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Is Transport Safety More Valuable in the Air?

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Abstract

Using a contingent valuation survey, people's willingness to pay for a given risk reduction is found to be much larger, consistently more than two times as large, when traveling by air compared to by taxi. Follow-up questions revealed that an important reason for this discrepancy is that many experience a higher mental suffering from flying, and that they are willing to pay to reduce this suffering. It was also consistently found that people are willing to pay more for a certain risk reduction if the original price was higher. Policy implications are discussed.

Keywords: contingent valuation, transport, value of a statistical life, willingness to pay, anchoring, bad deaths

JEL Classification: H0, H54, I18, I30, R40

Most of us know that it is safer to fly compared to traveling by most other transport modes. Nevertheless, this insight is often not accompanied by a corresponding feeling of security. Instead, we often tend to feel more insecure when flying compared to when traveling by car or by any other surface transport mode. A possible reason for this is that the genetic evolution, which largely determines our instincts and spontaneous fears, is very slow compared to the technological development, implying that our instincts are often poorly adapted to the modern society. Irrespective of the reasons for the differences in the degree of fear, does this imply that we are willing to pay more for a certain reduction in the risk of a fatal accident when flying compared to when traveling by other transport modes?

It is important to distinguish between two different aspects of this problem. One is that people in general may tend to overestimate certain risks, notably spectacular ones with large media coverage such as flight incidents and accidents (see e.g. Slovic, 2000) and those with very low probability (see e.g. Viscusi, 1992). Thus, it may be reasonable to believe that individuals systematically overestimate accident risks associated with flying relative to other transport modes. Although this in itself is an interesting issue, we will not analyze this any further in this paper. Instead we are interested in another aspect, namely if people are willing to pay more for a risk reduction when flying, even after they are explicity informed about, and have accepted, the true objective risks. If they are, should this be seen as rational, and should these values guide future public priorities?

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There are several reasons why individuals would be willing to pay more for the same risk reduction when traveling by air compared to by other transport modes, such as car or train. Subramanian and Cropper (2000) identify four characteristics of risks that affect the respondents' attached values to a risk reduction: the seriousness of the risk, if the respondents are at risk themselves, the voluntariness of the risk, and the controllability of the risk. The aim of this paper is to study whether there are *other* reasons that may explain why individuals may value risk reductions differently when traveling by air or by car. Thus, in order to identify such reasons for differences in people's maximum willingness to pay (WTP), per unit of risk reduction between different transport modes, the seriousness of the potential incidents have to be the same, and the respondent has to be personally at risk. Therefore we focus solely on fatal accidents for the respondents themselves. In the case of voluntariness there naturally exists a large range between for example paragliding, at one extreme, and passive smoking on the other.[1] In our case we compare trips that are undertaken freely by the persons themselves. The last reason, the controllability of the risk, is slightly more problematic. Depending on factors such as driving skills and speed, individuals can, to a large extent, affect the risk of a fatal car accident. In order to avoid a possible confounding effect of controllability and fear, we compare an air trip to a taxi trip. Our assumption is that the perceived degree of controllability is similar in these two modes, although it can be argued that the perceived controllability is somewhat higher for the taxi trip, e.g. since it is always possible to discontinue a taxi trip.

Remaining reasons for WTP discrepancies to be analyzed include: (i) individuals may perceive and suffer differently from the same objective risk when flying, (ii) it might be expected to be more traumatic to die in an air crash, and (iii) flights are generally more expensive, and that anchoring on the price of the trip may induce a higher WTP for risk reductions when flying.

There is growing evidence that it is problematic to consistently measure values of statistical lives using stated-preference methods (e.g. Beattie et al., 1999; Hammitt and Graham, 1999), e.g. due to the large cognitive burden of comparing the expected welfare effects from small risk reductions, to the ones from small monetary changes. However, the focus of this paper is not on the *absolute* WTPs values, and hence not on quantifying values of statistical lives either. Instead, the purpose is to determine the *sign* of the obtained WTP *differences* among different contexts, such as transport modes, for a given risk reduction.

By using the contingent valuation (CV) survey technique based on a representative random sample of adults in Sweden, we test the hypothesis of whether mode of transport matters for the elicited WTP, and also whether the baseline cost of the trip influences the WTP, e.g. through anchoring. This is done by designing different risk reduction scenarios for different modes of transport (taxi and air) and for different baseline costs.

We find that people's WTP for a given risk reduction is much larger when traveling by air compared to by taxi. This is shown using both between-sample and within-sample tests. Thus, also when the same respondent answered two WTP questions for the same risk reduction when flying and traveling by car, and for the same baseline cost of the trip, the mean WTP is more than two times as high for the same risk reduction when flying, implying that the implicit value per statistical life is also more than two times as large then. The underlying motives are analyzed by follow-up questions; these reveal that one important reason for the difference in WTP is that many experience a higher mental suffering from flying, and that they are willing to pay to reduce this suffering. We also find an effect on WTP of the baseline cost: people are willing to pay more for a certain risk reduction if the original price is higher. The policy implications of these results are not obvious, however. If it is individual welfare that matters intrinsically it is clear that confusion or psychological or cognitive inabilities to choose in a rational way, e.g. choices based on biased perceptions of certain small risks, should not influence public policy. For example, it is difficult to argue that welfare effects of reduced risks would be higher if the base price were higher. On the other hand, higher mental suffering from flying appears to be a legitimate reason for a higher value per statistical life in air transport compared to road transport, provided that this suffering is sensitive to changes in the real risk.

