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Valuing risks of death from terrorism and natural disasters

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Abstract This paper uses a random utility model to examine stated preferences for the valuation of public risks of fatalities from terrorist attacks and natural disasters. Traffic-related deaths serve as the common reference point in two series of pairwise risk-risk tradeoff choices. Even after taking into account differences in respondent risk beliefs, the nationally representative sample values the prevention of terrorism deaths almost twice as highly as preventing natural disaster deaths and at about the same level as preventing deaths from traffic accidents, which pose greater personal risk. Education, seatbelt usage, political preferences, and terrorism risk beliefs affect valuations in the expected manner.

Keywords Risk tradeoffs · Terrorism · Natural disasters · Dread · Hurricane Katrina · 9/11 attack

JEL D61 · D62 · D64 · H41 · H56

Risks of terrorism and natural disasters differ in four main respects from the principal risks for which economists have established money-risk tradeoffs—job risks, product risks, and motor-vehicle risks. First, terrorist attacks and natural disasters often generate a cluster of deaths rather than a single fatality. Hundreds or perhaps thousands of people may die in a single catastrophe. Second, the perceived probability of death due to a terrorist attack or a natural disaster is very heterogeneous across the country and is quite low for much of the country, typically much lower than for many other risks of accidental death. Thus far, the U.S. deaths from terrorist attacks have been clustered geographically, as are many disaster risks,

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whereas traffic risks are much more diffusely distributed. The absolute level of risk across the entire population differs as well. The number of people who die in motor-vehicle accidents every month exceeds the annual average death toll from natural disasters and the total number of deaths from the 9/11/01 attacks. Third, risks of terrorism and, to a lesser degree, natural disasters are public risks that often may be less the result of a market exchange than, for example, job risks or product safety risks. Risks that are not anticipated will not be captured in market risk premiums. It is unlikely that victims of the 9/11 attack received a compensating wage differential for the unanticipated risks posed by the attack from foreign terrorists.[1] After the risks of potential terrorist attacks become known there will be real estate market effects and labor market effects, as found by Becker and Rubinstein (2004) and by Abadie and Dermisi (2008). Real estate in areas with well known risks of natural disasters, such as beachfront homes in hurricane regions, likewise commands a lower price.[2] Fourth, risks from terrorism and natural disasters often involve dimensions other than risks to life and property. The 9/11 terrorist attack indicated a broader threat to national security and U.S. standing in the world, and the failure of the post-Katrina efforts and the flood prevention measures that had been in place have been viewed by many as a national disgrace.

This paper examines the American public's valuation of saving lives by reducing the fatality risks associated with terrorist attacks and natural disasters. These valuations will reflect the valuation of personal risks as well as an altruistic concern with reducing risks to others.[3] The primary matter of interest is the valuation of risks to the general public, which may include a personal risk component, but the main beneficiaries will be people other than the individual whose valuation is being elicited. Thus, as with the study of transportation safety by Chilton et al. (2002), the focus is on the total societal value of reductions in public risks rather than on the private value of statistical life. Rural residents in Montana and other areas far removed from New York or Washington, D.C. may perceive little personal threat from terrorism based on their observation of attacks in the U.S. and the pattern of attacks abroad. This phenomenon of assuming that the 9/11 attack provides a scenario that affects the likely profile of future terrorist attacks is reflected in individual risk perceptions that are much lower outside of New York City (Fischhoff et al. 2003). Similarly, real estate prices in Chicago for regions outside of the central business district areas in Chicago are less affected by the post-9/11 expectations because they are not as similar to the World Trade Center area as is the area including the Sears Tower (Abadie and Dermisi 2008).[4]

Despite the absence of a substantial perceived private benefit from disaster policies and anti-terrorism efforts, there may nevertheless be considerable support for public policies to address these risks. After the 9/11 attack, the U.S. enacted a

[1] The earlier, thwarted attempt to bomb the World Trade Center in 1993 may, however, have had some effect on wages.

[2] Terrorist attacks also produce economic costs generally, as found by Enders and Sandler (1996) and Abadie and Gardeazabal (2003).

[3] For analysis of the proper treatment of altruism for policy risk valuations, see Kaplow (1995) and Jones-Lee (1991).

[4] Similarly, there is evidence of a strong local housing market response to hurricanes and near-miss hurricanes, as found in Hallstrom and Smith (2005) and Bin et al. (2008).

victim compensation fund for those affected by the attack and initiated a variety of government policies directed at reducing future deaths from terrorism. Similarly, the plight of the victims of Hurricane Katrina evoked widespread concern that was not limited to the self interest of those exposed to these risks and led to a strengthening of the flood control system.[5] The public continues to be willing to provide support for victims of future natural disasters, but that support is tempered both by perceptions that people exposed to the risk have created a situation of moral hazard (Viscusi and Zeckhauser 2006) and the extent to which the public identifies with the demographic profile and deservingness of those affected (Fong and Luttmer 2007). These expressions of concern are also mirrored in government policies more generally as disaster shocks stimulate public support for policy interventions to compensate the victims and reduce future risks.[6]

Estimation of the value of terrorism risks is a fundamental building block for benefit-cost analysis of anti-terrorism policies. A pivotal component of valuing anti-terrorism policies is the value of the benefits of preventing terrorist attacks. This paper will estimate the benefits for reducing deaths from terrorism attacks relative to reducing other fatality risks. Because deaths from terrorist attacks differ in the many aforementioned ways from private risks traded in the market, the values placed on reducing these risks may differ from the usual values of statistical life. Put somewhat differently, the commodity that people are purchasing with reductions in terrorism risks is different in many dimensions from the usual private risks. To the extent that different risks of death have different values based on the nature of the risk, the approach adopted here of analyzing risk-risk tradeoffs for different kinds of risk will illuminate these differences.[7]

Data from an original survey provide the basis for estimating the implicit value of the lives saved by policies that reduce risks from terrorism and natural disasters. The choice-based survey presents respondents with a series of pairwise risk reduction choices, each of which involves a choice of reducing either disaster risks or terrorism risks, where respondents compare reductions in deaths from those risks to reducing traffic-related deaths. Thus, rather than asking survey respondents to make choices that imply a tradeoff between fatality risks and money, respondents make a series of risk-risk choices in which deaths from traffic accidents serve as the scale by which these risks will be valued.

In addition to exploring how the public's valuations of different kinds of risk reduction differ, and to what extent, the paper examines the factors that contribute to the utility values of the lives saved by reducing different risks. Some influential factors can be traced to the individual's personal exposure to the risk, while other determinants of utility values reflect the demographic characteristics of the respondent or attitudes toward risk-taking behavior.

[5] Closely related to the issue of public support for protective and compensatory policies is the role of insurance, both from the standpoint of private markets and the government. The issue of who should pay for terrorism risk events is examined by Kunreuther and Michel-Kerjan (2004, 2007).

[6] Kahn (2007) explores how environmental disasters have triggered regulatory policy actions.

[7] An innovative study along these lines is that by Smith et al. (2009), who find that households are willing to pay $100 to $200 to prevent terrorists from making a shoulder mounted missile attack on a commercial airplane.

