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THE PERCEPTION AND VALUATION OF THE RISKS OF CLIMATE CHANGE: A RATIONAL AND BEHAVIORAL BLEND

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ABSTRACT

Over 250 respondents--graduate students in law and public policy--assessed the risks of climate change and valued climate-change mitigation policies. Many aspects of their behavior were consistent with rational behavior. For example, respondents successfully estimated distributions of temperature increases in Boston by 2100. The median value of best estimates was 1-3 degrees Fahrenheit. In addition, people with higher risk estimates, whether for temperature or related risks (e.g., hurricane intensities) offered more to avoid warming. Median willingness to pay (WTP) to avoid global warming was $0.50/gallon, and 3% of income. And important scope tests (e.g., respondents paid more for bigger accomplishments) were passed. However, significant behavioral propensities also emerged. For example, accessibility of neutral information on global warming boosted risk estimates. Warming projections correlated with estimates for unrelated risks, such as earthquakes and heart attacks. The implied WTP for avoidance was much greater when asked as a percent of income than as a gas tax, a percent thinking bias. Home team betting showed itself; individuals predicting a Bush victory predicted smaller temperature increases. In the climate-change arena, behavioral decision tendencies are like a fun-house mirror: They magnify some estimates and shrink others, but the contours of rational decision remain recognizable.

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1. Introduction

This study assesses people's risk beliefs and policy attitudes about climate change. In contrast to publicly available surveys in this area, which primarily ask whether respondents are worried about global warming, our study asks much more precise questions.[1] In particular, it asks people to make explicit assessments of distributions of temperature outcomes. It then inquires how much they would pay for specific policy interventions that would achieve particular policy goals. Uncertainty about the magnitude of climate change plays a key role in this study.

For this exploratory survey, our sample had 257 adult respondents, 133 from Harvard Law School and 124 from the Kennedy School of Government.[2] The overall response rate to this internet-based survey was over 70%. The survey was undertaken in October and November 2004 and was closed the day before the 2004 presidential election, when the Bush-Kerry race was a toss up. The indicator employed for climate change was the temperature increase in Boston.[3]

The results of the survey provide intriguing evidence about the respondents' risk perceptions and attitudes toward policies to mitigate those risks.[4] Section 2 explores respondents' climate change risk beliefs in considerable detail. These risk beliefs are highly diffuse. The high level of scientific uncertainty is mirrored in people's assessed

[1] For examples of surveys, see Dunlap, Gallup, and Gallup (1993), Israel and Levinson (2004). Kempton (1991, 1997) provides an interesting critique of public opinion polls and explores more detailed questions regarding the perceived consequences of climate change.

[2] We restrict our sample for analysis to 255 respondents, as two respondents gave unrealistic outlier responses indicating a failure to attend to the survey task. This survey should be regarded as an experiment rather than a nationally representative sample.

[3] Boston was chosen because that is where the respondents lived, and it was probably easiest for them to think about. The authors well recognize that global warming will have variable effects across the globe, and by season.

distribution of possible global warming outcomes, as there is a substantial spread between the 5th percentile and the 95th percentile of their assessed temperature increase distributions. Respondents' attitudes toward policy remedies, discussed in Section 3, indicate a potentially substantial level of support for truly effective climate-change mitigation policies. The influence of scientific uncertainty, which in turn influences the diffuseness of risk beliefs, should bolster support for more aggressive policies if respondents exhibit the well known behavioral phenomenon called ambiguity aversion. We found that respondents predominantly view the current scientific uncertainty as a rationale for greater support of policy interventions rather than for a wait-and-see approach. Even though the United States has lagged behind many other countries in its political support for policies to address global warming, willingness to pay for climate-change mitigation policies in this survey was not significantly lower for the U.S. respondents than for the foreign respondents.

The study emphasized the uncertainties involved with global climate change. Virtually all climate-change experts agree that there is substantial uncertainty, and even a single scientific study may recognize a great range of possible outcomes.[5] Virtually all commentators admit that their estimates of global climate movements over the 21st century are imprecise, and most would indicate that their views changed substantially in the past decade.[6] Further uncertainties arise because for any given temperature increase,

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[4] Mitigation policies would include measures such as a gas tax (discussed here) or carbon sequestration (not discussed). There could also be policies that allow society to adapt to whatever change does occur, e.g., moving activity away from coastlines.

[5] Stainforth et al. (2005) employ a "grand ensemble" of simulations using a general circulation model to estimate uncertainties. They find predicted climate change values from less than 3.6 to more than 20 degrees Fahrenheit. Estimates above 13.4 degrees Fahrenheit emerge from 4.2% of simulations.

[6] Daniel Schrag, climate-change expert, private communication, January 15, 2005. Some observers suggest that since estimates of risk have risen dramatically in recent years we should expect more upward revision. But the logic does not follow. Today's best estimate should be the mean value that will apply a decade

there is also substantial disagreement about the economic and broader social consequences. Differing sides in the policy debate have used this massive uncertainty as a rationale for aggressive policy action or policy inaction, depending in part on whether they interpret the uncertainty as posing a risk of dire consequences, or an opportunity to learn whether there is a real problem.[7]

The four goals of this study are to: 1. Examine how a group of relatively well informed individuals estimate the risks of climate change; 2. Assess how much these individuals would pay to avoid climate-change risks; 3. Identify significant biases in individuals' responses to risk assessment and willingness-to-pay questions; and 4. Identify the role of uncertainty in affecting preferred policy choices.

In addressing all of these issues, we shall be attentive to a range of behavioral biases in decision making of the type made famous by Daniel Kahneman and Amos Tversky.[8] Many of our respondents' attitudes toward climate change policies were in accord with rational decision theory; for example, people who perceive greater risks of climate change express greater support for policies to address the risks of global warming. However, we also found important behavioral anomalies, such as evidence for what we call the "correlated risks hypothesis": people who fear climate change risks also fear other unrelated risks, such as the risk of heart attacks.

We should also be clear about what we did not attempt. We did not assess whether the respondents were well or poorly informed. Nor did we assess what

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hence. This is equivalent to the belief that a stock that has gone up recently in price is no more favorable going forward than one that has moved little.

[7] For reviews of the policy debate, see Aldy, Barrett, and Stavins (2003), Schelling (1997), and Stewart and Wiener (2003).

[8] See, among the most important contributions, Tversky and Kahneman (1974), and Kahneman and Tversky (1979).

information had led to their views, or would lead them to change their views, their values, or their recommended policies.

Part 2 reviews the evidence on how our respondents view climate-change risks. Part 3 assesses individuals' willingness-to-pay to avoid climate change, often in the context of particular policies. Part 4 discusses how well a range of behavioral hypotheses explains the responses we observed.