1. Survey design and methods

The questionnaire consisted of three parts. The first part contained questions about the respondent's long distance (more than 300 km one-way) travel experiences during the 6 months prior to the survey. The second part contained the WTP question and some follow-up questions related to the perception of the way risks were communicated, and the third part contained socio-economic questions. We used both focus groups and pilot tests in order to develop the CV survey and the wording of the scenario. In the introduction to the CV section of the questionnaire, small risks were generally discussed; the introductory text is presented in Appendix. The purpose of this section was to help the respondents to comprehend small risks. There has been an extensive discussion in the literature about the problems of communicating small risks to individuals and which approach to take when doing so. Corso, Hammitt, and Graham (2001) contains a recent discussion of different "visual aids" to improve the understanding of small risks. Examples of visual aids are "risk ladders" (Carson and Mitchell, 1993; Hammitt, 1990) and representations of risks using squared graph paper where the relevant number of squares were blacked out (Jones-Lee, Hammerton, and Philips, 1985; Corso, Hammitt, and Graham, 2001), but also verbal "probability analogies." (Hammitt and Graham, 1999). Corso, Hammitt, and Graham (2001) perform a test of different visual aids by randomly assigning them amongst the respondents. They find that in comparison to a situation where the risk is not communicated by any visual aid, visual aids result in responses that are more consistent with economic theory by being sensitivity to the magnitude of the risk reductions. Moreover, among the different visual aids used to communicate risk, a graph paper and a risk ladder with logarithmic presentation of the risk performed best, since in both of these cases the hypothesis of WTP being proportional to risk cannot be rejected.[2] We therefore used a graph paper presentation of the risks, but in addition we also used a verbal probability analogy (see Appendix).

A graph paper was presented in the questionnaire, consisting of 333 squares, where each square represents 3000 persons, which thus in aggregation equals to 1 million persons. This equals the number of people in the age group 45–55 year living in Sweden. The respondents were then informed that one square also represents the number of people in the age of 45–55 who will die in one year, i.e. the risk is one out of 333. After that we introduced the concept of small risks. It was explained that there are events which carry very low risks and thus to represent such a small risk in the graph paper would result in a partly covered square. We showed such a small risk in a square, which of course only looks like a tiny dot. This points to the inherent problem with small risks: visualizing them. Thus, in order to illustrate this tiny dot, we showed a magnified square. In the magnified square, the very small risk was again presented, and it was a rather small dot. Moreover, the respondents were told that an example of such a small risk is that of an adult male dying from an electric shock, which is one in a million. Finally, in a written section, respondents were told that a small risk of one in a million is equivalent to a case where all inhabitants of Stockholm receive one lottery ticket each and only one of them wins. The complete risk descriptions are provided in the appendix.

The WTP scenario contained a description of a reduction in the fatal accident risk for a journey by taxi and/or by air depending on the version of the questionnaire. Some respondents answered two valuation questions, one for each mode, while others only answered for one mode. In all scenarios the risk reduction was the same: from one in a million to 0.5 in a million. The reason for this very low risk is that communicated risks should be of a reasonable magnitude compared to the actual risk of flying.[3] Both the taxi and the air scenarios are presented below in Figures 1 and 2. As can be seen, the differences between the taxi and the air scenarios, including the final destination, were very small.

In order to test the influence of the price of the trip, two different versions of the air and taxi scenario were used. In the case of air travel the cost of the trip was either 500 SEK[4] (Case *i*) or 3000 SEK (Case *ii*), and for the taxi scenario the cost was either 50 SEK (Case *iii*) or 500 SEK (Case *iv*). Consequently, with this treatment we are able to directly compare the stated WTP for the two modes of transport since in Cases *i* and *iv* we use the

Suppose that you are going to travel by taxi, for example from your home to the train station or the airport, or from a restaurant to your home. It is only you from your household who are traveling.

- There are two taxi services to choose between, Taxi Service AAA and Taxi Service BBB. Both taxi services have cars with the same comfort, and the travel time is the same.
- The only thing that differs between the services is the risk of an accident with a fatal outcome. This is because Taxi Service BBB has a car with a more advanced safety system that decreases the impact of serious accidents. The risk for smaller accidents is however the same for both services. Both tax services comply with the Swedish authority's minimum restrictions on safety.

Swedish authorities have established for the two taxi services the following risk ratios for a serious accident with a fatal outcome for this type of trip:

Taxi Service AAA Risk = 1 in 1 million
Taxi Service BBB Risk = 0.5 in 1 million

These risks correspond to the ones shown on the graph paper. The risks are very small for both services compared to other risks in society. It is therefore a choice between very small risks that you will make.

Traveling with Taxi Service AAA costs 500 (or 50) SEK.

Question 1:
How much would you at most be willing to pay for traveling with Taxi Service BBB instead of with Taxi Service AAA? Remember that the extra money you pay for traveling with Taxi Service BBB reduces the possibility of other consumption. For example, this money could be used for reducing any other accident risk. Also remember that in all respect the services are identical except that Taxi Service BBB has a safer car, and that the risk are very small for both services.

