.; Rutström, E. Elisabet, and Sullivan, Melonie B., "Eliciting Risk and Time Preferences Using Field Experiments: Some Methodological Issues," in J. Carpenter, G.W. Harrison and J.A. List (eds.), *Field Experiments in Economics* (Greenwich, CT: JAI Press, Research in Experimental Economics, Volume 10, 2005).

Harrison, Glenn W.; Lau, Morten I., and Williams, Melonie B., "Estimating Individual Discount Rates for Denmark: A Field Experiment," *American Economic Review*, 92(5), December 2002, 1606-1617.

Harrison, Glenn W., and List, John A., "Field Experiments," *Journal of Economic Literature*, 42(4), December 2004, 1013-1059.

Harrison, Glenn W., and Martinez-Correa, J., "Behavioral Insurance: A Survey," *Mimeo*, Center for the Economic Analysis of Risk, Robinson College of Business, Georgia State University, 2012.

Harrison, Glenn W., and Rutström, E. Elisabet, "Risk Aversion in the Laboratory," in J.C. Cox and G.W. Harrison (eds.), *Risk Aversion in Experiments* (Bingley, UK: Emerald, Research in Experimental Economics, Volume 12, 2008).

Harrison, G. W., and Vinod, H. D., "The Sensitivity Analysis of Applied General Equilibrium Models: Completely Randomized Factorial Sampling Designs," *Review of Economics and Statistics*, 1992, 74, 357-362.

Holt, Charles A., and Laury, Susan K., "Risk Aversion and Incentive Effects," *American Economic Review*, 92(5), December 2002, 1644-1655.

Holt, Charles A., and Laury, Susan K., "Risk Aversion and Incentive Effects: New Data Without Order Effects," *American Economic Review*, 95(3), June 2005, 902-912.

Liang, K-Y, and Zeger, S. L., "Longitudinal Data Analysis Using Generalized Linear Models," *Biometrika*, 73, 1986, 13-22.

List, J. A., and Gallet, C. A., "What experimental protocol influence disparities between actual and hypothetical stated values?" *Environmental and Resource Economics*, 20, 2001, 241-254.

Murphy, J. J.; Allen, P. G.; Stevens, T.H., and Weatherhead, D., "A Meta-Analysis of Hypothetical Bias in Stated Preference Valuation," *Environmental and Resource Economics*, 30(3), 2005, 313–325.

Prelec, Drazen, "The Probability Weighting Function," *Econometrica*, 66, 1998, 497-527.

Quiggin, John, "A Theory of Anticipated Utility," *Journal of Economic Behavior & Organization*, 3(4), 1982, 323-343.

Rieger, Marc O., and Wang, Mei, "Cumulative Prospect Theory and the St. Petersburg Paradox," *Economic Theory*, 28, 2006, 665-679.

Rogers, W. H., "Regression Standard Errors in Clustered Samples," *Stata Technical Bulletin*, 13, 1993, 19-23.

Tversky, Amos, and Kahneman, Daniel, "Advances in Prospect Theory: Cumulative Representations of Uncertainty," *Journal of Risk & Uncertainty*, 5, 1992, 297-323.

Wakker, Peter P., "Explaining the Characteristics of the Power (CRRA) Utility Family," *Health Economics*, 17(12), 2008, 1329-1344.

Wilcox, Nathaniel T., "Stochastic Models for Binary Discrete Choice Under Risk: A Critical Primer and Econometric Comparison," in J. Cox and G.W. Harrison (eds.), *Risk Aversion in Experiments* (Bingley, UK: Emerald, Research in Experimental Economics, Volume 12, 2008).

Williams, Rick L., "A Note on Robust Variance Estimation for Cluster-Correlated Data," *Biometrics*, 56, June 2000, 645-646.

Wooldridge, Jeffrey, "Cluster-Sample Methods in Applied Econometrics," *American Economic Review (Papers & Proceedings)*, 93(2), May 2003, 133-138.

Yaari, Menahem E., "The Dual Theory of Choice under Risk," *Econometrica*, 55(1), 1987, 95-115.