2. Perception of Climate Change Risks

Temperature change survey. Two different versions of the survey were administered. An entire copy of one version of the survey is included as an Appendix. The first version provided no background information pertaining to the risks of climate change but proceeded directly to questions about temperature change and policy interventions. The second version of the survey, which was randomly given to half of the respondents, included a very general background description of climate change risks and policy:

> This survey deals with global climate change. Harvard researchers describe the source of global warming in the following manner: "The world's climate reflects, among other things, the concentration of greenhouse gases (including human-induced emissions of carbon dioxide and other pollutants) in the atmosphere. Like in a greenhouse, these gases allow the sun's heat to reach the planet surface but trap energy reflected from the surface resulting in warmer temperatures. Increasing greenhouse gas concentrations increases the warming effect."
>
> The 1997 Kyoto Protocol is the major international treaty addressing the control of greenhouse gases. The Protocol has been ratified by all major nations save the United States and Australia. Final ratification in Russia is expected shortly. The Clinton Administration, though signing the treaty, never brought it forward for ratification, and the Bush Administration announced that it would not do so. The principal rationales for the U.S. position are that: (1) the controls are ill conceived, and are too costly to

the United States, and (2) that the developing nations, most importantly China and India, are not required to cut emissions.

This background information was crafted to be factual but to convey no new information to respondents about the magnitude or consequences of climate change. Thus, any differences in answers across the two scenarios could indicate whether increasing the accessibility of climate change issues within the survey would affect participants' responses.[9] It could also promote different responses between U.S. citizens and noncitizens, given the U.S. stand alone position on this policy issue.

To elicit the distribution of respondents' risk perceptions, the survey elicited the 95th percentile, the 5th percentile, and the median of each respondent's risk assessment in degrees Fahrenheit.[10] In each instance, all questions focused on the increase in temperature that the respondent expected to take place in Boston between the time of the survey and 2100. The segment of the survey focusing on climate-change risk beliefs was as follows:

> **QUESTIONS ABOUT CLIMATE CHANGE**
> **(All questions below about temperature employ degrees Fahrenheit as the measure.)**
> Temperature Estimates for 2100. Global climate change has been at the forefront of many environmental debates. Much of the reason for the controversy is that scientists have not reached a consensus regarding the likely extent of climate change. The next three questions ask for your opinion regarding how much the temperature will rise, if at all, over the next century. In particular, we will ask you to estimate in degrees Fahrenheit how much temperature will rise between now and 2100 in Boston.

[9] Baron et al (1990) surveyed college students on their willingness to take action on the greenhouse effect. Two versions of the survey were used. One gave only best estimates; the other emphasized close-to-symmetric uncertainties about these estimates. Respondents reading the best estimates shifted toward the other side, e.g., nonactors became more willing to act. Those reading the uncertainties version stuck with their original position.

[10] Scientists and Europeans tend to use Celsius scales. Some respondents—used to working with degrees Celsius—may have reported on the wrong scale despite the emphasis on Fahrenheit throughout the survey. This would lead to lower estimates, since a 1 degree Fahrenheit change equals a 5/9 degree Celsius change. We thank Jeffrey Bielicki for alerting us to this possibility.

Upper-bound estimate. What is your upper-bound estimate of how much the temperature will rise? Thus, you think that there is only one chance in 20 that the temperature increase could be more than this amount. Check one.
Less than 1 degree_____
Between 1 degree and 3 degrees_____
Between 3 degrees and 7 degrees_____
Between 7 degrees and 11 degrees_____
Over 11 degrees_____

Lower-bound estimate. What is your lower-bound estimate of how much the temperature will rise? Thus, you think that there is only one chance in 20 that the temperature increase could be more than this amount. Check one.
Less than 1 degree_____
Between 1 degree and 3 degrees_____
Between 3 degrees and 7 degrees_____
Between 7 degrees and 11 degrees_____
Over 11 degrees_____

Best estimate. What is your best estimate of how much the temperature will rise? Thus, there is a 50-50 chance that the temperature increase could be above or below this amount. Check one.
Less than 1 degree_____
Between 1 degree and 3 degrees_____
Between 3 degrees and 7 degrees_____
Between 7 degrees and 11 degrees_____
Over 11 degrees_____

The survey then elicited the increase in temperature that respondents expected to take place in Boston between the time of the survey and the year 2024. That question, which is Question 3 in the Appendix, served two functions. First, it elicited views regarding near-term climate change risks as opposed to longer-term risks. Second, it provided the first step of a scope test on climate change responses to see whether respondents would pay more to achieve a more inclusive concept. The temperature increase between the time of the survey and 2100 should be greater than the temperature

increase between the time of the survey and 2024; a gas tax that could control climate change till the later date would be accomplishing more.

The survey also included a variety of other background questions and belief questions, which will be discussed in this section below, and Section 3.

Qualifications. Before turning to our findings and analysis, we should issue some qualifications. First, Harvard graduate students are far from representative of the general population as a whole. For example, they are far richer on a lifetime income basis, better informed, younger, and more concerned with policy, all attributes that likely affected their assessments. To extrapolate our results to the general population would be misguided. Second, we chose not to inform our respondents about global warming; therefore, we can not predict how additional scientific and policy relevant information would affect their responses. Third, we made no attempt to compare respondents' attitudes toward global warming to their attitudes on other policy issues where consequences come significantly in the future, such as personal decisions on saving and smoking behavior, or societal decisions on the future of Medicare or long-run tradeoffs in dealing with terrorism. Work in areas such as myopia and hyperbolic discounting show that individuals do not apply consistent, reasonable discount rates to future consequences.[11] Fourth, we follow traditional social scientific methodology and identify statistical significance for certain variables, though the equations include nonsignificant variables as well when there is a theoretical justification for doing so.[12]

[11] We thank a referee for highlighting this issue of lack of sound thinking about the future. See work by Strotz (1955-56) and Laibson (1997).

[12] For example, if we ran a regression with 20 independent variables, and one proved significant at the 0.05 level, that would be of little interest, since such an outcome would be expected by chance. All of our independent variables were selected in accordance with theory, and virtually all produced results in the right direction, which is reassuring in this regard.

Results for temperature increase estimates. Table 1 shows respondents' expected temperature increases. The upper bound estimate had a mean value of 6.1 degrees Fahrenheit and a median value of 5 degrees Fahrenheit, with 40 percent of respondents believing that the upper bound increase would be 3-7 degrees and 33 percent of respondents believing that it would be 7-11 degrees.[13]

The lower bound estimate of the temperature increase had a mean value of 1.5 degrees Fahrenheit and a median value of 0.5 degrees Fahrenheit. A substantial 60 percent of the sample believed that the lower bound of the temperature increase over the coming century would be less than one degree, and an additional third of the sample believed that the lower bound of the temperature increase would be 1-3 degrees.