Figure 1. Willingness-to-pay scenario for the taxi trip.

Suppose that you will fly to Amsterdam for a one-week vacation and that it is only you from your household who will travel. Imaging that you will fly from the airport located closest to your home. Even if you feel that it is unrealistic that you will travel alone, we ask you to imaging yourself in such a situation.

- There are two airlines to choose between, Airline AAA and Airline BBB. Both airlines use the same type of aircraft, and they have the same comfort, service onboard, flight time and departure times.
- The only thing that differs between the airlines is the risk of an accident with a fatal outcome. This is because Airline BBB has initiated a stricter service and pilot program than airline AAA. The risk for smaller accidents is however the same for both airlines, and the same also applies to hijacking and other terrorist actions. Both airlines comply with the Civil Aviation Administration's minimum restrictions on safety.

Swedish aviation authorities have established for the two airlines the following risk ratios for a serious flight accident for a roundtrip trip between Sweden and Amsterdam.

Airline AAA: Risk = 1 in 1 million
Airline BBB: Risk = 0.5 in 1 million

These risks correspond to the ones shown on the graph paper. The risks are very small for both airlines compared to other risks in the society. It is therefore a choice between very small risks that you will make.

Flying with Airline AAA costs 3000 (or 500) SEK for a roundtrip ticket.

Question 1:
How much would you at most be willing to pay for flying with Airline BBB instead of with Airline AAA? Remember that the extra money you pay for flying with Airline BBB reduces the possibility of other consumption. For example, this money could be used for reducing any other accident risk. Also remember that in all respects the airlines are identical except that Airline BBB has introduced a stricter service and pilot program, and that the risks are very small for both airlines.

Figure 2. Willingness-to-pay scenario for the air trip.

same risk reduction and cost of the trip. However, one could argue that a more relevant test would be to let a respondent answer both the air and the taxi scenarios. Then we could directly compare the WTP between the two modes of transport. However, it is possible that respondents may try to behave in what they consider to be a consistent manner. In order to test this, we designed two additional versions of the questionnaire. Thus, Case *v* included different transport modes but the same price, i.e. stating both Cases *i* and *iv*, and a Case *vi* included different transport modes at different prices, i.e. Cases *ii* and *iv*. The 6 cases are summarized in Table 1. These cases were randomly distributed among the respondents.

Following the WTP question(s), all respondents were asked an attitude question regarding what they thought about using graph paper for describing risks. Furthermore, for those respondents who answered two valuation questions (Cases *v* and *vi*) an additional section was included on the motivation of their responses. This section was divided in to three parts, depending on whether they stated the same, a higher, or a lower WTP in the taxi trip version in comparison to the air trip version. They were given a number of alternative explanations to choose from, including an open-ended alternative.

2. WTP results

The survey was sent out to 2380 randomly selected individuals in Sweden in May 2002. Of these, 90 were returned due to "address unknown."[5] Out of the remaining 2290 questionnaires, 1059 (46%) were returned out of which 996 were available for analyses while

Table 1. Cases of mode of transport and price of trips used in the contingent valuation scenarios.

Case	Air trip at a price of 500 SEK	Air trip at a price of 3000 SEK	Taxi trip at a price of 50 SEK	Taxi trip at a price of 500 SEK
i	X			
ii		X		
iii			X	
iv				X
v	X			X
vi		X		X

Table 2. Willingness-to-pay (SEK) for a risk reduction from one in one million to one in two millions.

Version	Mode	Price	Mean WTP	Mean VOL (SEK 10^6)	Median WTP	Std	Max WTP	Prop. zeros (%)	Nobs
i.	Air	500	212.4	424.8	100	305.1	2000	27	160
ii.	Air	3000	503.9	1007.7	300	901.1	6000	31	176
iii.	Taxi	50	17.3	34.6	10	25.2	100	41	159
iv.	Taxi	500	73.3	146.7	20	140.5	750	44	169
v.	Air	500	171.3	342.7	100	217.3	1500	27	166
v.	Taxi	500	67.8	135.6	50	118.5	600	41	166
vi.	Air	3000	400.9	801.7	300	493.7	3200	30	166
vi.	Taxi	500	57.5	115.1	45	96.6	700	42	166

the residual contained non-responses to various items.[6] The obtained responses to the WTP question on risk reduction are presented in Table 2, separated on the different versions.

As indicated in Table 2, the WTP for a risk reduction is systematically higher for traveling by air compared to by taxi. In Table 2 we also calculate the corresponding values per statistical life saved. The values are generally quite high. The major reason for this is presumably that we have used, compared to many other studies, a small risk reduction. Although testing for scale-effects is not the purpose of this study, the findings in almost all previous studies (Hammit and Graham, 1999) are that the WTP does not increase in proportion to the risk reduction, as one would theoretically expect for small risks according to conventional economic theory, implying that the resulting estimated values per statistical life saved decreases when the size of the risk reduction increases. In any case, we do *not* recommend these figures to be the base of a value per statistical life saved used in public policy; the survey was not designed for that purpose but rather to study some methodological issues.

