Valuing a pandemic:
Exploring trade-offs in rational risk reduction*

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Abstract
Emerging infectious diseases are on the rise, increasing the probability of a costly pandemic outbreak in the United States (US). Policymakers must decide how to prepare for a potential pandemic given scarce resources and competing risks. In this paper, we design a survey to elicit the opportunity cost of these choices based on two measures: (1) the risk-risk tradeoffs between pandemics and environmental/terrorist events, and (2) the risk policy effectiveness based on number of lives saved per dollar expenditure. Based on a nationally representative US web-based panel, we find three key results. First, the sample values the prevention of environmental disaster deaths or terrorist attack deaths approximately 3.5 times more than the prevention of pandemic outbreak deaths. While we recognize that a life saved is a life saved, our results likely reflect that people find it more challenging to quantify unfamiliar risks posed by pandemic outbreaks (at the time of this survey). Second, we find that respondents who are educated about or have experienced a catastrophe, are more vulnerable to a particular catastrophe, and are closer to a prior catastrophic event affect valuations as expected. Third, the average respondent said she would require at least 457,000 saved lives for a $5/year contribution to a pandemic risk policy (given all other taxpayers contribute too, and she knows the opportunity cost of the tax dollars). Further, these results suggest that people at the time of our survey undervalued infectious diseases, which in turn contributes to the current lack of preparedness in the United States.

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1.   INTRODUCTION

Emerging infectious diseases (EIDs) are growing at an alarming rate, increasing the probability of a costly pandemic outbreak in the United States, both in human lives and economic damages, e.g., Ebola, SARS (e.g., Jones et al. 2008: Gire et al. 2014).[1] As evident in the current Ebola threat, the United States is under prepared for such an outbreak. The open question is how do US policymakers rationally balance reducing pandemic risks relative to the array of other social health threats given scarce budgets? Scarce dollars could be spent fighting pandemic risk or they could be spent on reducing other catastrophic risks, such as terrorist attacks or environmental disasters, or health risks like heart disease and cancer. Policy makers could make better EID policy choices with a prospective understanding of social opportunity cost—how citizens choose to trade-off pandemic risk reductions relative to other catastrophic risks and health risks.[2] For example, a World Bank report (2012) on the One World, One Health Initiative [OWOH] explicitly asks for more data on social opportunity costs. The report states: "Because no comprehensive study of the economics of [OWOH] has been undertaken before, this report aims; above all else, to stimulate discussion of economic issues relating to [OWOH]. This will include identifying and describing existing gaps in part to invite additional work in these areas" (World Bank, 2012, pp. xi).

Herein we design a stated preference survey to estimate two key measures of pandemic risk reduction based on the opportunity costs of *relative lives saved*: (1) *Risk-risk tradeoffs*: We evaluate how people trade-off lives saved from pandemic policy relative to an environmental

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[1] A recent report by the World Bank (2012) estimated that on average, losses due to six major zoonotic disease outbreaks between 1997 and 2009 resulted in losses of US$6.7 billion per year.
[2] For example, social opportunity costs would be useful for the *One World, One Health Pandemic Mitigation Program*, which includes the World Bank, Food and Agriculture Organization (FAO), World Organization for Animal Health (OIE), World Health Organization (WHO), and the United Nations System Influenza Coordination (UNSIC). The initiative assesses the existing status of EID surveillance and control and proposes a strategic framework to address ongoing challenges (World Bank, 2012, FAO et al., 2008). In a 2012 report, the World Bank estimated that, depending on the level of disease prevalence, between $1.9 and $3.4 billion per year would be required to augment and fortify disease surveillance in 139 countries.

disaster (e.g., Bhopal, Exxon, Deepwater, Fukushima) or a terrorist attack (see e.g., Viscusi et al., 1991),[3] and (2) *Risk policy effectiveness*: We estimate the minimum lives that must be saved to justify a $5 per annual expenditure (over 15 years) in pandemic risk reduction policy that otherwise would have been spent on programs to reduce terrorism, flu, traffic accidents, cancer, and heart disease.[4] In doing so, we are using the *One World, One Health Initiative* as a motivating example to measure effectiveness based on changing lives saved for a given dollar amount.