The final column of Table 1 shows the results for the best estimates of the risk. The mean estimate of the temperature increase in Boston is 3.4 degrees, which is lower than but roughly consistent with the Intergovernmental Panel on Climate Change (IPCC) estimate of a 3.6-7.2 degree F. average increase for the world as a whole.[14] Almost half the sample believed that the best estimate was 1-3 degrees, which was the median estimate, with an additional third of the sample believing the temperature increase would be 3-7 degrees. Our analysis of projected temperature increases will focus on best estimates.

To explore the determinants of the risk beliefs, we undertook a series of regression analyses. Those analyses considered a respondent's best estimate of the

[13] For purposes of calculating the mean value, the midpoints of temperature intervals were employed. In addition, answers indicating a temperature increase of over 11 degrees were coded as a 13 degree increase.
[14] See IPCC, 2001. Stainforth et al (2005), although reporting greater uncertainty than the IPCC, had most estimates clustering around the similar value of 6.1 degrees Fahrenheit.

increase in temperature to be a function of the respondent's background characteristics and his or her beliefs about a number of risks.

A hypothesis underlies the choice of each of our independent variables. Each hypothesis is followed by its predicted sign.

Demographic hypotheses

a. *Male*. Some experiments and surveys suggest that men are more willing to take risks than females.[15] More directly relevant, males perceive environmental risks to be lower than do women, including the risks of climate change.[16] -- Negative coefficient.

b. *U.S. citizen*. The United States is by far the largest emitter of greenhouse gases in the world. Moreover, relative to other advanced nations, it has been much less supportive of international agreements. The responses of the 68 percent of the sample that are U.S. citizens may reflect their nation's policy stand. -- Negative coefficient.

c. *Law student*. Both groups of students are more liberal than the general population. However, it is believed that the Kennedy School students are more liberal than Law School students. -- Negative coefficient.

Behavioral decision hypotheses

Home team betting is a term we employ to refer to the tendency of individuals to predict the outcome that they would like to happen. This phenomenon could be a product of a number of phenomena related to overoptimism or motivated reasoning that are

[15] The meta-analysis by Byrnes, Miller, and Schafer (1999) concluded that there was some evidence of gender differences in risk taking along some dimensions, such as physical skills, but that there were fewer differences for other areas, such as smoking.

discussed in the literature. These phenomena are usually concerned with benefits to the decision maker (e.g., self image) from the bias, or to cognitive limitations, say due to selective memory or information processing difficulties. But other possibilities remain, such as herding or selective information revelation—e.g., favorable information is more likely to be revealed—among members of groups with particular preferences, e.g., Red Sox fans or Bush supporters. Given *home team betting*, those predicting a Bush victory are more likely to be Bush supporters.

d. *Bush predictor*. These individuals should have lower risk beliefs, given Bush's reluctant approach and Kerry's more aggressive approach to climate change interventions. -- Negative coefficient.

The regressions in Table 2 also include three variables pertaining to beliefs about risks that have no causal relationship with global warming. These variables are included to test the *correlated estimates hypothesis*, which states: People who predict high values for some risks will predict high values for unrelated other risks. This hypothesis predicts, for example, that individuals who think that mortality risks are high in one area are more likely to think they are high in another.[17] In this study we hypothesize that unrelated high risk estimates will not simply predict climate-change risk assessments, but will correlate with support for climate change policy interventions.[18]

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[16] Using a scale from 1 (almost no health risk) to 4 (high health risk), Flynn, Slovic, and Mertz (1994) found that the rating of the climate change risk was 3.0 for females and 2.7 for males.

[17] For documentation of such person-specific fixed effects, see Hakes and Viscusi (2004), who report regression estimates of risk beliefs for a series of mortality risks using a fixed effects regression model, i.e., they estimate a personal shift parameter for each individual.

[18] A referee, observing that time delay is a critical component of global warming risk, and that the risk is related to human action. We concur with the referee's suggestion that it would be intriguing to assess how respondents' attitudes towards global warming relate to decisions like smoking or saving for retirement, which reflect personal discount rates; or societal decisions, such as policies towards the deficit or social security, which reflect individuals' discount rates for long-term collective outcomes.

The heart attack question asked respondents to assess how many out of a group of 100 randomly chosen male Harvard students aged 24 would have a heart attack by age 65. The second risk belief variable asks about the number of U.S. citizens whom the respondents believed would be killed in the next 12 months because of attacks by foreign terrorists on airplanes. The final risk variable question asks how many dwelling units in the U.S. will be destroyed by earthquakes in the next 12 months. We posit that there will be a positive correlation between estimates of these risks and the risks of climate change. Our three Correlated estimates hypotheses are:

e. *Heart attacks*. -- Positive coefficient.

f. *Terrorism*. -- Positive coefficient.

g. *Earthquakes*. -- Positive coefficient.

A control variable indicates whether the background paragraphs were included in a respondent's survey, with a dummy of 1 if they were presented. We expected these paragraphs, which provide no information about the magnitude of global warming risks, to increase the *accessibility of* the problem, and thereby increase risk estimates. (Accessibility is a concept that includes salience, selective attention, and priming.[19]) Our accessibility hypothesis is:

h. *Background paragraphs*. -- Positive coefficient.

Finally, we include an interaction term for U.S. citizens who also received the background paragraphs. Our hypothesis is that this background information, which identifies the U.S. as the sole major nation not signing the Kyoto Protocol, should make

[19] See Kahneman (2002).

national differences more salient, and thereby further increase the gap between U.S. citizens and noncitizens.[20] This leads to

i. *U.S. citizen* and *Background paragraphs* Interaction. -- Negative coefficient.

Results for determinants of the estimates of temperature increase. The first column of Table 2 presents the regression for the best estimate of the temperature increase by 2100.[21] All statistically significant explanatory variables have coefficients with the predicted sign. Four are significant at the 0.05 level, and two at the 0.10 level. Most of our demographic variables are significant, indicating negative effects of being *Male*, a *U.S. citizen*, or a *Bush predictor*. The positive heart attack coefficient provides moderate positive evidence for correlated estimates. As hypothesized, background paragraphs boost risk beliefs, but their interaction with *U.S. citizen* is negative, sufficiently so that there is no net effect for U.S. citizens.