2.1. *The effect of the baseline price*

For a given transport mode, the WTP for a given risk reduction clearly increases in the original price. The results of the tests are presented in Table 3, and for both modes of transport we can reject the hypothesis of equal WTP distributions between the low and high

Table 3. Tests of equal WTP for different versions and WTP questions, for the same risk reduction.

Versions to be compared		Mean WTP difference	t-test[a] t-value	t-test[a] P-value	Non-parametric test of the distribution[b] Z-value	Non-parametric test of the distribution[b] P-value
Test of the same WTP for versions with different baseline prices and the same mode						
(i) Air mode, price = 500 SEK	(ii) Air mode, price = 3000 SEK	−291.46	−4.04	0.000	−3.26	0.001
(iii) Taxi mode, price = 50 SEK	(iv) Taxi mode, price = 500 SEK	−56.06	4.96	0.000	−2.74	0.006
Test of the same WTP for versions with different modes and the same baseline prices						
(i) Air mode, price = 500 SEK	(v) Taxi mode, price = 500 SEK	139.06	5.26	0.000	−5.43	0.000
(v) Air mode, price = 500 SEK	(v) Taxi mode, price = 500 SEK	103.55	7.48	0.000	−8.38	0.000
Test of the same WTP for versions with one or two WTP-questions; same modes and baseline prices[c]						
(i) Air mode, price = 500 SEK	(vi) Air mode, price = 500 SEK	41.07	1.40	0.164	−0.30	0.764
(ii) Air mode, price = 3000 SEK	(v) Air mode, price = 3000 SEK	102.99	1.32	0.188	−0.15	0.882
(iv) Taxi mode, price = 500 SEK	(v) Taxi mode, price = 500 SEK	15.82	1.29	0.230	−0.03	0.973
(iv) Taxi mode, price = 500 SEK	(vi) Taxi mode, price = 500 SEK	5.38	0.38	0.704	−0.37	0.714

[a]For independent sample, independent t-test assuming unequal variance.
[b]For independent samples, the test is the Wilcoxon-Mann-Whitney test and for dependent samples the test is the Wilcoxon signed rank test.
[c]Versions (v) and (vi) include two WTP questions, one for each mode (see Table 1 or 2); the other versions include only one.

price scenarios (comparing Cases *i* and *ii*, and Cases *iii* and *iv*) by using both a standard t-test and a non-parametric Wilcoxon-Mann-Whitney test. A likely reason for this difference in WTP is an anchoring effect (Tversky and Kahneman, 1974; Northcraft and Neale, 1987; Kahneman, 1992). Thus, the cognitive processes behind the stated WTPs are influenced by the given beseline price of the trip. A crucial issue is whether such anchoring effects exist only in the survey situation (see e.g. Green et al., 1998), or whether actual behavior is also affected so that people in real life are willing to pay more for a safety improvement if the baseline price is high. A reason why anchoring effects, and other choice heuristics, would be particularly important in survey situations is that the smaller the incentives, in terms of stakes involved, the less cognitively demanding strategies are likely to be applied by a rational consumer. On the other hand, Chapman and Johnson (2002) reviewed four experimental studies on anchoring and incentives and concluded that economic incentives reduce anchoring very little, if at all. In our case, follow-up questions (to be discussed below) indicate that the WTP for a risk reduction is affected by the baseline price in real choices as well.

2.2. The effect of transport mode

There is also a clear difference in WTP between the modes of transport, even when the price is the same. The effect of transport mode can be tested both *between* samples (comparing Cases *i* and *iv*) and *within* samples (comparing responses in Cases *v* and *vi*). In all three comparisons, the hypothesis of equal WTP distributions is firmly rejected at conventional levels. Finally, there is a possibility that the responses were affected by whether only one or two kinds of trips were considered. For example, by including both a taxi and an air trip version, respondents might be more likely to answer the same WTP in both scenarios. However, the hypothesis of equal WTP distributions between versions, for the same transport mode, cannot be rejected in any of the four comparisons (comparing Cases *i* and *vi*, Cases *ii* and *v*, Cases *ii* and *v*, and Cases *iv* and *v*). The results are summarized in Table 3.

2.3. Follow-up questions

The follow-up questions for the respondents answering to both the taxi and the air trip questions reveal some interesting information as shown in Tables 4(a) and (b). We begin with the questionnaire version where the prices were the same, and focus on those respondents who had a higher WTP for the air trip. The most important reason (almost 80%) for their responses was that they perceived a higher risk with flying, and that they were willing to pay for reducing this risk. We also see that only 6% stated that they believed that the actual risk of flying is larger than what we reported in the scenario. Still, we cannot rule out that people were influenced by their prior beliefs about the risks, as in the prospective reference theory model (Viscusi, 1992, 1998), and that these priors may differ systematically between the transport modes. Almost 10% considered it to be more traumatic to die in an air crash, and said that this affected their responses.

In the questionnaire version with a higher price for the air trip, more than half of those who stated a larger WTP for the air trip said that the price difference was a reason for their response, as shown in Table 4b. Hence, it seems not only to be the case that the reference level induced by the original price *unconsciously* affects people through some simplified heuristic choice strategies. People also seem to consider that a higher price level of a trip is a legitimate reason for spending more for the same safety improvement. This is interesting since conventional economic theory of course predicts that the original price should not matter.[7] At the same time, a rather large proportion of respondents (50%) still stated that they perceive a higher risk when flying, and hence are willing to pay more for a risk reduction.