We find three key results. First, our respondents value lives in both a terrorist attack and an environmental disaster more than a pandemic outbreak. Like spread betting in gambling, the person has to get "points" when trading off terrorism or environmental disaster risk for pandemic risk. If she is going to give up 1 terrorism attack life saved, she has to get 3.69 pandemic outbreak lives saved in return. Similarly for an environmental disaster—for 1 environmental disaster life saved, she needs 3.59 pandemic outbreak lives in return. We propose the variation in the value of lives saved is likely to reflect the subjective probability the event will lead to further deaths rather than an inherent difference in the value of a life saved from one event relative to another. Second, we find groups who have experience with or are educated about a

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[3] Viscusi et al. (1991) developed a method to measure the values that individuals place on morbidity risk reductions. The approach has several advantages to valuing policies that address catastrophic events. First, catastrophic risks tend to involve small absolute probabilities. Absolute probabilities may be difficult for a respondent to process. With this approach, they 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" (Viscusi, 2009).
[4] We use the stated-preference approach due the lack of identifiable related markets (see e.g., Kling et al. 2012). Conventionally it is appropriate to measure society's aggregate willingness to pay (WTP) using a survey to elicit the individual WTP directly. In Cameron and James (1987), the authors developed a procedure where the posted prices are varied across respondents such that the yes/no responses convey information about the variance of the posted price (the dispersion in the conditional distribution of the individual posted price). Using the variation in the threshold values, this allows for direct point estimates of regression-like slope coefficients. Modifying the Cameron and James approach, we contribute to the method by testing a specific policy with an estimated cost, but vary only the effectiveness of the policy. Rather than measuring WTP and holding effectiveness constant, we examine the problem of measuring minimum lives saved, holding WTP constant.

particular catastrophic event, are more vulnerable to a particular catastrophic event, and are closer to a prior catastrophic event will value lives saved greater in the both tradeoffs. Third, we find the average respondent requires at least 457,000 saved lives for a $5/year contribution to pandemic risk reduction—given all other taxpayers also contribute and she is aware of the opportunity cost of the tax dollars. These results suggest that people undervalue infectious diseases, which in turn is a contributing factor to our current lack of preparedness in the United States (see for example the critical review written by the Office of Inspector General in the US Department of Homeland Security, USDHS, 2014).

2. ANALYTICAL FRAMEWORK

We now present an analytical framework for our two measures of rational risk reduction—the risk-risk tradeoff and the minimum effectiveness requirement. Consider each in turn.

Risk-risk tradeoff model

We use a random utility model to determine the rate of tradeoff between deaths from catastrophic events. The structure of the survey is designed so that respondents are presented with twelve discrete pairwise policy choices that provide data for estimation based on a random utility model. The twelve choices are between a policy that would prevent US deaths from a pandemic outbreak or policies that would prevent US deaths from an environmental disaster or terrorist attack (Viscusi, 2009).

Policy choices can reduce three types of risk: policies that reduce pandemic outbreak deaths (p), environmental disaster deaths (e), and terrorist deaths (t). A fundamental feature of the tradeoff choice is that respondents are valuing a specific number of US deaths for each class of risks. The utility for policy j ($j = 1,2$) for respondent i is given by u_{ji}. Following Viscusi (2009), the basic model where utility is a function of only the three main effects is:

$$u_{ji} = \beta_p p_{ji} + \beta_e e_{ji} + \beta_t t_{ji} + \varepsilon_{ji} \tag{1}$$

where ε_{ji} is the random error term. All demographic characteristics are the same for all policy option valuations. We exclude these from the model because they drop out of the analysis when taking the utility difference between the policy alternatives. The interactions of these characteristics with the main effects, however, can be observed.