Figure 1. Decision Weights under EUT and RDU

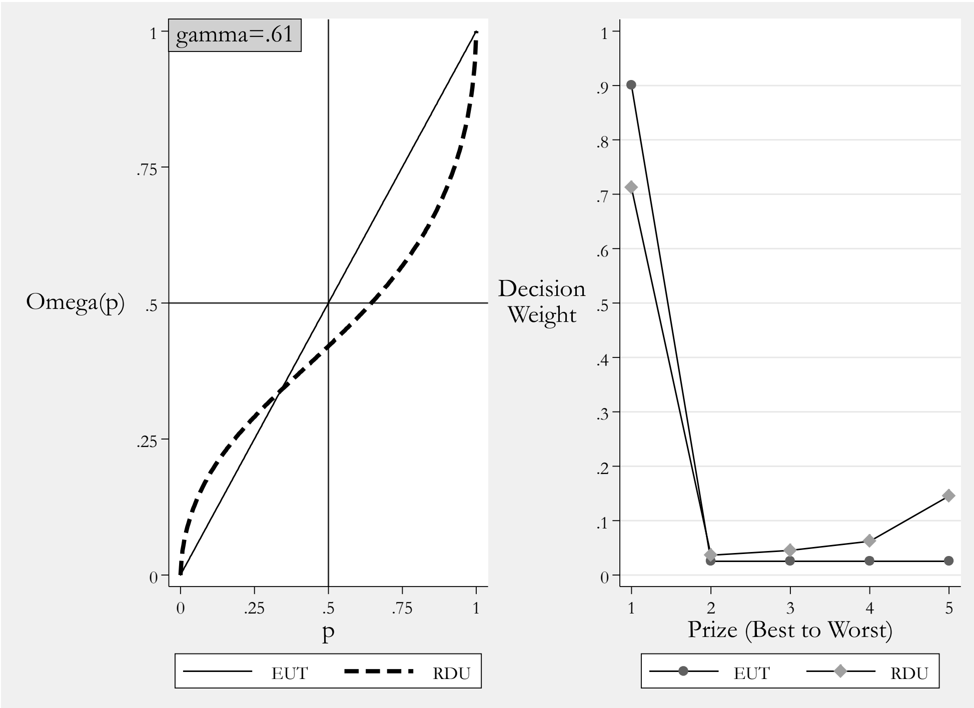

Figure 2. Distribution of Auto Insurance Claims by Household Type

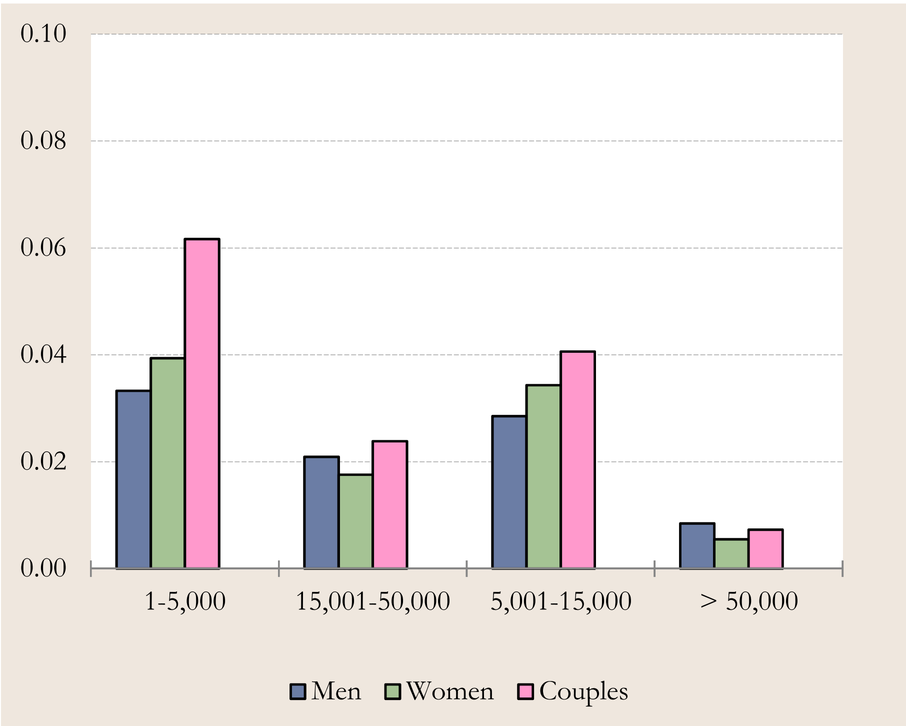

Figure 3. Distribution of Home Insurance Claims by Household Type

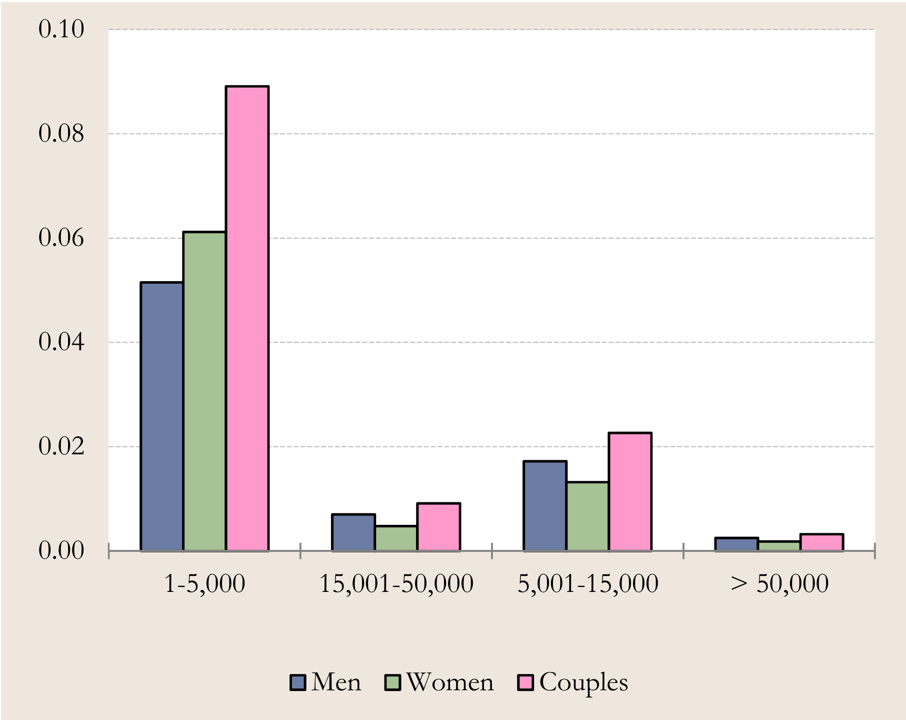

Figure 4. Distribution of House Insurance Claims by Household Type

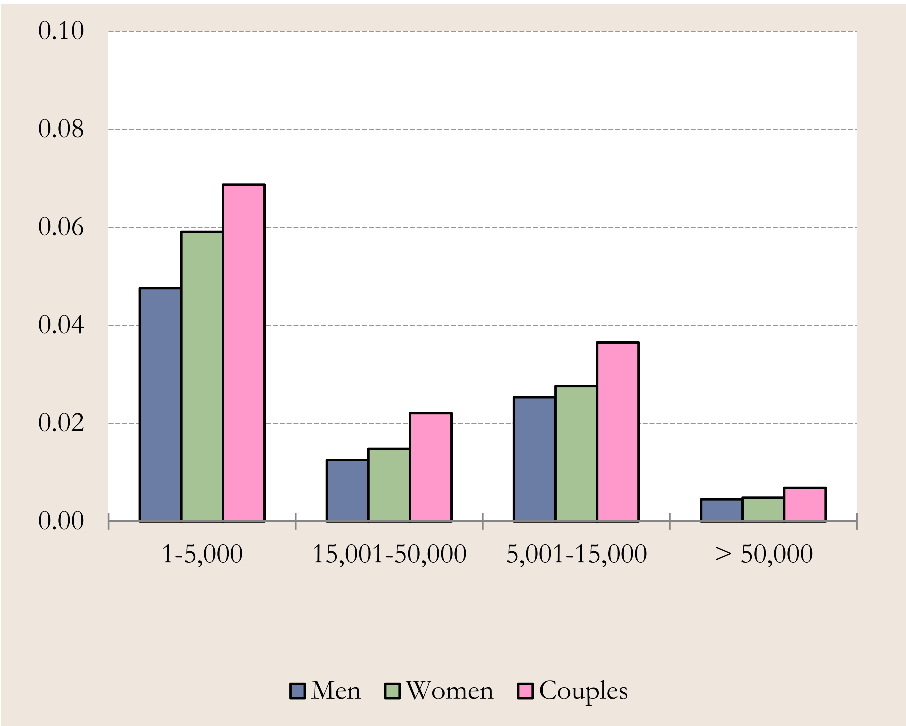

Figure 5. Probability Weighting: Power-Prelec Function

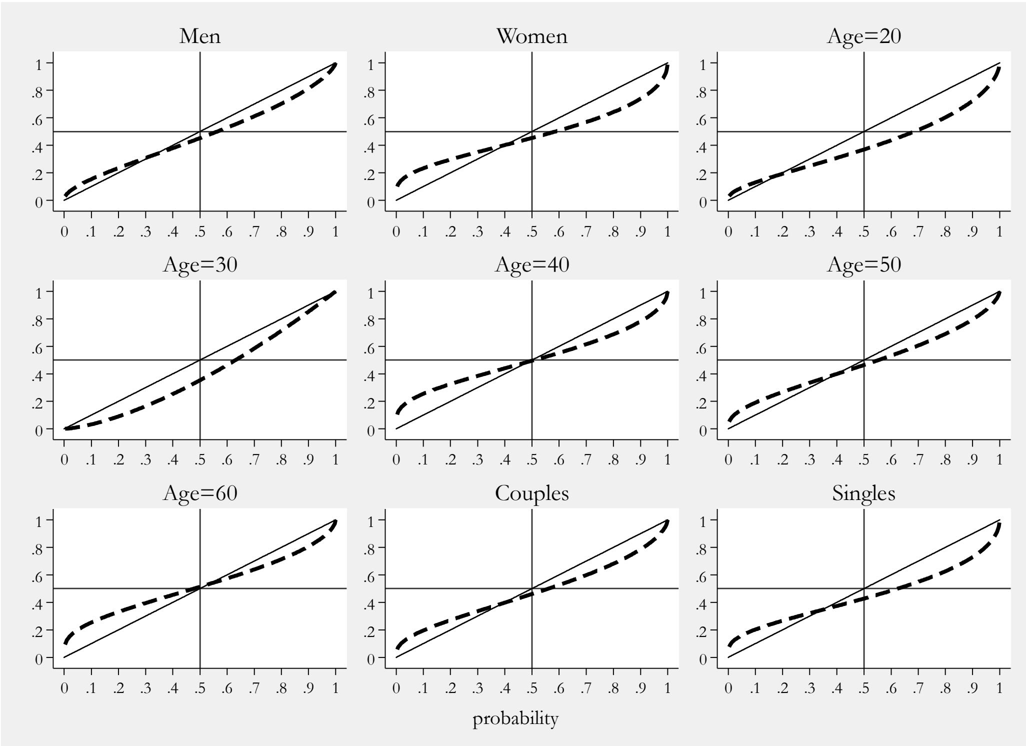

Table 1. Estimates of Risk Preferences Assuming EUT