3. Regression analysis

In the regression analysis of the WTP responses, we test our hypotheses regarding WTP for risk reductions when allowing for different influences of the socio-economic characteristics and survey versions on stated WTP. Thus, this allows us to explain differences in WTP among different socio-economic groups. Table 5 presents descriptive statistics for the whole sample. In the survey, information on several personal characteristics of the respondents was collected. Total net household income, which includes any benefits and allowances, was collected in 16 predetermined intervals. We assigned the midpoint income of the appropriate

Table 4. (a) Stated reasons behind WTP responses for those respondents who were asked about both the taxi and air trips. The same baseline prices (500 SEK) were given for both the air and the taxi trips. Several response options were possible.

Reason for stated WTP difference between modes	Fraction (%)
Stated WTP Air > Stated WTP Taxi (n = 89)	
Believe the risk of flying is higher than what is given in the scenario	6
Perceive a higher risk when flying	79
More terrible to die in an air crash	9
Other	22
Stated WTP Air < Stated WTP Taxi (n = 3)	
Believe the risk of traveling by taxi is higher than what is given in the scenario	33
Perceive a higher risk with taxi	0
More terrible to die in a car crash	33
Other	33
Stated WTP Air = Stated WTP Taxi (n = 66)	
Same risk change	55
Same prices	24
Other	26

(b) Stated reasons behind WTP responses for those respondents who were asked about both taxi and air trips. Air trips had a higher baseline price than taxi trips (3000 versus 50 SEK). Several options were possible.

Stated WTP Air > Stated WTP Taxi (n = 106)	
Believe the risk of flying is higher than what is given in the scenario	11
Perceive a higher risk when flying	50
More terrible to die in an air crash	12
Higher air price	57
Other	7
Stated WTP Air < Stated WTP Taxi (n = 4)	
Believe the risk of traveling by taxi is higher than what is given in the scenario	0
Perceive a higher risk with taxi	50
More terrible to die in a car crash	0
Lower taxi price	0
Other	50
Stated WTP Air = Stated WTP Taxi (n = 43)	
Same risk change	60
Higher air price	5
Lower taxi price	5
Other	42

Table 5. Descriptive statistics.

Variable	Description	Mean	Std
Male	1 if male	0.51	0.50
Age	Age in years	44.11	13.38
Senior high	1 if completed senior high	0.44	0.50
University	1 if completed university	0.35	0.48
Income	Equivalence scaled monthly household income in SEK	13372.10	6951.58
Low income	1 if Income is lower than 4000	0.05	0.21
Kids	1 if kid(s) under 18 in household	0.37	0.48
Fear of flying	1 if expressed fear of flying	0.05	0.23
Scenario helped	1 if the scenario facilitated understanding to a large extent or facilitated understanding	0.59	0.49
Squares helped	1 if the squares facilitated understanding to a large extent or facilitated understanding	0.61	0.49

interval to each household. In order to compare income among households, we employ the equivalence scale used by the Swedish National Tax Board. The scale assigns the first adult the value of 0.95, all other adults are set at 0.7 and each child at 0.61. Finally, we also included responses on the question regarding whether our scenario and graph paper helped the understanding of risks. From Table 5, we see that a majority of respondents considered our description of small risks to be relatively helpful.

The dependent variable, WTP, is censored since it equals zero for a substantial fraction of the respondents. We therefore estimate a conventional Tobit (sometimes denoted Tobit type I) model. This is a rather restrictive model. In particular, it does not really acknowledge that there are two fundamentally different issues: whether to state a positive WTP or not, and how much to state, given a positive WTP. As discussed in Carlsson and Johansson-Stenman (2000), there are a number of less restrictive specifications that could be used, such as the Tobit with selection (Tobit type II) model, which in turn can be estimated in different ways. However, as is the case for most selection models, they are sensitive to how well the first stage (the probability of a positive response) can be explained by the data. This is the case in our study as well, and therefore we focus on a less sophisticated, but a more robust, independent two-stage model. Here the decision on whether or not to state a positive WTP is modeled with a standard Probit model, followed by an independently estimated truncated regression on the positive responses.[8] Hence, we do not estimate any correlation between the selection and the structural model.

In the estimations we pool the data for the different survey versions for each transport mode and we include dummy variables in order to identify the different versions: High Price Scenario and Combined Scenario. The latter means that both taxi and air were valued in the same questionnaire (Cases *v* and *vi*). The dependent variable is the (natural) logarithm of WTP.[9]

As shown in Table 6, few of the coefficients are significant at conventional levels in any of the models, reflecting relatively small differences *among* groups of people with different

Table 6. Marginal effects for Tobit, Probit and truncated regression models of the WTP for risk reduction in air and taxi survey versions.