Section 1 describes the survey structure and the nationally representative sample used for the study. The estimates of the random utility model in Section 2 yield information on the relative valuations of these three different kinds of risk. Section 3 explores the degree of heterogeneity in the valuations and the demographic factors that influence these values, and Section 4 concludes. Not all fatalities are valued equally. Terrorism-related deaths command a substantial premium relative to preventing deaths from natural disasters and are comparable in value to the more personal risks from traffic accidents. Thus, respondents place a higher value for each expected terrorism death than for each natural disaster death. Interestingly, differences in personal risk exposure play the greatest role for deaths from a terrorist attack, but even people with low terrorism risk beliefs value the reduction of terrorism-related fatalities much more highly than fatalities from natural disasters.

1 The survey structure, sample, and model

1.1 Survey design

The stated preference survey used to value fatality risks from terrorist attacks and natural disasters is a computer-based questionnaire administered to a nationally representative web-based panel. The questionnaire begins with a series of questions that elicit information on the respondent's experience with disaster risks, then elicits risk beliefs for the pertinent risks, and subsequently presents respondents with a series of tradeoff questions involving two different pairs of risks—traffic deaths v. natural disaster deaths and traffic deaths v. terrorism deaths. Traffic deaths consequently serve as the common reference point, which can then be used empirically to establish tradeoff rates among all three types of fatalities. Demographic background questions follow and are supplemented by demographic information that the survey firm has about the respondents.

A distinctive aspect of the survey approach is the use of risk-risk tradeoffs to elicit valuations of risks of terrorism and natural disasters. This approach, which was introduced in the environmental economics literature by Viscusi et al. (1991), offers several advantages in dealing with the valuation of these types of hazards. First, because the risks tend to involve small absolute probabilities, respondents can focus on more readily processed comparisons such as whether preventing 100 deaths from a terrorist attack is valued more highly than preventing 100 traffic deaths. Second, the comparisons involve a single dimension of choice—fatalities—so that respondents can focus on how fatalities are viewed without dealing with the less readily commensurable tradeoff between money and fatality risks. Eliminating money as an attribute of choice also eliminates the task of establishing a credible payment mechanism for the policy. Third, because the risk-money tradeoffs for risks such as those associated with auto safety are well established, the valuations can potentially be converted into dollar equivalents. In 2008 the U.S. Dept. of Transportation established $5.8 million as the agency's value of statistical life (VSL) for all transportation-related deaths.[8]

[8] U.S. Department of Transportation, Office of the Assistant Secretary for Transportation Policy, Memorandum: Treatment of the Economic Value of Statistical Life in Departmental Analyses, 2008.

The main assumption involved in making this bridge chaining the risk-risk tradeoffs with VSL estimates is that the income effects of the program expenditures embedded in the risk-risk survey question are small. The risk-risk questions in the survey assume a program cost c for some risk reduction policy, which will lower respondents' income level. The standard VSL estimates are at the original income level. The key assumption in being able to chain the empirical results with VSL figures is that the income effects of the program cost c are small.

How low probability risks will be valued is not clear a priori. Kahneman and Tversky (1979, p. 283) hypothesize that "highly unlikely events are either ignored or overweighted." Based on the characteristics of the risk and previous research, one would expect that natural disaster risks are more likely to be undervalued and terrorism risks will receive a greater weight. Studies of individual insurance purchases by Kunreuther et al. (1978) indicate a private failure to purchase sufficient insurance coverage for risks from natural disasters. In addition, the influence of perceived moral hazard may reduce the valuation amounts.[9] Factors that may affect the valuations of natural disaster risks positively include the role of dread with respect to these risks, press coverage of disaster risks, and a desire to avoid a repetition of the adverse effects associated with Hurricane Katrina.[10] Whether these influences are sufficient to offset the factors leading to undervaluation is unclear, and it is unlikely that these positive influences will be as strong as their counterpart for risks from terrorist attacks.

The factors likely to boost the relative valuations of preventing deaths from terrorist attacks are likely to be more influential and include much more than the linkage of terrorism risks to broader concerns regarding national defense. A primary determinant of public risk perceptions and support of policy interventions is news coverage, and the most prominent recent news event is the 9/11 attack, which Eisensee and Strömberg (2007, p. 703) found to have generated the largest recent spike in news coverage. While storms and floods also receive substantial coverage, they have received less attention than what are arguably more visually dramatic hazards, such as volcanoes and earthquakes. The unprecedented nature of terrorist attacks in the U.S. also produced a substantial increase in risk beliefs, which will tend to generate a stronger reaction than would risks of the same magnitude to which one has become accustomed, such as hazards posed by natural disasters. The analysis below will take into account individual perceptions of the risk so as to control for the effect of differences in individual risk beliefs on their risk-risk tradeoffs.

The survey elicits these personal risk beliefs after presenting respondents with general information concerning the level of the risks. The survey then asks respondents to assess their risks relative to the average population risk. The use of the above-average, below-average, and average risk format for eliciting risk beliefs is necessitated by the low level of the risks, which makes elicitation of objective risk values difficult.[11] Moreover, given that respondents are presented with average risk

[9] The prominence of these and other concerns is a central theme of Viscusi and Zeckhauser (2006) and Fong and Luttmer (2007). The demographic characteristics of disaster victims also have an important effect on the public's attitudes toward disaster policies.

[10] Chilton et al. (2006) provide a detailed exploration of dread risks.

[11] This formulation is also consistent with the approach taken by Chilton et al. (2002) in which risk-risk matching tasks account for whether the respondent is "at average, above average, or below average" risk.

information, giving them an objective reference point for what is an average risk, distinguishing how they perceive their personal risk relative to that level is sufficient for the subsequent empirical analysis, which seeks to ascertain valuations for standardized risk levels.

The traffic safety information that precedes the question asking respondents to rate their relative risk is as follows: "Each year just under 40,000 people in vehicles die in traffic accidents in the United States. On the average day about 100 people die due to traffic accidents. These risks are isolated deaths. Even for major accidents the number of people killed in a particular accident is not great." Following that information, respondents rate their own relative risk. The distribution is that 48% perceive their risk as being average, 44% perceive their risk as being below-average, and 8% perceive their risk as being above-average.[12] This pattern in which few people view themselves as facing above-average risks from motor-vehicle accidents is a well documented phenomenon.[13]

The other two risks considered in the survey are the catastrophic risks of natural disasters and terrorist attacks. The survey describes each of these risks with reference to highly publicized risk events. Because Hurricane Katrina and the 9/11 attacks are among the most highly publicized and most costly risk events in U.S. history, using these events to illustrate the risks should engage respondents in thinking about the risks. The possible influence of extensive past publicity or preferences is similar for both of these risks. This publicity may affect the valuations elicited in this survey, just as it may also influence the general public's attitudes toward preventing similar events in the future.