	Estimate	Standard Error	95% Confidence Interval	
		Constant Relative Risk Aversion		
Average	0.73	0.045	0.64	0.81
Men	0.69	0.051	0.59	0.79
Women	0.76	0.039	0.69	0.84
Younger than 30 years of age	0.82	0.058	0.71	0.93
Between 30 and 40 years of age	0.76	0.078	0.60	0.91
Between 40 and 50 years of age	0.88	0.057	0.77	0.99
Between 50 and 60 years of age	0.85	0.070	0.71	0.99
Older than 60 years of age	0.89	0.057	0.78	1.00
Single	0.74	0.042	0.66	0.83
Lives with spouse or partner	0.72	0.050	0.62	0.81

Table 2. Estimates of Risk Preferences Assuming RDU

	CRRA		Probability Weighting (γ)	
	Estimate	Standard Error	Estimate	Standard Error
Average	0.41	0.039	0.68	0.028
Men	0.40	0.044	0.71	0.049
Women	0.44	0.066	0.67	0.040
Younger than 30 years of age	0.36	0.036	0.54	0.033
Between 30 and 40 years of age	0.36	0.038	0.61	0.053
Between 40 and 50 years of age	0.40	0.130	0.71	0.072
Between 50 and 60 years of age	0.51	0.064	0.80	0.084
Older than 60 years of age	0.22	0.094	0.62	0.053
Single	0.40	0.071	0.61	0.039
Lives with spouse or partner	0.41	0.040	0.70	0.032