	Air			Taxi		
Regression	Tobit	Probit	Truncated regression	Tobit	Probit	Truncated regression
Dependent variable	ln(WTP + 1)	Pr(WTP > 0)	ln(WTP + 1) given WTP > 0	ln(WTP + 1)	Pr(WTP > 0)	ln(WTP + 1) given WTP > 0
Intercept	−2.715	−0.489	4.001	−0.969	−0.357	4.884
	(0.344)	(0.248)	(0.000)	(0.672)	(0.458)	(0.000)
Male	−0.234	−0.008	−0.319	0.114	0.044	−0.203
	(0.332)	(0.808)	(0.000)	(0.544)	(0.268)	(0.033)
Age	−0.011	−0.001	−0.0007	−0.015	−0.004	0.002
	(0.260)	(0.320)	(0.840)	(0.049)	(0.028)	(0.541)
Senior high	−0.204	−0.036	0.006	−0.349	−0.048	−0.373
	(0.564)	(0.498)	(0.960)	(0.183)	(0.397)	(0.005)
University	−0.296	−0.040	−0.085	−0.426	−0.052	−0.460
	(0.428)	(0.482)	(0.511)	(0.123)	(0.377)	(0.001)
ln(Income)	0.619	0.079	0.138	0.231	0.062	−0.170
	(0.044)	(0.083)	(0.201)	(0.352)	(0.236)	(0.185)
Low income	0.299	0.049	−0.008	0.836	0.201	−0.394
	(0.748)	(0.702)	(0.980)	(0.264)	(0.179)	(0.281)
Kids	0.348	0.033	0.277	0.019	−0.0008	0.022
	(0.166)	(0.421)	(0.005)	(0.931)	(0.986)	(0.837)
Fear of flying	1.422	0.161	0.538	0.571	0.081	0.395
	(0.005)	(0.003)	(0.001)	(0.142)	(0.330)	(0.038)
Scenario	−0.101	−0.004	−0.075	0.045	0.021	−0.123
helped	(0.745)	(0.930)	(0.491)	(0.856)	(0.689)	(0.312)
Squares	0.343	0.058	−0.063	0.503	0.103	0.058
helped	(0.264)	(0.203)	(0.562)	(0.038)	(0.046)	(0.628)
High price	0.424	−0.031	1.001	0.328	−0.070	1.377
Scenario	(0.078)	(0.381)	(0.000)	(0.211)	(0.201)	(0.000)
Combined	−0.025	0.004	−0.062	0.127	0.034	−0.005
Scenario	(0.918)	(0.906)	(0.462)	(0.569)	(0.471)	(0.967)
Sigma	3.563			3.267		
	(0.000)			(0.000)		
Number of observations	659	659	471	652	652	386

p-values in parentheses.

socio-economic characteristics. The estimates confirm our non-parametric test results that the cost of the trip affects people's behavior (or at least their survey responses) and that whether or not the two trips were valued in the same questionnaire does not affect the stated WTP. It is also interesting to note that the cost of the trip does not significantly affect the *probability* of stating a positive WTP; instead it has only a significant, positive, effect on the *level* of WTP.

Male respondents have a lower WTP for both air (about 30%) and taxi (about 20%) trips, which may reflect that males are less risk averse, as found in other studies such as Jianakoplos and Bernasek (1998) and Hartog, Ferrer-i-Carbonell, and Jonker (2002). The effects of education are small in most cases, although higher education implies a lower WTP for the taxi trip (given a positive WTP).

In order to calculate the overall income-elasticity of the expected WTP, we simply differentiate the log of the expected WTP with respect to the log of income; cf. McDonald and Moffitt (1980). Since we have that $E[WTP] = Pr[WTP > 0]E[WTP|WTP > 0]$, the corresponding income-elasticity is given by

$$\frac{\partial \ln E[WTP]}{\partial \ln y} = \frac{\partial \ln[\Pr[WTP > 0]E[WTP \mid WTP > 0]]}{\partial \ln y}$$
$$= \frac{\frac{\partial \Pr[WTP>0]}{\partial \ln y}}{\Pr[WTP > 0]} + \frac{\partial \ln(E[WTP \mid WTP > 0])}{\partial \ln y},$$

where the first term is the marginal effect from the Probit model divided by the fraction of positive responses, and the second is the coefficient estimate from the OLS. Both are evaluated at sample mean.[10] Thus, for air trips the estimated overall income elasticity is equal to 0.25 using the independent two-stage model, which is much lower than the elasticity obtained from the conventional Tobit model (type I). In both cases the estimated income elasticities are positive and below unity. Note that, due to the functional form, these income elasticities are also valid for the value per statistical life saved. Thus, we find value of life income elasticity for value per statistical life saved clearly below unity, which is found in most CV studies; see for example Persson et al. (2001), who also used Swedish data and found an income elasticity of 0.24. It is debated whether this is a reflection of underlying preferences, or whether it is an artifact of the CV method *per se* (Diamond and Hausman, 1994; Hanemann, 1994). As a comparison, Miller (2000) made a large cross-country comparison of value of statistical life studies and found the income elasticity to be in the range of 0.85 to 1. In the taxi trip case, the coefficient is insignificant for income.

Not surprisingly, those who are scared of flying are willing to pay much more for a risk reduction when flying, but it is less obvious that they are also willing to pay more also for taxi risk reductions. The reason is presumably that those who are afraid of flying are, on average, somewhat more cautious in general. Whether the respondents found the risk descriptions helpful or not did not affect their WTP very much, although those who did not find them helpful reported zero WTP to a somewhat higher degree, and for the taxi scenario in particular.