We repeated these regressions for our upper and lower bound estimates. In results not shown, all significant variables had the predicted signs for each of the two bounds. As before, *Male* and *U.S. citizen* had significant negative effects.[22] In the upper bound estimates, background paragraphs lost significance, as did heart attacks. However, *Terrorism* and *Earthquake* gained significance.

[20] Some respondents may have been unaware of such differences. Hence, nationalism or the pursuit of national interest could promote such differences as well.

[21] The regression estimates reported in Tables 3 and 4, and all other analyses in this paper, exclude two outliers on particular questions. One respondent estimated 60,000 deaths annually to terrorist attacks on airplanes, and another respondent indicated a willingness to sacrifice 100 percent of personal income to combat climate change. For the terrorism airplane death toll question, the second largest outlier was 500, or one-twelfth of the size of the largest estimate. For the percentage of income willingness to pay question, the second highest value was 60 percent, and the third highest was 50 percent.

[22] That U.S. citizen was negative and significant suggests that any confusion between Fahrenheit and Celsius was probably not great. U.S. citizens are the most used to Fahrenheit, which would lead to values 9/5 as high.

An additional study, not reported, used upper and lower bound estimates as explanatory variables when predicting the best estimate. Not surprisingly, both were exceedingly significant both statistically and in their predictive impact, with the lower bound estimate having the greater effect.[23]

A further unreported study about the shape of the distributions looked at individual surveys to see whether those who assessed high values for upper bounds assessed higher or lower values for lower bounds. Either outcome has a plausible explanation. The former would suggest that some individuals just had higher estimates (or similarly, lower estimates) than others. The latter would indicate that some individuals had broader distributions than others. A rank order correlation of high and low estimates yielded a Spearman rank correlation coefficient of 0.46, suggesting that the higher estimates explanation predominates.

We then redid our best estimates analysis looking to the temperature change in Boston till 2024. This was intended partly as a scope test. The test was easily passed; predictions for the temperature increases were noticeably smaller. Specifically, the mean value of respondents' best estimates drops from 3.4 degrees Fahrenheit for the year 2100 to 1.4 degrees Fahrenheit for 2024. On an individual basis the scope test results are very strong. For the best estimate, 201 of the 255 respondents predicted a greater temperature increase till 2100 than 2024, while 250 of the 255 respondents assessed an increase at least as great for the longer term. In terms of statistically significant coefficients that

[23] The lower bound estimate had a greater coefficient, which is as expected if respondents believe, as would seem appropriate, that assessed distributions should be right skewed. We repeated this study using logarithmic values for the best estimate of the temperature as well as the upper and lower bound. This allowed for the possibility that variables were distributed geometrically about their median, implying that a value twice as high was equally likely as one half as high. The results find that the upper bound estimate has a coefficient larger in magnitude than the lower bound. This pattern indicates that the shape of the respondents' estimated distributions are somewhere between arithmetic and geometric in shape.

have the same sign in column 1 and column 2 of Table 2, the background paragraphs and heart attack variables are positive, while the U.S. citizen-background paragraphs variable is negative. The variables that are newly significant for 2024 are *Law student* (5 percent level) and *Earthquakes* (10 percent level).

Results for other consequences of global warming. In Part 3, we shall turn to respondents' willingness-to-pay for policies that ameliorate global warming. These valuations will depend not only on the amount of temperature change expected, but also on the predicted consequences, such as changes in the economy, disease, storms, etc. The survey included a series of questions that asked respondents which outcomes were likely to occur as a result of a five degree temperature increase by 2100. The questions include three legitimate and widely discussed risks of climate change as well as one policy outcome—New England forest fires—that is not widely expected to be affected by climate change.[24] (New England rarely experiences significant forest fires. Though scenarios where such fires become significant can be envisaged, this consequence has not been part of the climate-change discussion, much less media reports, unlike our other three consequences. This suggests that respondents were conjecturing scenarios that might lead to the forest fires on their own.[25]) These four questions were intended to explore the extent to which respondents' perceived consequences affect their willingness-to-pay for remedies. They also tell how well respondents distinguish widely discussed possible outcomes from one that has received virtually no attention.

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[24] Information on these four consequences came from geochemist and climate scientist Daniel Schrag, private communication, September 2004. Forest fires was recommended as a plausible sounding but not likely risk.

[25] A referee alerted us that some forecasts on the effects of global warming include significant loss of maple sugarbush due to ice storms. The resulting dead trees would increase the likelihood of summer forest fires.

The specific questions and responses appear in Table 3. Four-fifths of the sample believed that there was more than a 50 percent chance that there would be a significant increase in hurricane activity. In fact, the intensity of hurricanes is likely to increase, but not their number. This was by far the most prominent risk outcome indicated among respondents and will be the main "consequence" variable examined in our analysis of willingness-to-pay. There could have been a strong Availability Effect, since the survey was conducted just weeks after a period of unusually intense hurricane activity striking Florida, though before the massively disastrous Katrina, Rita, and Wilma hurricanes of 2005.[26]

Two other risks discussed in the literature—widespread tropical diseases and a significant loss in world agricultural output—were each perceived as likely by half of the sample. Perhaps reassuringly, the smallest percentage of the sample, 35 percent, believed that New England forest fires would increase significantly as a consequence of global warming. Neither this variable nor the tropical disease and world agricultural output variables proved to be significant in any of the subsequent empirical analyses of attitudes toward global climate-change mitigation policies. As a result, they are not reported even though they were in the specifications. In contrast, the hurricane activity variable, the risk for which there was the greatest consensus in the sample, and probably also the greatest scientific consensus, proves strongly significant in some of these explorations.

3. Willingness to Pay for Climate-Change Mitigation Policies

Do stronger beliefs that climate change is a serious risk translate into support for stronger policy interventions? To answer this question, we assessed respondents'

[26] See Tversky and Kahneman (1974) for discussion of the availability effect.

willingness to pay (WTP) to curb global warming, i.e., the financial costs they were willing to incur in support of alternative policies. We first focused on gas taxes as the payment mechanism. Gas taxes are a familiar instrument: their rough current values are probably known to most respondents, they can be converted to annual incremental costs, and respondents perceive the use of gasoline as related to the risks of global warming.

We did not want to ask respondents to estimate the effectiveness of a tax in curbing climate change, so we posited that our hypothetical gas taxes would be completely effective in addressing the risks of climate change, which is well beyond what actual gas taxes could achieve.

The survey first ascertained what gas tax the respondent would favor if it would completely eliminate the risks of global climate change. Subsequently, respondents encountered a gas tax question that focused only on climate change risks that would occur until 2034. At that time, the survey hypothesized, technologies would become available that could reverse any problems of climate change, and eliminate them for the future. Thus, this would be an interim gas tax that would hold the effects of climate change at bay for the next 30 years. In the earlier question, the gas tax would be permanent.