Table 3. Estimates of Time Preferences Assuming Exponential Discounting

	Estimate	Standard Error	95% Confidence Interval	
		Discount Rate		
Average	0.101	0.0085	0.084	0.117
Men	0.103	0.0105	0.083	0.124
Women	0.099	0.0088	0.082	0.116
Younger than 30 years of age	0.090	0.0126	0.065	0.115
Between 30 and 40 years of age	0.092	0.0127	0.067	0.117
Between 40 and 50 years of age	0.099	0.0116	0.076	0.121
Between 50 and 60 years of age	0.102	0.0124	0.078	0.126
Older than 60 years of age	0.121	0.0160	0.089	0.152
Single	0.115	0.0120	0.091	0.138
Lives with spouse or partner	0.097	0.0091	0.079	0.114

Table 4. Auto Insurance Claims and Willingness to Pay (Danish kroner)

	Men	Women	Couples
A. Average Insurance Claims			
Younger than 30 years of age	3,197	1,550	3,159
Between 30 and 40 years of age	2,506	2,226	2,226
Between 40 and 50 years of age	1,931	2,204	2,722
Between 50 and 60 years of age	1,862	1,360	2,240
Older than 60 years of age	1,153	1,137	1,637
B. Willingness to Pay Assuming EUT			
Younger than 30 years of age	3,307	1,586	3,212
Between 30 and 40 years of age	2,548	2,281	2,242
Between 40 and 50 years of age	1,957	2,239	2,743
Between 50 and 60 years of age	1,891	1,372	2,254
Older than 60 years of age	1,163	1,145	1,650
C. Willingness to Pay Assuming RDU			
Younger than 30 years of age	14,766	9,001	17,490
	(1,597)	(983)	(1,728)
Between 30 and 40 years of age	10,394	11,891	10,807
	(1,330)	(1,579)	(1,297)
Between 40 and 50 years of age	7,486	8,641	10,855
	(1,185)	(1,264)	(1,509)
Between 50 and 60 years of age	6,270	4,601	7,900
	(1,087)	(745)	(1,232)
Older than 60 years of age	5,108	5,257	8,762
	(706)	(668)	(1,140)

Table 5. Home Insurance Claims and Willingness to Pay (Danish kroner)

	Men	Women	Couples
A. Average Insurance Claims			
Younger than 30 years of age	967	791	1,257
Between 30 and 40 years of age	929	883	1,223
Between 40 and 50 years of age	803	863	1,258
Between 50 and 60 years of age	537	744	1,027
Older than 60 years of age	358	344	676
B. Willingness to Pay Assuming EUT			
Younger than 30 years of age	978	800	1,268
Between 30 and 40 years of age	939	891	1,229
Between 40 and 50 years of age	812	872	1,264
Between 50 and 60 years of age	542	754	1,033
Older than 60 years of age	363	352	683
C. Willingness to Pay Assuming RDU			
Younger than 30 years of age	5,018	4,630	8,379
	(624)	(544)	(977)
Between 30 and 40 years of age	4,831	4,879	6,839
	(725)	(692)	(911)
Between 40 and 50 years of age	3,903	4,030	5,715
	(728)	(694)	(891)
Between 50 and 60 years of age	2,202	3,391	4,474
	(446)	(674)	(814)
Older than 60 years of age	2,742	3,186	5,578
	(506)	(566)	(897)

Table 6. House Insurance Claims and Willingness to Pay (Danish kroner)

	Men	Women	Couples
	A. Average Insurance Claims		
Younger than 30 years of age	1,732	1,758	2,226
Between 30 and 40 years of age	2,518	1,997	2,680
Between 40 and 50 years of age	1,351	1,901	2,475
Between 50 and 60 years of age	1,298	1,916	2,101
Older than 60 years of age	888	1,235	2,169
	B. Willingness to Pay Assuming EUT		
Younger than 30 years of age	1,786	1,784	2,248
Between 30 and 40 years of age	2,582	2,033	2,704
Between 40 and 50 years of age	1,365	1,930	2,494
Between 50 and 60 years of age	1,311	1,941	2,115
Older than 60 years of age	895	1,250	2,193
	C. Willingness to Pay Assuming RDU		
Younger than 30 years of age	11,147	8,450	12,329
	(1,485)	(829)	(1,247)
Between 30 and 40 years of age	12,387	10,221	13,444
	(1,749)	(1,330)	(1,637)
Between 40 and 50 years of age	5,678	8,018	10,431
	(958)	(1,234)	(1,502)
Between 50 and 60 years of age	4,461	6,712	7,827
	(794)	(1,105)	(1,268)
Older than 60 years of age	4,404	6,537	12,146
	(657)	(892)	(1,606)