The risk information for the natural disaster questions is as follows: "In contrast, natural disasters kill large numbers of people at the same time and are major national catastrophes. Hurricanes, floods, tornadoes, and earthquakes are major types of disasters. Hurricane Katrina killed over 1,000 people, and every year natural disasters kill over 100 people on average." As with the traffic safety risk, most respondents believe that they do not face above-average risks, but a greater percentage think that their risks are below-average. The distribution of responses is 35% average risk, 59% below-average risk, and 6% above-average risk.[14]

The final risk category of terrorism risks presents similar information: "Natural disaster risks aren't the only risks that kill many people at the same time. Attacks by international terrorists can cause a catastrophic number of deaths. The 9/11 terrorist attacks killed 2,976 people." The terrorism risk belief distribution is 41% who believe that they face average risk, 50% who consider themselves to be facing

[12] Unless indicated otherwise, these and subsequent statistics will be for what I will term the "consistent sample" of respondents. The responses for the full sample are virtually identical and differ by less than 1 percentage point for any category—e.g., average traffic risk of 47.7% for the full sample versus 47.8% for the consistent sample.

[13] This pattern of risk beliefs could of course be accurate if risks are highly concentrated among a small segment of the driving population, as discussed in Viscusi and Zeckhauser (2006). Or the result could be a form of overoptimism, as in Rethans (1979). Finally, the result could also be due to a framing effect resulting from people's unwillingness to rate themselves worse than the average.

[14] This distribution of risk beliefs is not unprecedented for risks of natural disasters. See generally Kunreuther et al. (1978) and Camerer and Kunreuther (1989) for documentation of low risk beliefs for natural disasters.

below-average risk, and 8% who believe they face above-average risk. All three types of risks have similar percentages for the above-average risk belief category, as these percentages range from 6% to 8%. The main differences arise with respect to the average risk/below-average risk split. The percentage of people who believed their risk to be below-average for terrorism risks is 6 percentage points higher than the comparable percentage for traffic safety and 9 percentage points lower than the below-average risk beliefs for natural disasters. Traffic-related hazards, which are the most uniformly distributed across the population, have the lowest percentage of people who view themselves as facing below-average risks.

The orders of magnitude for the levels of the three types of risks are quite different. Consider the risk levels relative to the size of the 2006 U.S. population of 302 million. Based on the information provided above, the annual traffic safety risk across the population is 0.00013, or 13/100,000, which is the only risk of the three risk categories in the study that exceeds 1/10,000. The hurricane risk in a typical year involves only 100 deaths. As a result, this risk is 3.3 per 10 million people, or 3.3×10^{-7}. Even in the Hurricane Katrina year when an additional 1,000 people were killed, which respondents would interpret as bringing the death toll to 1,100, the risk is only 3.6×10^{-6}, or about 1/250,000. If the 9/11 attacks were to become an annual event, which seems to be unlikely given the post-9/11 experience, then the risk would be 9.8×10^{-6}, or about 1/100,000. The traffic safety risks are more than an order of magnitude greater than the two other risk categories. These risk level differences and the low levels of risk led to the use of the relative risk questions to elicit risk beliefs.

The higher level of risks for traffic safety risks as compared to natural disasters and terrorism risks also implies that people have more of a personal stake in protection, which in turn will boost their valuation of this risk category. In contrast, due to the much lower level of personal risk, the valuations of reductions in natural disaster deaths and terrorism deaths are almost exclusively altruistic valuations. By analyzing risk valuations for different categories of risk belief, it will be possible to take into account the effect that differential risk exposures and risk beliefs have on the valuations.

After providing information on their assessed risk beliefs, respondents considered a series of paired tradeoff questions. The top panel of Fig. 1 presents the sample disaster valuation question. The framework elicits a policy choice between two policies, one reducing the number of deaths from natural disasters and the second reducing the number of traffic-related deaths. The survey characterizes the nature of the risks, isolates accidents versus a major catastrophe, and tells respondents the expected number of deaths prevented by the policy. For example, a choice of Policy 1 in the top panel implies that preventing 50 traffic deaths is more valuable than preventing 100 natural disaster deaths. For those selecting Policy 1, traffic deaths are more than twice as highly valued per statistical death. The bottom panel of Fig. 1 presents the comparable tradeoff question for traffic deaths and terrorism deaths.[15] A choice of Policy 2 for this question implies that the value of terrorism deaths is at least three times as great as the value of an expected traffic-related death. The

[15] There could, of course, be multiple terrorist attacks in a given year, but the frequency of such attacks in the U.S. is sufficiently low that a single attack scenario is more plausible.

Examples of Risk Tradeoff Questions

Sample Disaster Question:

Suppose you can vote for one of two different policies that cost the same amount but reduce different kinds of risks. Traffic safety policies reduce isolated deaths. Natural disaster policies prevent deaths from a single major catastrophe. Which of the two policies would you prefer?

	Traffic Safety	Natural Disaster
Type of Deaths Prevented	Isolated Accidents	Major Catastrophe
Average Number of Deaths Prevented	50	100
Which Policy would you prefer?	Policy 1	Policy 2

Sample Terrorism Question:

Suppose you can vote for one of two different policies that cost the same amount but reduce different kinds of risks. Traffic safety policies reduce isolated deaths. The terrorism policy prevents deaths from a single major attack. Which of the two policies would you prefer?

	Traffic Safety	Terrorism Policy
Type of Deaths Prevented	Isolated Accidents	Major Terrorism Attack
Average Number of Deaths Prevented	150	50
Which Policy would you prefer?	Policy 1	Policy 2

Fig. 1 Examples of risk tradeoff questions

estimated tradeoff rates will be determined using all responses within the context of a random utility model rather than focusing on the bounds implied by the individual responses. The empirical analysis pools the within subject responses for all three tradeoff situations considered.

For each of the tradeoff pairs, respondents considered a series of 6 different tradeoff combinations: (50,100), (250,25), (25,125), (125,100), (150,50), and (100,100). These pairs are randomized across respondents in two ways. First, the order of the choices is reversed so that half the respondents receive tradeoff combinations from the block of choice combinations (100,50), (25,250), etc. rather than from the block indicated above. Second, the order in which these 6 tradeoff questions appear from the particular tradeoff question block is randomized so that only one in six respondents seeing the first question block receives (50,100) as the first choice.

The use of traffic-related deaths as a reference point has as its antecedents the risk-risk tradeoff analyses in Viscusi et al. (1991), Magat et al. (1996), and Chilton et al. (2002, 2006). Those studies used an iterative choice format in which respondents indicated preferences between two types of risk reduction, where the choices were subsequently altered until indifference is achieved. The methodology used here does not iterate to establish indifference directly but rather adopts a random utility model of individuals' expressed preferences and based on these responses estimates the utility values and tradeoff rates for the different risks.