4. Conclusions and policy discussion

In a between-sample test we have found that people's WTP for a given risk reduction is significantly higher for flying than for traveling by taxi. The choice of these two transport modes was designed because we wanted the controllability of the risks to be the same. Moreover, the same result was obtained in a within-sample test where each respondent answered two WTP questions for the same risk reduction when flying and traveling by taxi; people were still willing to pay more than two times as much for the same risk reduction, even when the baseline cost was the same, implying that the implicit value per statistical life is also more than two times as large when flying. Follow-up questions also revealed that the main reason for the higher WTP in the air trip case, when the original prices of the trips were the same, was that they subjectively suffered more from this risk, and therefore were willing to pay more to reduce this mental suffering. It was also consistently found that people were willing to pay more for a certain risk reduction if the original price was higher.

From a public policy perspective, should we then apply a higher value per statistical life saved for improvements in air transport safety compared to for example road transport planning? Following Broome (1999) and Johansson-Stenman (2002), we think it is individual welfare or well-being that matters intrinsically, and not utility as revealed by their choices in cases where the two differ. Unfortunately, the terminology is far from standardized in this area. Kahneman, Wakker, and Sarin (1997), for example, use the pedagogical terminology *experienced utility* versus *choice utility*, where the latter guides individual behavior, and the former has effects on individual well-being.[11] Irrespective of terminology, given that it is individual well-being that matters intrinsically, it is clear that confusion or psychological or cognitive inabilities to choose in a rational way, e.g. choices based on biased perceptions of certain small risks, should not influence public policy. Hence, there is a limit to consumer sovereignty based on revealed preferences in this respect.[12] For example, it is difficult to argue that welfare effects of reduced risks would be higher if the base price were higher; we see this as something that affects choice utility rather than experienced utility, to use the terminology of Kahneman, Wakker, and Sarin (1997). Consequently, the facts that air trips are more expensive in general, and that people are willing to pay more for increased safety if the trip is expensive, does not justify a higher value per statistical life saved for air trips.

On the other hand, it was also found that air safety improvements were valued higher when the price was the same, and that the mental suffering appears to be the main reason for the higher WTP in the air transport case. Even though one may think that such suffering *per se* is irrational in the sense that it is not appropriately related to the objective risk, clearly the suffering is perfectly real to those who perceive it. Again, given that it is individual welfare that matters intrinsically, it is hard to see why that suffering should not count as much as other kinds of mental and physical pains. The implication of this seems to be that a higher value per statistical life saved should be applied in air transport compared to road transport planning.

However, it is also possible that it is the action of paying for increased safety *per se* that reduces the suffering, and not the corresponding risk reduction.[13] That is to say, the same risk reduction caused by stricter general regulations implemented by the authorities may have a much less profound effect on the travelers' risk sufferings. It is of course the latter effect that matters for policy. Whether that effect is negligible or not is still very much an open question left for future research.

There are also other possible reasons for applying different values per statistical life saved for different modes of traveling. For example Viscusi (1998, p. 65) argues that since airline passengers are, on average, wealthier than others, their WTPs for safety improvements are also higher, implying that there are pure efficiency arguments for using higher value per statistical life saved for air trips. He also defends this proposition against potential distributional objections (cf. e.g. Sunstein, 1997) since the cost of these stricter safety standards would fall on the travelers themselves through higher ticket prices. On the other hand, we have found that females are willing to pay more for a risk reduction, corrected for income. Since males are over-represented among air travelers, this gender effect partly offsets the income effect. In addition, the incentives for an airline to promote itself as a "safe airline" are of course present irrespective of WTP discrepancies and their underlying reasons. For such advertisement to be credible there must be some correspondence between stated high safety levels and actual safety, i.e. that differences in safety between airlines are at least partly observable to the travelers. If so, travelers with high WTPs for safety probably already enjoy lower risks since they will travel by safer airlines. This illustrates that it is questionable to base analyses of appropriate safety standards on averages from the traveling population, since the implemented standard may be binding for only certain parts of that population, i.e. for those with relatively low willingness to pay for safety.

To conclude: This paper has shown that people's WTP for a given risk reduction vary significantly between transport modes, but that this fact does not necessarily imply that different values of statistical lives should be applied.

Appendix: Risk description

Most activities that we humans conduct involve exposing ourselves to risks of different kinds. On the graph paper to the right, some different risks of dying are illustrated. Each square represents 3000 individuals in their fifties (ages 45–55), and all the squares together represent all individual in their fifties in Sweden (approximately 1 million).

One square also corresponds to the average number of individuals in their fifties who die in Sweden in one average year. Thus, approximately 3000 individuals in their fifties die per year in Sweden.