Table 7. Auto Insurance Claims and WTP using Power-Prelec, Power and Power Functions (Danish kroner)

	Men	Women	Couples
	A. Power-Prelec Function		
Younger than 30 years of age	13,822	9,904	13,469
	(2,364)	(1,797)	(2,067)
Between 30 and 40 years of age	7,429	9,536	6,360
	(1,541)	(2,154)	(1,213)
Between 40 and 50 years of age	8,527	11,294	10,006
	(1,412)	(1,661)	(1,309)
Between 50 and 60 years of age	7,865	6,682	7,989
	(1,489)	(1,159)	(1,216)
Older than 60 years of age	4,782	5,758	6,644
	(823)	(907)	(970)
	B. Prelec Function		
Younger than 30 years of age	15,143	10,021	14,046
	(2,364)	(1,656)	(1,698)
Between 30 and 40 years of age	8,992	10,830	7,323
	(1,667)	(2,182)	(1,144)
Between 40 and 50 years of age	8,545	10,346	9,505
	(1,442)	(1,574)	(1,096)
Between 50 and 60 years of age	7,238	5,623	7,014
	(1,546)	(1,125)	(1,168)
Older than 60 years of age	5,626	6,155	7,379
	(1,012)	(1,031)	(1,029)
	C. Power Function		
Younger than 30 years of age	4,033	1,900	3,734
	(321)	(154)	(257)
Between 30 and 40 years of age	3,145	2,755	2,635
	(235)	(208)	(164)
Between 40 and 50 years of age	1,964	2,187	2,586
	(154)	(173)	(150)
Between 50 and 60 years of age	1,993	1,412	2,240
	(158)	(112)	(137)
Older than 60 years of age	1,150	1,102	1,529
	(90)	(86)	(86)

Willingness to Pay for Insurance in Denmark: Appendix

Table A1. Annual Income After Tax in 2004 (Danish kroner)

	Men	Women	Couples
A. Customers with auto insurance			
Younger than 30 years of age	130,423	128,267	270,171
Between 30 and 40 years of age	181,149	185,522	363,080
Between 40 and 50 years of age	229,180	194,564	396,663
Between 50 and 60 years of age	193,506	192,722	387,518
Older than 60 years of age	166,626	168,351	295,759
B. Customers with home insurance			
Younger than 30 years of age	129,807	115,809	249,004
Between 30 and 40 years of age	179,684	174,773	362,881
Between 40 and 50 years of age	218,262	184,303	402,477
Between 50 and 60 years of age	191,900	191,900	391,802
Older than 60 years of age	159,794	140,976	290,295
C. Customers with house insurance			
Younger than 30 years of age	166,266	144,915	294,168
Between 30 and 40 years of age	196,987	194,353	383,066
Between 40 and 50 years of age	249,399	208,590	421,494
Between 50 and 60 years of age	217,833	207,729	412,129
Older than 60 years of age	189,422	166,478	317,122

Table A2. Private Financial Wealth in 2004 (Danish kroner)

	Men	Women	Couples
	A. Customers with auto insurance		
Younger than 30 years of age	19,533	34,666	-60,094
Between 30 and 40 years of age	100,187	68,855	67,420
Between 40 and 50 years of age	367,952	238,806	328,811
Between 50 and 60 years of age	491,470	581,935	768,707
Older than 60 years of age	1,029,863	1,400,974	1,304,591
	B. Customers with home insurance		
Younger than 30 years of age	6,253	5,945	-48,253
Between 30 and 40 years of age	85,398	43,978	67,353
Between 40 and 50 years of age	311,785	175,551	327,180
Between 50 and 60 years of age	384,695	418,451	738,979
Older than 60 years of age	827,064	704,793	1,210,484
	C. Customers with house insurance		
Younger than 30 years of age	73,039	128,236	-109,879
Between 30 and 40 years of age	182,632	249,629	113,315
Between 40 and 50 years of age	570,648	501,402	426,223
Between 50 and 60 years of age	756,115	914,765	915,569
Older than 60 years of age	1,382,683	1,416,771	1,534,322

Table A3. WTP for Auto Insurance under EUT (Danish kroner)