Overall, the respondents were willing to pay fairly substantial gas taxes to address the risks of climate change. Existing taxes are in the 15-25 cent range for most states. For the initial global warming question, where the tax would address risks through 2100, the mean willingness to pay was $0.79 per gallon. For the policy that would curb climate change until the miraculous new technologies of 2034, the mean willingness to pay was

$0.44 per gallon. The respective medians for these two values were $0.50 (to 2100) and $0.10 (to 2034).

The lower mean value for the less valuable gas tax—the one curbing climate change only till 2034 when new technologies come along—thus passes a scope test: in accord with rational decision, WTP is higher when more is accomplished.[27] Overall, 134 out of 255 respondents had a value for the 2100 question that was higher than for the 2034 question, and 238 out of 255 had a value greater than or equal to their 2034 value. Logically, the longer-term gas tax WTP should secure a higher WTP even though it would also have to be paid for the longer period. First, it would have to do the job in the absence of a miracle cure. Second, presumably society would develop more fuel efficient cars over time, and also get richer, making a gas tax more affordable. We can not be confident, however, that respondents thought about all these issues.

By any standard, the willingness-to-pay values are quite high relative to what we would expect citizens to pay on average for gas taxes to curb climate change. First, the claimed efficacy of the gas tax is much higher in the survey than it would be in practice. Second, the respondent group is substantially more affluent in discounted lifetime income than the typical American.[28] Third, the degree of environmental concern among our respondents is likely to be much greater than for the populace at large. As a rough calculation, if these individuals drove 10,000 miles per year and got 20 miles per gallon, they agreed to pay roughly $1500 per year for the long-term gas tax solution to climate change. This value can be compared to the finding of Curry (2004, p. 48) for the general population. He found that just over 50% of the population would pay as much as

[27] Failure to meet such a test is often referred to as "embedding effects," which are discussed by Kahneman and Knetsch (1992).

$10/month or $120/year on their electric bill "if it solved global warming." These WTP estimates were highly variable. The standard deviation of the WTP estimate for the gas tax till 2100 remedy was 72 cents. What factors predict respondents' disparate willingness to pay amounts? The logic underlying our predictions is that people predicting worse outcomes from global warming and having a more environmental focus will pay more, and that self-interest will influence WTP. Further justifications for our predictions are discussed alongside the results. The predictions were:

i. *Male*. Ambiguous coefficient.

j. *Best estimate*. Positive coefficient.

k. *Hurricanes*. Positive coefficient.

l. *More aggressive*. Positive coefficient.

m. *Less aggressive*. Negative coefficient.

n. *Use a car*. Negative coefficient.

Results for willingness to pay. Table 4 shows the results. Males have lesser environmental concerns, indeed lower beliefs for most risks. However, controlling for the level of risk beliefs males exhibit in higher willingness-to-pay than females in the gas tax to 2100 equation, they are willing to pay 30 cents more than women. This result may be due to gender differences in expected lifetime wealth.

As expected, beliefs about the risk of global warming had a strong effect for both gas tax questions. A three-degree increase in the assessed temperature increase pushed up WTP for gas taxes by 18 cents and 12 cents for the 2100 and 2034 scenarios, respectively. The hurricane risk variable was also powerful, leading to 29 cent and 17 cent increases in WTP. Thus, we find that the percentage of respondents reporting a

[28] Our survey included foreign students, but they too will be wealthier than average Americans.

consequence is positively related to incremental willingness-to-pay for those who do report it. If a priori the consequences were felt to be equally serious, and if believes in them were equally strong by those who report them, this should not be. This suggests that frequency of belief may be correlated with strength of belief across these four consequences.

A factor that may influence WTP, holding risk estimates constant, is whether a respondent feels scientific uncertainty motivates a more aggressive or less aggressive approach to climate change policy; this is addressed in the next section. Environmentalists are overwhelmingly in the first camp, climate change skeptics in the second. Given the accompanying political attitudes, we would expect to see a positive sign for those who would be *more aggressive* and negative for those who would be *less aggressive*. All four coefficients went in the hypothesized direction; three were significant at the 0.10 level or better.

These equations also included a variable for whether the respondent used a car and would therefore bear a gas tax directly. Self-interest would predict a negative effect. In fact, car users were willing to pay a higher tax in the year 2034 scenario. A possible explanation is that car users are richer than other respondents, and expected to be richer in the future. [29]

As a final test of the willingness to pay for reducing the risks of climate change, the survey asked what percentage of income the respondent would be willing to pay to avert the risks of climate change. Unlike the gas tax questions, this formulation also included additional information regarding possible severe adverse consequences of global

[29] We had no income or expected income variable. Had we had an adequate control for income, the car coefficient might have been negative.

climate change. Thus, the question format involved more than a simple difference in framing; it involved a difference in substance. This survey question also does not include a well-defined payment mechanism, so that respondents may have treated the expenditures as being less real.

Table 5 provides the distribution of these responses for the sample. Of the respondents, 81 percent were willing to contribute at least 0.1 percent or more of their income to address the risk of climate change, and 23 percent of the sample were willing to give up 5 percent or more of their income. The median willingness to sacrifice was 3% of income. The mean was 6%. If these individuals expect to earn $150,000 per year—a compromise between higher-earning law graduates and lower-earning Kennedy School graduates—they expressed a median willingness to give up roughly $4,500 per year, roughly three times what they said they would pay in a gas tax.[30] Two factors contribute to this five times disparity. First, our income sacrifice question posited a 5 degree F. temperature change, and described the consequences of such a change, whereas 58% of our respondents thought that the change would be between 0 and 3 degrees. Hence, the question entailed a greater change in temperature. Second, offering more concrete consequences may have escalated payment amounts due to availability and accessibility effects. So too may have the fact that we asked about annual income, rather than say straight dollars. Due to what we label the *percent thinking bias* – people are willing to pay more absolutely when asked in relation to a greater quantity, e.g., annual income versus annual expenditures on gasoline – this may have led to larger WTP amounts. The responses to the income sacrifice question had a much greater spread than

[30] It is unlikely that individuals' gas tax answers were influenced by their percent of income answers, given the structure of this web-based survey.

those for the gas tax, perhaps because the current gas tax and its familiarity served as an anchor.[31] Finally, respondents may have answered the percentage contribution question in terms of their present low incomes rather than their future incomes.[32]

The Role of Scientific Uncertainty. Finally, we examined respondents' views on how scientific uncertainty affects the desirability of vigorous policies to curb climate change. This issue has been at the center of policy debate. Those who wish to "go slow" point to the level of scientific uncertainty; they propose that we wait to learn more, and possibly learn that the risk was greatly overstated. Those who favor aggressive action state that greater uncertainty, holding mean consequences fixed, should spur us to greater action. Usually concerns about irreversibility and risk aversion on losses motivate this attitude.