A fundamental feature of the tradeoff choice is that respondents are valuing a specific number of deaths for each class of risks. One would expect that averting a terrorist attack or deaths from a natural disaster would be more highly valued than preventing deaths from a single automobile crash, which will entail fewer fatalities. If respondents were to assess prevention of particular adverse risk events rather than preventing some total number of fatalities, doing so would lead to traffic safety policies having the lowest value. Similarly, inordinate concern with large scale, highly publicized risks would also decrease the relative value of improvements in traffic safety. To the extent that such discrepancies are not observed below, it will serve as a check on the degree to which respondents focused on the number of deaths prevented, as stated in the survey, rather than their vision of a representative risk outcome. The two main risks of interest, natural disasters and terrorist attacks, each have a symmetric structure with natural disasters involving a "major catastrophe" and terrorism policies addressing a "major terrorism attack." Thus, the clustering aspect of the deaths for these two risk categories is constant.[16] For the comparison of terrorism deaths and natural disaster deaths, traffic safety deaths serve as the numeraire. The fact that traffic-related deaths are not clustered deaths is irrelevant for purposes of the analysis. However, when comparing the valuation of traffic-related deaths to either terrorism deaths or natural disaster deaths, multiple attributes are in play including the number of deaths in a single event, the context of the deaths, and one's perceived personal risk.

The nature of the individual deaths may be consequential. Although all the risks involve acute accidental deaths rather than deaths after lingering illnesses, the degree of "dread" associated with terrorism risks may be greater. A premium for terrorism risk reduction may stem in part from differences in risk beliefs. The survey will address these differences by giving explicit fatality reduction numbers for each risk category, thus telling respondents the expected number of deaths rather than asking them to calculate this value based on their own risk beliefs. It will also be feasible to control for the level of respondents' assessment of the personal risk so that it will be possible to analyze tradeoff rates conditional on the perceived risk level.

Because of the small probabilities involved, the questions focus on the total numbers of deaths prevented. These fatalities can be converted into a reduction in population risk levels.[17] In each instance, the risks are broadly based throughout the U.S. population so that the overall risk population denominator is common to all these risks. People may, however, differ in their personal risk exposure, and these differences will be taken into account in the estimation process by analyzing tradeoff rates conditional on the respondent's perceived risk levels for each of the hazards.

[16] Jones-Lee and Loomes (1995) did not find an effect of the scale of accidents on the valuation of transport safety.

[17] The nature of this conversion is common to similar risk-risk comparison tasks. As Chilton et al. (2002, pp. 213–214) observe: "In order to convert deaths prevented into a risk reduction the respondent must therefore, at least implicitly, take account of (a) the size of the population at risk in that context; (b) whether or not he/she is a member of that population and (c) if so, whether he/she is at average, above average, or below average exposure to the risk."

1.2 The sample

After a series of pretests, the survey was administered by Knowledge Networks (KN) in 2006. The KN sample is a nationally representative panel recruited using a probability sampling approach. Participants in the panel take surveys either by computer or a Web TV device. The response rate for the survey is 79%. The characteristics of the sample for this study closely parallel the U.S. population and include a diverse mix of the U.S. population age 18 or older. For example, the February 2006 CPS benchmark fraction of males is 48.4%, as compared to 47.4% for the complete sample.[18] The full sample consists of 1,135 respondents. The sample was reduced from 1,135 to 1,108 after dropping the 27 respondents who did not give complete answers to all questions being analyzed.

As is the norm in the literature on stated preference surveys, it is essential to undertake validity checks to ascertain whether the responses pass a series of scope tests. For example, at the most basic level, a reduction in traffic safety deaths should have a positive value. A variety of these rationality tests based on the overall regression results for the sample are reported below and are consistent with rational survey responses.

In addition to these broadly based tests, the series of pairwise choices made by respondents provides the opportunity for numerous more rigorous checks on the transitivity of responses that are more demanding than the usual kinds of scope tests in the literature. Respondents considered two sets of 6 question blocks, and within each block there are multiple opportunities for intransitive choices. For example, a respondent choosing Policy 1 from the choice pair (50,100) has revealed relative values for the two injury groups that will be inconsistent if the respondent also picks Policy 2 for the choice pairs (250,25), (125,100), (150,50), or (100,100). Each of the 12 choices made by respondents provides similar, numerous opportunities for intransitive behavior. Only 119 respondents failed one or more of these transitivity tests, and only 45 failed more than one inconsistent choice. The possibility for occasional random errors is great in view of the difficulty of the choice task. Given the very demanding nature of the rationality test, the overall consistency rate of the responses is quite high. The analysis below is restricted to the 989 respondents who passed all the consistency checks. Thus, every one of their choices passes a sometimes demanding transitivity test. As indicated below, the overall estimated pattern of the valuations is similar for the full sample.[19] The Appendix reports additional scope tests of the validity of the survey responses.

[18] Even for demographic groups for which one might expect the greatest differences, such as education, the parallels are quite close. The percentage distribution of the sample is 15.2% for less than high school, 32.1% for high school, 25.5% for some college, and 27.3% for bachelor or higher. The February 2006 CPS counterpart percentages are 15.0, 31.6, 28.0, and 25.4. The college-educated are overrepresented by just under 2%, those with some college are underrepresented by 2.5%, and the other educational categories are within 0.5% of their national averages.

[19] The sample characteristics are quite similar as well. The fraction of female respondents is 0.52 for the full sample and 0.51 for the consistent sample. The average age is 46.9 for the full sample and 47.0 for the consistent sample. The average number of years of schooling is 13.5 for the full sample and 13.7 for the consistent sample.

1.3 Random utility model

The survey structure is designed to provide data for estimation based on a random utility model, as it presents respondents with a series of discrete pairwise policy choices involving the number of traffic deaths prevented and either the number of natural disaster deaths prevented or the number of terrorism deaths prevented. The focus of these choices is on prevention of deaths among the general population for policy purposes rather than private self-protection. Respondents then choose which of the two policies they prefer. The stated preferences with respect to these choices can then be used in a random utility framework to analyze the utility tradeoffs between each of the three possible tradeoff pairs.

The statistical analysis of the series of risk choices uses the following random utility model.[20] The three types of risk that potentially can be affected by the policy choices are reductions in traffic deaths t, natural disaster deaths h, and terrorism deaths r. The utility for policy i ($i=1,2$) for respondent n is given by u_{ni}. The basic model will make utility a function of only the three main effects, or

$$u_{ni} = \alpha\, t_{ni} + \beta\, h_{ni} + \gamma\, r_{ni} + \varepsilon_{ni} \qquad (1)$$

where ε_{ni} is the random error term. Because all demographic characteristics are common to all policy option valuations, they are not included in the model as main effects, as they will drop out of the analysis when taking the utility difference between the policy alternatives.