	Men	Women	Couples
A. 1-year planning period			
Younger than 30 years of age	5,693	2,072	3,765
Between 30 and 40 years of age	3,016	3,088	2,378
Between 40 and 50 years of age	2,215	2,611	2,922
Between 50 and 60 years of age	2,192	1,478	2,374
Older than 60 years of age	1,252	1,218	1,762
B. 2-year planning period			
Younger than 30 years of age	3,817	1,736	3,416
Between 30 and 40 years of age	2,715	2,517	2,298
Between 40 and 50 years of age	2,056	2,375	2,816
Between 50 and 60 years of age	2,001	1,415	2,304
Older than 60 years of age	1,199	1,175	1,695
C. alpha = 0			
Younger than 30 years of age	3,306	1,585	3,213
Between 30 and 40 years of age	2,546	2,280	2,242
Between 40 and 50 years of age	1,955	2,236	2,742
Between 50 and 60 years of age	1,886	1,370	2,252
Older than 60 years of age	1,160	1,142	1,647
D. r = 0.1			
Younger than 30 years of age	3,336	1,595	3,227
Between 30 and 40 years of age	2,558	2,294	2,246
Between 40 and 50 years of age	1,962	2,245	2,747
Between 50 and 60 years of age	1,894	1,373	2,256
Older than 60 years of age	1,163	1,144	1,650

Table A4. WTP for Auto Insurance under RDU and TK Function (Danish kroner)

	Men	Women	Couples
A. 1-year planning period			
Younger than 30 years of age	19,027	10,398	18,989
Between 30 and 40 years of age	11,404	14,059	11,204
Between 40 and 50 years of age	8,010	9,409	11,265
Between 50 and 60 years of age	6,871	4,838	8,179
Older than 60 years of age	5,309	5,437	9,076
B. 2-year planning period			
Younger than 30 years of age	15,867	9,466	18,061
Between 30 and 40 years of age	10,769	12,585	10,972
Between 40 and 50 years of age	7,692	8,933	11,025
Between 50 and 60 years of age	6,497	4,697	8,017
Older than 60 years of age	5,190	5,331	8,892
C. alpha = 0			
Younger than 30 years of age	14,763	8,998	17,493
Between 30 and 40 years of age	10,389	11,886	10,806
Between 40 and 50 years of age	7,479	8,634	10,852
Between 50 and 60 years of age	6,260	4,596	7,896
Older than 60 years of age	5,101	5,250	8,753
D. r = 0.1			
Younger than 30 years of age	14,831	9,029	17,531
Between 30 and 40 years of age	10,415	11,931	10,818
Between 40 and 50 years of age	7,495	8,655	10,865
Between 50 and 60 years of age	6,277	4,604	7,905
Older than 60 years of age	5,108	5,256	8,764

Table A5. Home Insurance Claims and WTP using Power-Prelec, Power and Power Functions (Danish kroner)

	Men	Women	Couples
A. Power-Prelec Function			
Younger than 30 years of age	4,750	5,278	6,339
	(962)	(1,065)	(1,142)
Between 30 and 40 years of age	3,221	3,884	3,792
	(797)	(942)	(797)
Between 40 and 50 years of age	4,745	5,915	5,367
	(951)	(1,074)	(775)
Between 50 and 60 years of age	2,957	5,636	4,652
	(675)	(1,231)	(821)
Older than 60 years of age	2,717	4,121	4,199
	(649)	(947)	(746)
B. Prelec Function			
Younger than 30 years of age	5,301	5,350	6,675
	(983)	(980)	(964)
Between 30 and 40 years of age	4,066	4,463	4,449
	(904)	(971)	(775)
Between 40 and 50 years of age	4,758	5,310	5,063
	(976)	(997)	(665)
Between 50 and 60 years of age	2,678	4,546	3,989
	(691)	(1,152)	(793)
Older than 60 years of age	3,392	4,532	4,791
	(852)	(1112)	(853)
C. Power Function			
Younger than 30 years of age	1,196	957	1,474
	(94)	(76)	(100)
Between 30 and 40 years of age	1,162	1,078	1,445
	(87)	(81)	(90)
Between 40 and 50 years of age	815	852	1,193
	(64)	(67)	(69)
Between 50 and 60 years of age	572	775	1,026
	(46)	(62)	(63)
Older than 60 years of age	359	337	632
	(28)	(27)	(36)