From a normative standpoint, the proper influence of scientific uncertainty on policies depends in part on the nature of the uncertainty. If, for example, we were dealing with a simple lottery in which there is some probability p of an adverse outcome and a probability of 1 - p that there will be no adverse outcome, then the precision with which p is estimated should not be influential. Indeed, greater concern about ambiguous probabilities, as opposed to precisely estimated probabilities, is known as ambiguity

[31] Indeed, the only statistically significant variable in a regression analysis that uses the same set of variables as in Table 4 was that those who believe that policies should be less aggressive in the face of scientific uncertainty also favored giving up less of their income. None of the other variables were statistically significant. The gas tax question had a mean of 0.79 and a standard deviation of 0.72, as compared to a mean of 6.2 and a standard deviation of 10.1 for the income percentage question.

[32] Daniel Kahneman's (2002) Nobel Lecture reflects wisely on the behavioral concepts discussed here, including importantly the concept of framing, and provides references to the original literature.

aversion, and is a well-documented form of irrationality that is inconsistent with Bayesian decision theory.[33]

In contrast, if there is uncertainty about the magnitude of the consequences, almost certainly the case with global warming, then additional considerations come into play. Conventional risk aversion by the citizenry would lead to more costly action if society were taking a one-time only measure to curb warming. However, decisions to curb global warming take place in a dynamic context, with decisions made in each time period as uncertainty unfolds. From a rational decision theoretic standpoint, the combination of the following two conditions is sufficient for scientific uncertainty to make greater aggressiveness desirable: (1) Increasing costs of curbing greenhouse gas emissions within a period. (2) The damage function from greenhouse gas emissions has positive first, second, and third derivatives.[34] Few if any respondents, we are confident, considered the mathematical properties of cost and damage functions when replying.

Of the respondents, 51 percent believe that policy should be more aggressive in the face of uncertainty, 16 percent believe that it should be less aggressive, and 33 percent believe that there should be no effect on policy choice. Not surprisingly, the role of uncertainty and its relationship to policy aggressiveness is correlated in a plausible manner with the distributions of outcomes that individuals predict. For example,

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[33] See Raiffa (1968). The Ellsberg (1961) and Allais Paradoxes show that people have an aversion to uncertain probabilities, despite what decision theory prescribes. The ambiguities with global warming entail an additional element, what has been called "ignorance" as opposed to risk and uncertainty (Zeckhauser and Viscusi, 1990, p. 561). With risk probabilities are known, with uncertainty states of the world are known, but not their probabilities. With ignorance, as in global warming, even the states of the world are unknown.

[34] Thus damage must increase faster than the quadratic, the borderline case with positive first and second derivatives but a zero third derivative. With a quadratic function, adding a random component to the underlying variable does not change the expected derivative, i.e., the expected marginal cost. In our context, this would mean that the expected marginal cost of emissions is not affected by temperature uncertainty. If both conditions are on the border, e.g., quadratic case and constant costs for curbing

respondents with lower values of lower bound temperature estimates are more likely to favor less aggressive policies, while respondents with higher upper bound estimates of temperature change are more likely to favor more aggressive policies. Causality presumably runs in both directions: right skewed distributions promote policy aggressiveness, and more aggressive attitudes lead respondents to produce right skewed distributions.[35]

4. Behavioral Aspects of Attitudes toward Climate Change Policies

Many of the themes that have emerged in the literature on behavioral versus rational aspects of individual choice, particularly those that relate to significant uncertainties, are echoed by our results for respondents' risk beliefs concerning climate change, and their willingness to invest in climate change policies. Table 6 summarizes many of the key themes that emerged.

We looked first at individuals' general performance as risk assessors. In important respects our respondents behaved according to rational prescriptions. They passed scope tests, and showed that they could assess distributions in a manner scientists would think reasonable; e.g., a big spread between upper and lower bounds, with estimates strongly skewed to the right.[36] Their ability to think in terms of distributions is reassuring. Just as a few decades' practice has enabled ordinary people to think about the

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emissions within a period, then uncertainty about consequences should not affect the aggressiveness of policies.

[35] Referee Jonathan Baron conjectured that aggressiveness would influence the upper-bound estimate more than the lower-bound one, which proves true. In regressions not shown, the coefficient of 1.36 (degrees if "more aggressive") was nearly four times as large as for the lower bound, and was significant at the 0.005 level, whereas the other coefficient was not. Baron attributes this outcome to "belief overkill," the tendency of individuals to ignore arguments on the other side of controversial issues (Jervis, 1976, 128-142). Belief overkill may well have affected many other responses to questions about climate change.

weather probabilistically – e.g., 70% chance of rain tomorrow – perhaps policy issues such as global warming, which are afflicted with massive uncertainties, should be talked about in terms of distributions of outcomes, at least to moderately sophisticated audiences.

Important phenomena did emerge that suggest or show our respondents' behavioral tendencies. Their estimates of global warming risks correlated positively with their risk assessments for other hazards. This finding indicates that there are systematic person-specific differences in assessments of risks, implying that biases in people's risk beliefs in general are likely reflected in their beliefs about climate change. Some individuals may be Pollyannas, others Chicken Littles, under- or over-estimating all risks. Alternatively, the bias may be due to the tightness or breadth of distributions.[37]

The background paragraph information, which provided a general description of the source of climate change but no information on consequences and no numerical values, was expected to increase the accessibility of climate change as an issue. As predicted, presenting the paragraph did increase respondents' best estimates of the likely temperature increase. This finding suggests that even fairly innocuous general information about climate change may call respondents' attention to the policy importance of this issue.

The second major component of our study was assessing willingness to pay to avoid climate risk. The willingness of respondents to pay for policies to address the risks of climate change was quite substantial in our sample relative to values found for the

[36] See Zeckhauser, Shearer and Memishian (1975) for a discussion of the use of lognormal distributions in assessing environmental consequences.
[37] Alpert and Raiffa (1982) show that most individuals assess distributions far too tightly.

general population, probably reflecting their greater affluence and stronger environmental concerns. That would be perfectly rational.