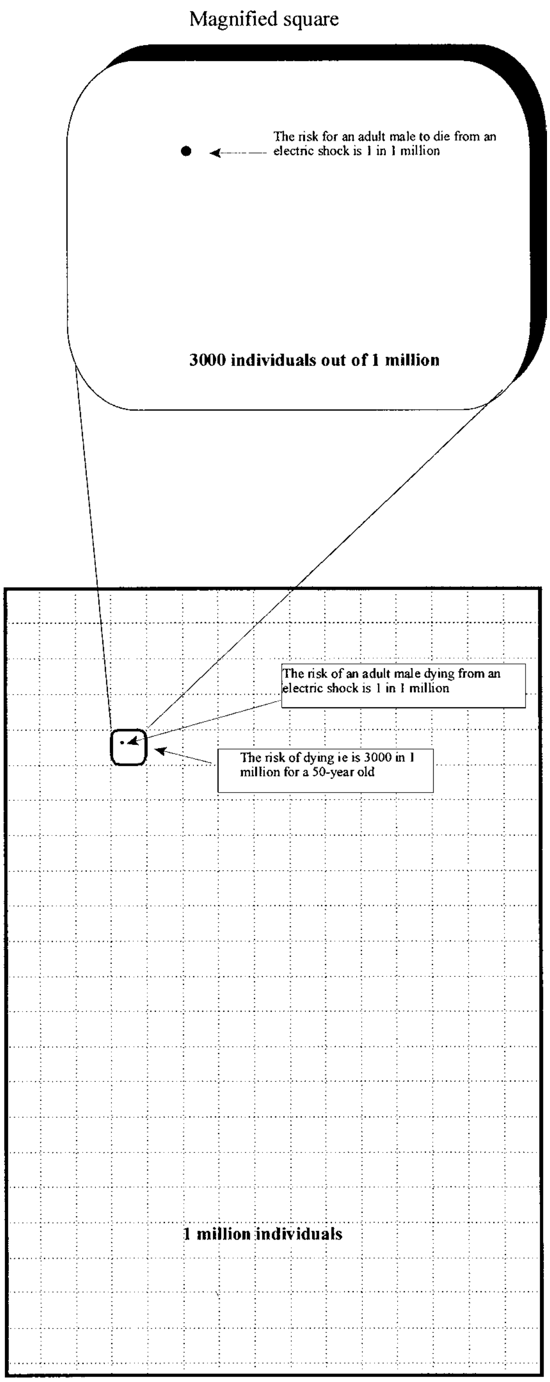
Some activities that we humans undertake imply *very* small risks. One such small risk is illustrated on the graph paper. As you see, this risk is just a tiny dot on the graph paper, i.e. this risk is very small compared to many other risks.

We have also magnified one of the squares in the cross-ruled figure. This magnified square corresponds to 3000 individuals (out of 1 million). In this square, one such small risk is shown:

- ○ The risk of an adult man dying from en electric shock is 1 in 1 million (in one year)

As you see, this risk is very small compared to the overall risk of dying. The probability is the same as if all inhabitants of Stockholm would each receive a lottery ticket and that only one person would win.

We are now going to ask you some questions to you about your view on such very small changes in risks.


Magnified square
The risk for an adult male to die from an electric shock is 1 in 1 million
3000 individuals out of 1 million
The risk of an adult male dying from an electric shock is 1 in 1 million
The risk of dying ie is 3000 in 1 million for a 50-year old
1 million individuals

Notes

1. For example, Sunstein (1997) found that people are willing to pay a premium to avoid what he labels "bad deaths" that are especially dreaded, uncontrollable, involuntarily incurred and inequitably distributed, such as cancer.
2. When there is a small change in risk, economic theory predicts that WTP is approximately proportionate to the risk reduction (Hammit, 2000).
3. Indeed, the actual risk of flying may be even lower; for example in the US the fatal accident rate per 1 million departures varied between 0.1 and 1.1 between 1987 and 1996 (Federal Aviation Administration, 1996).
4. The exchange rate at the time of the survey was 1 USD = 10.05 SEK.
5. Two weeks after the questionnaire was sent out, a reminder was sent out to those respondents who had not yet answered.
6. One individual gave extreme answers to the valuation questions in Case *vi*, 2 million SEK and 1 million SEK, and we therefore excluded this respondent from the analyses.
7. And the small income effect induced by the price would, if anything, imply that a higher basic price should cause a smaller WTP (for a normal good with a positive demand income elasticity).
8. We estimate the second stage with a truncated regression since the dependent variable is strictly positive, however the results are almost identical if we instead use a standard OLS.
9. Since there are observations with zero WTP in the Tobit model, we estimate all models with In(WTP+1) as the dependent variable.
10. Given that $\frac{\partial \ln(E[WTP|WTP>0])}{\partial \ln y} \approx \frac{\partial E \ln([WTP|WTP>0])}{\partial \ln y}$.
11. This is also related to the view of Harsanyi (1982, 1995), who argues that what should matter in social decision making is the *true* or *informed* preferences, that is, the preferences a rational individual equipped with perfect information would have.
12. Still, there are of course *instrumental* reasons why one should be very careful, and restrictive, when applying paternalistic policies in practice (Johansson-Stenman, 2002).
13. This is somewhat similar to the warm glow (Andreoni, 1989, 1990), or purchase of moral satisfaction (Kahneman and Knetsch, 1992), obtained for the mere act of contributing to a good social cause, and where the same utility would not appear if someone else instead made the contribution. Here, however, there is no contribution to a good social cause that causes utility, but rather the instrumental effect on one's own suffering or anxiety.

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