Table A6. House Insurance Claims and WTP using Power-Prelec, Power and Power Functions (Danish kroner)

	Men	Women	Couples
	A. Power-Prelec Function		
Younger than 30 years of age	10,514	9,063	9,486
	(2,300)	(1,448)	(1,485)
Between 30 and 40 years of age	8,453	8,236	7,829
	(1,970)	(1,815)	(1,520)
Between 40 and 50 years of age	6,620	10,770	9,645
	(1,181)	(1,675)	(1,299)
Between 50 and 60 years of age	5,662	9,797	7,954
	(1,110)	(1,715)	(1,253)
Older than 60 years of age	4,171	7,342	9,186
	(782)	(1,248)	(1,361)
	B. Prelec Function		
Younger than 30 years of age	11,832	9,151	9,905
	(2,354)	(1,338)	(1,225)
Between 30 and 40 years of age	10,498	9,321	9,043
	(2,181)	(1,833)	(1,438)
Between 40 and 50 years of age	6,636	9,816	9,144
	(1,209)	(1,581)	(1,096)
Between 50 and 60 years of age	5,197	8,230	6,946
	(1,148)	(1,666)	(1,207)
Older than 60 years of age	4,978	7,886	10,220
	(980)	(1,426)	(1,449)
	C. Power Function		
Younger than 30 years of age	2,182	2,137	2,615
	(175)	(172)	(179)
Between 30 and 40 years of age	3,184	2,458	3,177
	(240)	(186)	(199)
Between 40 and 50 years of age	1,370	1,885	2,351
	(108)	(149)	(137)
Between 50 and 60 years of age	1,383	1,996	2,102
	(109)	(159)	(129)
Older than 60 years of age	885	1,202	2,031
	(69)	(94)	(114)

Figure A1. Probability Weighting: Prelec Function

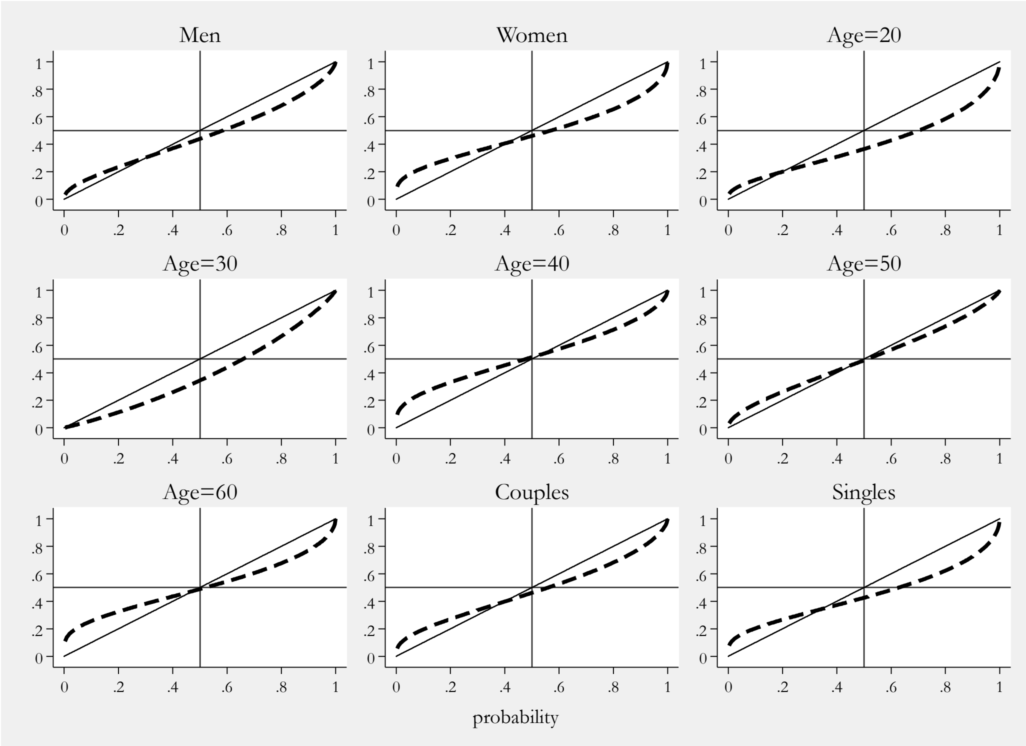

Figure A2. Probability Weighting: Power Function