However, important behavioral propensities emerged in the related to willingness to pay arena as well. Respondents who believed that Bush was likely to win the 2004 presidential election were less willing to contribute to higher gas taxes to combat climate change, which is consistent with a combination of home team betting—you predict what you wish for—in conjunction with favoring the Bush administration's policies toward climate change. This suggests, more generally, that the general public may interpret the debate over the science associated with global warming through a political lens. Or alternatively, that leaders with particular political views can convince their adherents of their own views on science. In his famed essay "The Methodology of Positive Economics," Milton Friedman (1958) speculates that most policy debates could be resolved if we reached agreement about probabilities, even if values still diverged. Even if he is right, reasonable societal consensus on global warming may still be far away. Values differences may continue to drive differences in probabilities, that is, assessments of risk. Substantial differences in assessments of risks will make agreement difficult to reach.

Anchoring effects may also be important in eliciting meaningful estimates of willingness to pay, as the percentage share of income questions elicited much higher and perhaps less credible estimates of willingness to pay than did the gas tax question. Respondents may have anchored on current values for gas taxes. We conjecture the presence of *percent thinking* bias, namely that respondents tend to think of expenditures relative to some category, but pay inadequate attention to the relative sizes of the

category. For example, individuals might get more upset by a 10% increase in the price of milk than a 1% increase in the price of natural gas, even if the latter would cost them twice as much. Thus, offering 3% of income (the median amount) might seem small, whereas offering to pay a gas tax of $0.79 (the median amount) might seem large if both were considered as part of their respective budgets of all spending, and automobile or transport spending.

Finally, the magnitude of scientific uncertainty, which has played such a prominent role in the policy debate, influences respondents' attitudes as well. If the likely consequences of climate change become more uncertain, a slight majority of respondents believe that policies should be more aggressive, and they are also willing to pay more to eliminate climate change. Not surprisingly, the connection between values and policy predictions emerges here as well. Those predicting a Bush victory, whom motivated reasoning predicts are disproportionately Bush supporters, were significantly more likely to think that scientific uncertainty made a less aggressive policy appropriate.

Our survey results show that respondents provide estimates and assess preferences that would disappoint ardent believers in either side of the rational versus behavioral debate. Their responses reflect a blend of rational and behavioral decision. They avoid some of the classic behavioral traps, their estimates and willingness-to-pay amounts often respond in rational ways to important parameters in reasonable ways, and they are impressively able to provide probability distributions in their answers. But they also make choices that show significant behavioral tendencies: anchoring, accessibility, and framing effects are prevalent, home team betting shows itself in both predictions and policy preferences, and percent thinking is revealed in willingness to pay estimates. In

the climate-change arena, behavioral decision tendencies are like a fun-house mirror: They magnify some estimates and shrink others, but the contours of rational decision remain recognizable.

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Appendix

HLS VERSION

Environmental Policy Survey - Version B

This survey consists of a series of 17 questions dealing with your assessments of various risks, and your attitudes toward different environmental policies. We recognize that you are not likely to be knowledgeable on these subjects. Professor W. Kip Viscusi of Harvard Law School and Professor Richard J. Zeckhauser of the Kennedy School will analyze these survey results. The results will be posted on our websites.

Your individual responses will remain confidential. However, if you provide us your name or email address you will be eligible to be one of four HLS students, chosen at random, each of whom will win a $50 gift certificate to the Harvest Restaurant for completing the survey.

Your name or email address (optional; secures prize eligibility): _____

OVERVIEW. This survey deals with global climate change. Harvard researchers describe the source of global warming in the following manner: "The world's climate reflects, among other things, the concentration of greenhouse gases (including human-induced emissions of carbon dioxide and other pollutants) in the atmosphere. Like in a greenhouse, these gases allow the sun's heat to reach the planet surface but trap energy reflected from the surface resulting in warmer temperatures. Increasing greenhouse gas concentrations increases the warming effect."

The 1997 Kyoto Protocol is the major international treaty addressing the control of greenhouse gases. The Protocol has been ratified by all major nations save the United States and Australia. Final ratification in Russia is expected shortly. The Clinton Administration, though signing the treaty, never brought it forward for ratification, and the Bush Administration announced that it would not do so. The principal rationales for the U.S. position are that: (1) the controls are ill conceived, and are too costly to the United States, and (2) that the developing nations, most importantly China and India, are not required to cut emissions.

QUESTIONS ABOUT CLIMATE CHANGE
(All questions below about temperature employ degrees Fahrenheit as the measure.)
1. Global climate change has been at the forefront of many environmental debates. Much of the reason for the controversy is that scientists have not reached a consensus regarding the likely extent of climate change. The next 3 questions ask for your opinion regarding how much the temperature will rise, if at all, over the next century. In particular, we will ask you to estimate in degrees Fahrenheit how much temperature will rise between now and 2100 in Boston.

a. **Upper-bound estimate.** What is your upper-bound estimate of how much the temperature will rise? Thus, you think that there is only one chance in 20 that the temperature increase could be more than this amount. Check one.
Less than 1 degree_____
Between 1 degree and 3 degrees_____
Between 3 degrees and 7 degrees_____
Between 7 degrees and 11 degrees_____
Over 11 degrees_____

b. **Lower-bound estimate.** What is your lower-bound estimate of how much the temperature will rise? Thus, you think that there is only one chance in 20 that the temperature increase could be more than this amount. Check one.
Less than 1 degree_____
Between 1 degree and 3 degrees_____
Between 3 degrees and 7 degrees_____
Between 7 degrees and 11 degrees_____
Over 11 degrees_____

c. **Best estimate.** What is your best estimate of how much the temperature will rise? Thus, there is a 50-50 chance that the temperature increase could be above or below this amount. Check one.
Less than 1 degree_____
Between 1 degree and 3 degrees_____
Between 3 degrees and 7 degrees_____
Between 7 degrees and 11 degrees_____
Over 11 degrees_____

2. The effects of climate change will depend on where you live. Canada and Russia will have longer growing seasons, while sea level rises, possible droughts, and changes in storm patterns may have adverse effects. Do you believe the residents of Boston in the year 2100 will be better off or worse off because of the effect of climate change on our environment?
Better off_____
Worse off_____
No significant change in well-being_____

3. Now let's think of the nearer term. What is your best estimate of how much the temperature will rise over the next 20 years?
Less than 1 degree_____
Between 1 degree and 3 degrees_____
Between 3 degrees and 7 degrees_____
Between 7 degrees and 11 degrees_____
Over 11 degrees_____

4. The science of global warming is highly uncertain. In 20 years time, for example, predicted outcomes for year 2100 could be significantly better than scientists predict

given current knowledge, or they could be considerably worse. Does this uncertainty make you think the policy should be more or less aggressive in dealing with global warming?
More aggressive_____
Less aggressive_____
No effect_____

5. One policy that would help reduce emissions that lead to global warming would be a gas tax, whose effect would be to reduce motor vehicle use. Would you favor paying a higher gas tax if doing so would eliminate the risk of climate change? Check the highest amount of the tax below that you would be willing to pay per gallon of gas, assuming that all others paid it, to reduce the buildup of greenhouse gases.
Zero_____
10 cents_____
50 cents_____
$1_____
$2_____

6. Suppose that scientists are developing new technologies that would eliminate and reverse any problems of climate change, but that these technologies would not be on line until 2024. So there may be some immediate consequences of climate change, but eventually the problems could be eliminated. Thus emissions reductions would only reduce climate change effects for the next 30 years. What is the highest amount of a tax per gallon of gas that you would be willing to pay to eliminate the risks of climate change for this 30-year period?
Zero_____
10 cents_____
50 cents_____
$1_____
$2_____

7. Consider a hypothetical question. Assume that the average temperature worldwide increased by 5 degrees Fahrenheit by 2100, how likely do you think each of the following outcomes would be for 2100?