The probability p_{ni} that respondent n chooses policy option i on any given pairwise policy comparison is given by

$$p_{ni} = \text{Prob}\left(\alpha t_{ni} + \beta\, h_{ni} + \gamma r_{ni} + \varepsilon_{ni} \ \rangle\ \alpha t_{nj} + \beta\, h_{nj} + \gamma r_{nj} + \varepsilon_{nj}\right), \text{ for } j \neq i. \qquad (2)$$

The regression analysis pools the results for twelve different choices made by respondents—six for each of the two sets of paired comparisons that they consider. Because the analysis uses multiple observations per individual, the estimated standard errors reported for the conditional logit models are robust and clustered by individual respondent.[21]

The models estimated below will include several additional refinements. Personal characteristics enter the analysis through interactions with the main effects. In particular, there is a series of possible interactions of demographic variables x_n with the main effects. Let Ψ_k denote the coefficient of the interaction of x_n with main effect k, k = t,h, and r. Then utility in the model including interactive effects will be characterized by

$$u_{ni} = \alpha\, t_{ni} + \beta h_{ni} + \gamma\, r_{ni} + \Psi_t t_{ni} x_n + \Psi_h h_{ni} x_n + \Psi_r r_{ni} x_n + \varepsilon_{ni}. \qquad (3)$$

Personal characteristics such as risk beliefs alter the utility values and consequently the tradeoff rates but do not have any independent effect on choices because they do not vary across the policy choices.

[20] McFadden (1974) and Train (2003) provide background on this approach.
[21] The conditional logit model also includes fixed effects for each set of tradeoff questions.

2 Policy choice regressions

2.1 Conditional logit estimates

For any given policy choice, respondents considered policy tradeoffs involving traffic deaths and either disaster deaths or terrorism deaths. Column 1 in Table 1 pools the data from all 12 paired comparisons involving both sets of tradeoffs. Columns 2 and 3 in Table 1 report regression estimates in which only the particular pair set is analyzed. The main matter of interest is not the absolute level of the utility coefficients, as utility levels are defined only up to a positive linear transformation. Rather the focus will be on the signs and statistical significance of the effects and the coefficient ratios, which provide information on the tradeoff rates between the different risk categories. All the individual main effect coefficients are positive and statistically significant at the 0.01 level. Thus, all three fatality risk categories pass the pertinent scope test in terms of their average regression estimates. This result is simply the regression valuation counterpart to the individual transitivity tests above in which each of the 12 choices made by every respondent met the transitivity requirement. The series of behavioral scope tests reported in the Appendix also are consistent with national survey responses.

Totally differentiating the value of u_{ni},

$$0 = \alpha \mathrm{dt} + \beta \mathrm{dh} + \gamma \mathrm{dr}. \tag{4}$$

The rate of tradeoff between natural disaster deaths and traffic deaths is given by

$$\partial \mathrm{h}/\partial \mathrm{t} = -\alpha/\beta, \tag{5}$$

which has a value of 1.94 for column 1 in Table 1 and 1.93 for column 2 in Table 1. Lives saved by reducing traffic safety deaths are valued almost twice as highly as lives saved by preventing natural disaster deaths.

Similarly, one can calculate the tradeoff between reducing terrorism deaths and reducing traffic safety deaths given by

$$\partial \mathrm{r}/\partial \mathrm{t} = -\alpha/\gamma, \tag{6}$$

Table 1 Conditional logit estimates of policy choice[a]

Deaths prevented by policy	1	2	3
Traffic deaths	0.0125***	0.0156***	0.0100***
	(0.0005)	(0.0006)	(0.0004)
Disaster deaths	0.0064***	0.0081***	–
	(0.0004)	(0.0005)	
Terrorism deaths	0.0112***	–	0.0095***
	(0.0005)		(0.0005)
N	23,682	11,844	11,838

[a] Notes. Figures in parentheses are robust and clustered standard errors. ***Significant at the 0.01 level, two-tailed test

which has a value of 1.11 for column 1 and 1.05 for column 3. Respondents view the value of reducing risks of traffic safety deaths and terrorism deaths as being very comparable.

The third tradeoff rate is between disaster deaths and terrorism deaths and is given by

$$\partial \mathrm{r}/\partial \mathrm{h} = -\beta/\gamma, \tag{7}$$

which has a value of 0.57. Terrorism deaths have a utility value almost twice as great as natural disaster deaths.

While these and subsequent results will focus on the full sample, including the inconsistent responses in this analysis does not greatly alter the results. The results for the full sample, including the inconsistent responses, show a similar pattern. Traffic-related deaths have a value 1.14 times as great as terrorism deaths, while terrorism deaths have a value 1.82 times as great as natural disaster deaths. If only respondents with more than one inconsistent response are eliminated, the tradeoff rates are 1.14 for traffic deaths relative to terrorism deaths and 1.73 for terrorism deaths relative to natural disaster deaths. Restricting the sample to those respondents who gave consistent responses that pass all pertinent transitivity tests has very little effect on the estimates.

Table 2 summarizes the relative valuations associated with the coefficient ratios implied by the results in Table 1. These tradeoff rates as well as those calculated below involve the ratios of coefficients and sometimes more elaborate formulations, complicating the calculation of the standard errors for the tradeoff rates. All standard errors reported for the tradeoff rates will involve nonlinear combinations of coefficient estimates.[22] Table 2 also reports the standard errors for these tradeoff rates. The final column in Table 2 uses these results and reports the associated 95% confidence intervals. For the estimation including all three risks reported in column 1 in Table 1, it takes between 1.71 and 2.17 disaster deaths to provide the same utility as one traffic death. In contrast, terrorism deaths have a value that is not substantially different than that of traffic deaths, as that confidence interval is from 1.01 to 1.22 for column 1, and for column 3 the confidence interval includes 1.0. In that instance, one cannot reject the hypothesis that these death risks are equally valued. The tradeoff rate between natural disaster risks and terrorism deaths has a confidence interval from 0.51 to 0.64 so that disaster deaths are valued just over half as much from a utility standpoint as are terrorism deaths.

2.2 Regressions with risk perception interactions

An important possibility is that these values do not reflect simply the utilities associated with the risk outcomes, but they instead also capture the respondent's assessed high vulnerability or perceived low vulnerability to these risks. For example, do people have an exaggerated perception of risks from terrorist attacks and an inadequate assessment of natural disaster risks that might account for the observed pattern of risk-risk valuations? To control for differences in risk perceptions, the conditional logit model estimates reported in Table 3 include

[22] These values were estimated using the delta method commands in Stata to calculate the fitted standard errors.

Table 2 Relative risk valuations implied by tradeoffs[a]

Fatality risk tradeoff category	Implied relative valuations	Standard error	95% confidence interval
Disaster deaths/ Traffic deaths			
– Equation 1	1.9394	0.1192	1.7057, 2.1731
– Equation 2	1.9236	0.1029	1.7219, 2.1253
Terrorism deaths/ Traffic deaths			
– Equation 1	1.1135	0.0548	1.0060, 1.2210
– Equation 3	1.0466	0.0594	0.9302, 1.1629
Terrorism deaths/ Disaster deaths			
– Equation 1	0.5742	0.0330	0.5045, 0.6388

[a] Note. The tradeoff categories indicate the number of deaths in the numerator that are equivalent to a single death in the denominator, e.g., Disaster deaths/Traffic deaths is the number of disaster deaths equivalent to a single traffic related safety death

Table 3 Conditional logit estimates of policy choices with risk perception interactions[a]