	Likely (over 50% chance)	Unlikely (below 50% chance)
Significant increase in hurricane activity	_____	_____
Significant increase in New England forest fires	_____	_____
Tropical diseases noticeably more widespread	_____	_____
Significant loss in world agricultural output	_____	_____

8. Assume that the average temperature would increase by five (5) degrees Fahrenheit by 2100. Scientists project that among the effects of a five degree increase would be a two foot increase in sea level, and an intensification of weather. Thus, thunderstorms would be much more severe and droughts more intense. What percentage of your own current and future annual income would you be willing to give up, assuming that other citizens here and overseas did the same, to eliminate such warming?

_____

9. Consider a group of 100 randomly chosen male Harvard students aged 24. How many of them do you think will have a heart attack by age 65?

_____

10. What is your best estimate of the number of U.S. citizens whom you believe will be killed in the next 12 months because of attacks by foreign terrorists on airplanes?

_____

11. What is your best estimate of the number of dwellings in the U.S. which will be destroyed by earthquakes in the next 12 months?

_____

12. Who do you expect to win the next presidential election?
Bush_____ Kerry_____

13. Where is your status at HLS?
JD candidate____
LLM____
Other____

14. What is your citizenship?
United States____
African____
Asian____
European or Canadian____
South American____
Other____

15. What was your undergraduate background?
Social science_____
Humanities_____
Natural science_____

16. Please give your gender.

Male_____
Female_____

17. Do you regularly use a car?
Yes_____
No_____

Table 1
Percentage Distribution of Estimates of Temperature Change in Boston

Degrees Fahrenheit Temperature Increase by 2100	Upper Bound	Lower Bound	Best Estimate
	Percentage Distribution		
Less than 1	2	59	9
1-3	20	33	49
3-7	40	5	35
7-11	33	2	5
Over 11	5	1	1
Mean estimate of temperature increase	6.1	1.5	3.4
Median estimate of temperature increase	5	0.5	2

Table 2
Regression Estimates for Best Estimate of Temperature Increase in Boston[a]

	Increase by 2100	Increase by 2024
	Coefficient (Std. Error)	
Male	-0.841**	-0.195
	(0.295)	(0.151)
U.S. citizen	-0.592*	-0.125
	(0.345)	(0.189)
Law student	0.013	-0.309**
	(0.303)	(0.157)
Bush predictor	-0.449*	-0.046
	(0.268)	(0.150)
Heart attacks	0.026**	0.014**
	(0.009)	(0.007)
Earthquakes	1.4 E-5	2.1 E-5*
	(9.5 E-6)	(1.2 E-5)
Background paragraphs	1.764**	0.929**
	(0.619)	(0.362)
U.S. citizen x Background paragraphs	-1.573**	-0.906**
	(0.691)	(0.404)
R^2	0.17	0.17

[a] All standard errors are heteroskedasticity-adjusted White standard errors. All equations also include an intercept and Terrorism.
* Statistical significance at the 90 percent level, two-tailed test.
** Statistical significance at the 95 percent level, two-tailed test.

Table 3
Global Warming Consequences Assessment

Percent who Believe Risk Is Likely*
(over 50% chance)

Significant Increase in Hurricane Activity	Significant Increase in New England Forest Fires	Tropical Diseases Noticeably More Widespread	Significant Loss in World Agricultural Output
81%	35%	52%	51%

*Response alternative was Unlikely, (below 50% chance).

Table 4
Regression Estimates for Willingness to Pay a Climate Change Gas Tax[a]

	Gas Tax Remedy Till 2100	Gas Tax Interim Remedy Till 2034 New Technology
	Coefficient (Std. Error)	
Male	0.305**	0.084
	(0.084)	(0.066)
Best estimate	0.065**	0.042**
	(0.022)	(0.018)
Hurricanes	0.292**	0.168**
	(0.098)	(0.056)
More aggressive	0.121	0.214**
	(0.100)	(0.075)
Less aggressive	-0.267**	-0.128*
	(0.112)	(0.067)
Use a car	-0.013	0.130**
	(0.082)	(0.065)
R^2	0.21	0.18

[a] All standard errors are heteroskedasticity-adjusted White standard errors. All equations also include an intercept, U.S. citizen, Bush predictor, Law student, Heart attacks, Terrorism, Earthquakes, Tropical diseases, N.E. fires, Agricultural output, and Background paragraphs.
* Statistical significance at the 90 percent level, two-tailed test.
** Statistical significance at the 95 percent level, two-tailed test.

Table 5
Willingness to Sacrifice Income to Prevent All Global Warming

Percentage of Income Willing to Sacrifice	Cumulative Distribution
25	4
10	13
5	23
1	62
0.1	81
Mean	6%
Median	3%

Table 6

Summary of Rational and Behavioral Findings

Results Consistent with Rational Behavior	
Think in terms of distributions.	People are able to provide reasonable estimates of the distribution of likely temperature changes associated with global warming.
Pass a Scope test.	Expectations of temperature changes till 2024 and 2100 passed a scope test overall and on an individual basis.
Identify likely risks.	There is evidence that people understand the more likely risks of climate change, such as hurricanes, as well as the less likely risks, such as New England forest fires.
Pay more to avoid greater risks.	Higher perceived temperature increases raise the expressed willingness-to-pay amounts for policies to address global warming.
Results Consistent with Behavioral Models	
Accessibility enhances magnitude.	Neutral background information boosts risk beliefs, showing that the accessibility of the problem matters.
Correlated estimates of independent risks.	There is evidence for the correlated estimates hypothesis, people's risk estimates are positively correlated across different risk domains.
Home team betting.	People who predict a Bush election victory support Bush's policies that are based on lower estimated risks.
Percent thinking.	People pay more when asked in percentage terms of a larger quantity.