	Coefficient (Standard error)
Main effects:	
Traffic deaths	0.0127***
	(0.0006)
Disaster deaths	0.0071***
	(0.0007)
Terrorism deaths	0.0128***
	(0.0009)
Interactions:	
Traffic deaths × Above-average traffic risk	0.0012
	(0.0016)
Traffic deaths × Below-average traffic risk	−0.0004
	(0.0009)
Disaster deaths × Above-average disaster risk	0.0023
	(0.0019)
Disaster deaths × Below-average disaster risk	−0.0012
	(0.0009)
Terrorism deaths × Above-average terrorism risk	0.0059***
	(0.0022)
Terrorism deaths × Below-average terrorism risk	−0.0035***
	(0.0011)

[a] Notes. Figures in parentheses are robust and clustered standard errors. ***Significant at the 0.01 level, two-tailed test

interactions with the different risk perception variables. Thus, in the case of traffic deaths, there are interactions with the dummy variable for the belief that one is exposed to an above-average risk as well as for the dummy variable for the belief that the respondent is exposed to a below-average risk level. The omitted category for these and the other two pairs of interactions is that of perceived risks in line with the average risk level. In terms of Eq. 3, each of the main effects k includes an interaction term that yields a coefficient Ψ_{1k} for respondents who believe their risk is above-average and Ψ_{2k} for respondents who rate their risk as below-average. By including these sets of risk belief interactions, the main effects estimated in Table 3 will pertain to the utility values for respondents at the average risk level.

The regression estimates reported in Table 3 indicate significant positive effects of each of the main effect variables. The only risk belief interactions that are statistically significant are the two interactions for terrorism risks. Respondents with above-average terrorism risk beliefs have a higher utility value for terrorism deaths, while respondents with below-average risk beliefs have a lower utility value for terrorism deaths, each of which reflect reasonable directions of influence. The interactions for traffic deaths and disaster deaths exhibit the same pattern of signs, but are not statistically significant. Thus, the main effect estimates of the utility values for these fatalities do not vary significantly across respondents based on their risk beliefs regarding the risk. The point estimates for these two main effects are used below for all respondents when calculating the tradeoff rates. For terrorism deaths, the main effect coefficients pertain only to calculating the preferences of those in the average terrorism risk belief group.

The utility coefficient weight for terrorism deaths is quite different based on the level of risk beliefs. The utility premium for above-average risk beliefs is 1.7 times as great as the utility decrement for below-average risk beliefs. Whereas the average terrorism death utility value is 0.0128, for those who believe that they face above-average terrorism risks this value is 0.0187, while for those who believe that they face below-average terrorism risks the utility value is 0.0093.

The effect of the risk belief interaction terms is to alter the tradeoff rates. Suppose that Ψ_{r1} is the coefficient of the interaction of above-average terrorism risk beliefs and terrorism deaths, and let Ψ_{r2} be the coefficient of the interaction of below-average terrorism risk beliefs and terrorism deaths. Then the traffic death–terrorism death tradeoff for respondents who believe they face an above-average risk from terrorism is

$$\partial t / \partial r = -(\gamma + \Psi_{r1}) / \alpha, \tag{8}$$

while for those who believe that they face below-average risks, the tradeoff is

$$\partial t / \partial r = -(\gamma + \Psi_{r2}) / \alpha. \tag{9}$$

Table 4 reports the tradeoff rates implied by the results in Table 3. The first tradeoff rate shown does not involve terrorism risk, but focuses on the other two risk categories using the main effect coefficients in Table 3. Traffic-related deaths are valued 1.79 times as greatly as disaster deaths, which is a bit below the point estimate of the tradeoff rate in Table 2. The standard errors reported in Table 4 for this ratio are larger than for Table 2, and the 95% confidence interval extends from 1.44 to 2.14.

The next two sets of tradeoff rates shown in Table 4 pertain to the valuation of traffic death risks relative to the different risk perception groups for terrorism risk beliefs. For those who believe that they face above-average terrorism risks, each terrorism death is

Table 4 Relative risk valuations after accounting for risk beliefs[a]

Fatality risk tradeoff categories	Implied relative valuations	Standard error	95% confidence interval
Average disaster death risk/ Average traffic death risk	1.7888	0.1807	1.4347, 2.1429
Above-average terrorism death risk/ Average traffic death risk	0.6794	0.0785	0.5256, 0.8333
Average terrorism death risk/ Average traffic death risk	0.9940	0.0370	0.8491, 1.1389
Below-average terrorism death risk/ Average traffic death risk	1.3642	0.1157	1.1374, 1.5910
Above-average terrorism death risk/ Average disaster death risk	0.3798	0.0545	0.2730, 0.4866
Average terrorism death risk/ Average disaster death risk	0.5557	0.0545	0.4488, 0.6625
Below-average terrorism death risk/ Average disaster death risk	0.7626	0.0860	0.5942, 0.9311

[a] Note. The tradeoff categories indicate the number of deaths in the numerator that are equivalent to a single death in the denominator, e.g., Average disaster death risk/ Average traffic death risk is the number of disaster death risks at the average risk belief level for disasters that are equal to preventing a single traffic-related death for respondents with average traffic safety risk beliefs

more highly valued than a traffic death. The point estimate is that 0.68 terrorism deaths equal one traffic-related death for the above-average terrorism risk group. The 95% confidence interval for this tradeoff rate does not include 1.0. Respondents with average terrorism risk beliefs have a value of terrorism deaths that is almost identical to that of traffic deaths, with a point estimate of 0.99. For those facing below-average terrorism risks, one can reject the hypothesis that they have value of terrorism risks equal to that of traffic deaths, as 1.36 terrorism deaths equal 1 traffic-related death.

In contrast, irrespective of the terrorism risk beliefs, terrorism deaths are valued more highly than natural disaster deaths. For those who perceive an above-average terrorism risk, 0.38 terrorism deaths are equivalent to a death from a natural disaster. Those who have average terrorism risk beliefs value terrorism deaths almost twice as highly as natural disaster deaths. For the below-average risk perception group 0.76 terrorism deaths equal a disaster death. The confidence intervals for all these tradeoff rates are below 1.0 so that lives saved from reducing disaster risks are always less highly valued than the lives saved by reducing terrorism risks, irrespective of one's category of terrorism risk beliefs.

3 The heterogeneity of valuations

3.1 Mixed logit estimates

Attitudes toward prevention of fatality risks of different kinds will vary with a variety of factors, such as one's education. The extent of heterogeneity is reflected in the mixed logit regression counterpart to the conditional logit results in Table 2. Whereas the

Table 5 Mixed logit estimates of policy choice[a]

	Coefficient mean	Standard deviation
Traffic deaths	0.2881	0.1878
Disaster deaths	0.1981	0.1709
Terrorism deaths	0.2986	0.2102

[a] Note. Estimates are obtained using a hierarchical Bayes estimate technique

conditional logit model makes assumptions regarding the independence of irrelevant alternatives and does not account for the heterogeneity of risk valuations, the mixed logit approach relaxes each of these assumptions. The estimates of the mixed logit model in Table 5 utilize a hierarchical Bayes estimation technique and serve as a robustness check of the more conventional conditional logit results.[23]

The pattern of effects is generally similar to that in column 1 of Table 2. Each of the fatality risk categories commands a positive utility coefficient. However, the relative magnitudes are a bit different than earlier, and as a consequence the relative tradeoffs differ somewhat as well. The mean effects are greatest for terrorism deaths, as 0.96 terrorism deaths are equivalent to 1.0 traffic deaths. Natural disaster deaths remain lowest valued, as 0.66 terrorism deaths have the same utility value as 1.0 natural disaster deaths. As with the conditional logit results, terrorism deaths are valued roughly the same as traffic deaths, and disaster deaths have a lower value.

The figures in the final column of Table 5 are the standard deviations of the individual coefficient estimates across the sample. These values provide a measure of the degree of dispersion of the utility coefficients. Disaster death valuations are most highly variable, relative to the value of the main effect, as the utility coefficient is just a bit larger than its standard deviation. Next in terms of relative variability is terrorism deaths, for which the standard deviation is three-fourths the size of the utility coefficient. Finally, traffic deaths have a standard deviation that is two-thirds the size of the utility coefficient. This lower degree of variability in utility levels for traffic fatalities suggests that there is less variability of traffic preferences across the population.

3.2 Detailed interactions

To explore the factors generating the observed heterogeneity in valuations, Table 6 reports conditional logit estimates that include a detailed series of interaction terms with each of the main effects. There are 52 interaction terms in all, but Table 6 only reports those that are statistically significant at the 0.10 level or better. Despite the large number of such interactions, the effects are very robust with respect to the exclusion or inclusion of variables.[24] Because the interaction terms capture most of the influence of the fatality risk categories, only the traffic deaths main effect remains statistically significant.

[23] See Huber and Train (2001) for analysis of the close relationship between hierarchical Bayes and mixed logit estimates.

[24] Some important effects do vary with the specification. In the absence of including the terrorism risk belief variables, residence in a metropolitan statistical area boosts the terrorism utility coefficient. This relationship is quite plausible given the pattern of terrorism attacks to date and the strong effect of metropolitan residence on risk beliefs. See Viscusi and Zeckhauser (2003, 2006) and Fischhoff (2003).

Table 6 Conditional logit estimates of policy choice with interactions[a]

	Coefficient	Standard error
Main effects		
Traffic deaths	0.0153***	0.0058
Disaster deaths	−0.0018	0.0057
Terrorism deaths	0.0009	0.0070
Traffic deaths interactions[b]		
Environmental group member	0.0019*	0.0010
Seatbelt usage %	5.51E-5***	1.57E-5
Household income	−0.0015***	0.0005
Years of education	0.0008***	0.0002
Race: black	−0.0070***	0.0024
Hispanic	−0.0042***	0.0015
Disaster deaths interactions[c]		
Income ≥ 175K	−0.0064**	0.0029
Years of education	0.0004**	0.0002
Age	−4.87E-5*	2.78E-5
Hispanic	−0.0023*	0.0013
Northeast	0.0033**	0.0015
Terrorism interactions[d]		
Republican	0.0038***	0.0012
Seatbelt usage %	3.65E-5*	2.08E-5
Years of education	0.0100**	0.0044
West	−0.0029*	0.0016
Above-average perceived risk	0.0062***	0.0022
Below-average perceived risk	−0.0031***	0.0011

[a] Notes. *Significant at the 0.10 level; **significant at the 0.05 level; and ***significant at the 0.01 level, two-tailed test. The equation included 52 interaction terms

[b] Other interactions included Republican, Income ≥ 175K, Age, Race: Black, Female, Northeast, South, West, Metropolitan Statistical Area, Above-Average Traffic Risk, and Below-Average Traffic Risk

[c] Other interactions included Environmental Group Member, Republican, Seatbelt Usage %, Experienced Hurricane, Household Income, Income ≥ 175K, Race: Black, Female, South, West, Metropolitan Statistical Area, Above-Average Disaster Risk, and Below-Average Disaster Risk

[d] Other interactions included Environmental Group Member, Household Income, Age, Race: Black, Race: Nonwhite Nonblack, Hispanic, Female, Northeast, South, and Metropolitan Statistical Area

The total number of years of schooling of the respondent (Years of Education) has the most consistently significant effect. More education raises the utility coefficient in every instance, where the strongest effect is for deaths from terrorism. Education could be capturing either a lifetime wealth effect, a lower rate of time preference, or differences in risk beliefs not otherwise reflected in the included variables. However, it seems unlikely that lifetime income alone is the determining factor, as the level of household income (Household Income) has a negative effect on traffic fatality valuations and household income in excess of $175,000 (Income ≥ 175k) has a negative effect on disaster fatality valuations. Conceivably these surprising negative income effects are a reflection of greater self protection on the part of more affluent respondents, who may perceive less of a safety benefit if they drive safer cars and live in sturdier homes not exposed to hurricane risks.

While the education interaction term is positive and statistically significant in all three instances, what is important in assessing the tradeoff rates is how education affects the ratios of the tradeoff rates. The magnitude of the education interaction is much larger for the terrorism fatality interactions than for traffic deaths or disaster deaths. This difference in turn alters the fatality tradeoff rates. Consider the effect on the mean tradeoff rates of a one standard deviation increase in education levels. This increase in education levels leads to terrorism deaths being much more highly valued, as 0.20 terrorism deaths have the same utility value as a disaster death, and 0.39 terrorism deaths is as highly valued as a traffic-related death. The disaster death/traffic death tradeoff remains virtually unchanged by a one standard deviation increase in education levels as both utility values are affected similarly, leading to a disaster death/traffic death tradeoff of 1.97.

Another variable that has a consistent significant effect for more than one set of interactions is Seatbelt Usage %. One would expect that people who use seatbelts have a higher value of reducing risks of death from traffic accidents and are more engaged in self protective efforts in other contexts as well.[25] Seatbelt usage increases the utility of reducing traffic deaths, which is in the same risk domain, but it also increases the utility of reducing deaths due to terrorism. These effects are consistent with seatbelt usage serving as a broader index of risk valuation that extends across other types of risk as well. Seatbelt usage does not have a significant effect on the valuation of natural disaster deaths.

The interactions that indicate differences in the value of preventing terrorism deaths also accord with expectations. Respondents who are Republican (Republican party membership d.v.) place a higher relative value on preventing terrorism deaths, which is consistent with the occurrence of the 9/11 attack during a Republican administration and the prominence of combating terrorism in that political party's agenda. Those who live in the Western United States (West d.v.) are far removed from the past terrorism attacks and prominent targets such as Washington, D.C. They place a lower value on reducing these risks.[26] This result is consistent with evidence in the literature that there are less pronounced effects on risk beliefs or real estate values for areas that are remote from the 9/11 attack site or have different characteristics than the World Trade Center area.

Even after including a very extensive set of interaction terms, the two terrorism risk belief variables continue to have very strong effects on utility. Those who perceive above-average risks from terrorism place a higher utility value on reducing these deaths, while those who perceive below-average risks have a lower utility value of terrorism deaths. As with the earlier results in Table 3, the differential effect

[25] See Hakes and Viscusi (2007) for correlation of seatbelt usage with the individual's value of statistical life.

[26] The omitted regional categorical variable is the Midwest. The other included regional variables for the Northeast and South were not statistically significant as terrorism interactions.

relative to the average risk belief group is greater for those with above-average risk beliefs. That group's interaction term is double the size of the interaction term for the below-average risk belief group. This asymmetry is not unexpected, as it reflects the more general behavioral phenomenon that increases in one's risk level relative to the average for the population generate much larger effects than do risk decreases.

Traffic death risk valuations and natural disaster death valuations likewise vary with several other variables as well. Members of an environmental group (Environmental Group Member d.v.) place a higher value on reducing traffic accidents than do non-members.[27] Relative to the omitted racial category of whites, Blacks place a lower value on traffic-related deaths, and Hispanic respondents place a lower value on both traffic deaths and disaster deaths. Older respondents are less concerned with natural disaster deaths, while those residing in the Northeast have greater valuations of these risks.

4 Conclusion

While economists know a great deal about the valuation of personal risks from traffic-related deaths, the evidence on the public's valuation of deaths from natural disasters and terrorism attacks is far more fragmentary. Few people are subject to these risks, and to the extent that they are valued it will largely be through broader public concerns with these deaths rather than personal self protective actions. What we do know is that the public's willingness to pay for compensation to victims of the 9/11 attacks and Hurricane Katrina is substantial, and the government has invested billions in homeland security efforts to protect against such disasters in the future.

This article's estimates of the value of reducing terrorism deaths and natural disaster deaths relative to traffic deaths provide a sense of how highly the risks of terrorism are valued. Analysis of a series of stated preferences using a random utility model indicates that reductions in terrorism deaths have a value almost twice as great as reductions in deaths from natural disasters. For people who believe that they face above-average terrorism risks, the discrepancy is much greater. Even those who believe that they face below-average terrorism risks value reducing terrorism fatalities more highly than preventing fatalities from natural disasters. This premium for terrorism risks relative to natural disasters will also be mirrored in political support for government policies and is consistent with the Department of Homeland Security's greater emphasis on combating terrorism than preventing losses from natural disasters.[28]

The estimates indicating a high valuation of terrorism deaths and a low valuation of natural disaster deaths are not necessarily inconsistent patterns of risky behavior. The apparent underweighting of natural disaster risks is in line with other evidence

[27] This dummy variable has a value of 1 if the respondent is a member of any of the following environmental groups: Greenpeace, Sierra Club, National Resources Defense Council, Environmental Defense Fund, National Audubon Society, National Wildlife Federation, and Nature Conservancy.

[28] Of course, one cannot rule out the contributory role of bureaucratic mismanagement. Posner (2007, p. 206) critiques what he calls the government's "mishandling of the crisis created by the flooding of New Orleans as a result of Hurricane Katrina. Preoccupied with the threat of terrorism, the Department of Homeland Security allowed its attention to wander from threats of natural disaster."

suggesting that those directly exposed to disaster risks underweight them.[29] Whereas previous studies have placed primary emphasis on the role of risk perceptions in the undervaluation of natural disasters, the low weight accorded to reducing fatalities from natural disasters does not appear to be due to the levels of risk beliefs alone. The relative valuations of terrorism risks and disaster risks persist even after taking into account the respondent's risk beliefs regarding each of the hazards, thus addressing the main source of irrational responses discussed in the literature. Differences in utility values rather than differences in risk beliefs pertaining to individual exposure to the risk appear to be largely responsible for the greater valuation of reductions in terrorism deaths relative to natural disaster deaths.

To account for the high valuation of deaths from terrorism as compared to natural disasters, it should be noted that dimensions of the risk commodity other than the absolute number of deaths may be at work. Terrorism risks involve a substantial element of dread. They are also involuntary risks outside the individual's control. The dramatic nature of the 9/11 attacks surely contributes to the vivid character of the risks, which may be influential as well. Terrorism risks also bring to bear an additional aspect of national security. Terrorism attacks represent an attack on the country and involve commodity attributes that go beyond the number of lives lost. These broader political concerns may account for why terrorism risk prevention has higher values for respondents who are Republicans. Irrespective of its cause, reducing fatalities due to terrorism risks commands a considerable premium as compared to reducing fatalities from natural disaster risks. Despite the highly focused nature of past terrorism-related fatalities, terrorism deaths are valued as highly as are fatalities associated with motor-vehicle accidents, which are much more diffusely distributed. The main outlier is deaths from natural disasters, which are undervalued irrespective of one's personal risk beliefs.

Appendix

Additional scope tests

In addition to the series of transitivity tests and the positive valuation of reducing all three fatality risk groups, it is also instructive to assess whether these preferences are consistent with broad measures of behavior and attitudes toward risk within an expanded conditional logit model. These behavioral and affective scope tests expand the range of rationality tests beyond the standard scope tests, as described by Smith and Osborne (1996). As discussed by Heberlein et al. (2005), these scope tests will utilize one interaction for each of the three main effects. For traffic deaths, the interaction variable is the percentage of time that the respondent uses a seatbelt (Seatbelt Usage %). Seatbelt users have revealed a higher value of motor vehicle safety through their personal self-protection decision. There is no comparable self protective variable for natural disasters, but there is an indicator variable for whether the respondent has experienced a hurricane (Experienced Hurricane dummy variable—d.v.). One would expect such a disaster

[29] The seminal study of disaster risks documenting this result is Kunreuther et al. (1978).

experience to raise the valuation for reducing these risks. For terrorism deaths, there is neither a terrorist attack experience measure nor a self-protection variable, but there is a variable for whether the government should provide assistance to future victims of a terrorist attack (Government Assistance to Terrorism Victims d.v.).

The results reported in Table A1 for these interactions are all consistent with rational valuations. Those who use seatbelts more often have revealed a higher value of traffic safety, and this high value is reflected in their greater traffic death utility coefficient. Similarly, victims of hurricanes place a higher value on reducing deaths from natural disasters. Finally, those who favor ex post government financial assistance to terrorism victims also favor prevention of terrorism deaths to a greater degree. These preferences are consistent across these two closely related domains of choice. Because of the potential endogeneity of attitudes toward the ex ante terrorism prevention policy and the ex post terrorism victim compensation policies, this variable is not included in the subsequent regressions but is presented here as a consistency check.

Table A1

Behavioral Scope Test Conditional Logit Estimates of Policy Choice[a]

	Coefficient (Standard error)
Traffic deaths	0.0095***
	(0.0017)
Disaster deaths	0.0059***
	(0.0005)
Terrorism deaths	0.0094***
	(0.0010)
Traffic deaths × Seatbelt usage %	3.38 E-5*
	(1.86 E-5)
Disaster deaths × Experienced hurricane	0.0022**
	(0.0010)
Terrorism deaths × Government assistance to terrorism victims	0.0025**
	(0.0012)

[a] Notes. Figures in parentheses are robust and clustered standard errors. *Significant at the 0.10 level; **significant at the 0.05 level; and ***significant at the 0.01 level, two-tailed test.

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