The probability pr_{ji} that respondent i chooses policy option j on any given pairwise policy comparison (pandemic outbreak versus terrorist attack or pandemic outbreak versus environmental disaster) is such that

$$pr_{ji} = pr\left(\beta_p p_{ji} + \beta_e e_{ji} + \beta_t t_{ji} + \varepsilon_{ji} > \beta_p p_{ki} + \beta_e e_{ki} + \beta_t t_{ki} + \varepsilon_{ki}\right), \text{ for } j \neq k. \tag{2}$$

For the regression analysis, the results are pooled for twelve different choices made by respondents in a conditional logit model. There are six different choices for each of the two sets of paired comparisons.

We also examine the interactions of personal characteristics with the main effects. Let utility in the model including interactive effects be characterized by:

$$u_{ji} = \beta_p p_{ji} + \beta_e e_{ji} + \beta_t t_{ji} + \varphi_p p_{ji} x_j + \varphi_e e_{ji} x_j + \varphi_t t_{ji} x_j + \varepsilon_{ji}$$

where x_j is a series of interactions of demographic variables with the main effects. Let $\varphi_k < k$ denote the coefficient of the interaction of x_j with main effect k, $k = p, e,$ and t. Personal characteristics such as experience with infectious diseases and socioeconomic characteristics affect the utility values, but do not have an effect on choices because they do not vary across the policy choices.

To compute the risk tradeoffs, we totally differentiate equation (1) holding utility constant

$$du_{ji} = 0 = \beta_p dp + \beta_e de + \beta_t dt. \tag{3}$$

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The rate of tradeoff between environmental disaster (terrorist attack) policies and pandemic outbreak policies is computed by deriving the derivative of environmental disaster (terrorist attack) polices with respect to pandemic outbreak policies.[5] These tradeoffs are shown in equations (4) and (5):

$$\partial e/\partial p = - \beta_p/\beta_e \qquad (4)$$

$$\partial t/\partial p = - \beta_p/\beta_t \qquad (5)$$

We use equations (4) and (5) and the stated-preference method to suggest how a representative sample of the US population values the risk tradeoffs between catastrophic events.

Minimum required effectiveness model

Now we develop a model to estimate minimum lives saved (LVS) using a dichotomous-choice contingent valuation approach. Respondents are asked "yes" or "no" if they are willing to pay for a particular policy that will reduce the number of expected US deaths resulting from a pandemic outbreak. With this type of approach, the exact magnitude of the respondent's valuation is not revealed, but it more closely replicates the type of "take-it-or-leave-it" decisions that consumers encounter in their daily market transactions. Cameron and James (1987) developed an empirical methodology that estimates maximum WTP when the threshold values for costs are randomly varied across the sample, also known as an interval regression model (Wooldridge, 2002). In contrast, we vary the number of lives saved from a policy costing $X per household per year ($X will be explicitly defined in the survey design).

Modifying Cameron and James (1987) and the traditional WTP model, we specify

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[5]Given equation (3), equation (4) states that holding the number of terrorism deaths constant ($\partial t = 0$), the marginal change in environmental disaster deaths required to keep utility constant given a marginal change in pandemic outbreak deaths is $\partial e/\partial p = - \beta_p/\beta_e$. Given equation (3), equation (5) states that holding the number of environmental disaster deaths constant ($\partial e = 0$), the marginal change in terrorist attack deaths required to keep utility constant given a marginal change in pandemic outbreak deaths is $\partial t/\partial p = - \beta_p/\beta_t$.

$$LVS_i^* = x_i'\beta + \varepsilon_i \tag{6}$$

where LVS_i^* is the latent variable, x_i is a vector of explanatory variables, β is a vector of

coefficients, ε_i are independently and identically distributed normal errors with mean zero and

standard deviation, σ; and $i = 1, \ldots, N$ indexes households in a sample of size N. Each

individual encounters a randomly chosen number of lives saved, lvs_i. For the lives saved

questions, denote an acceptance of lvs_i by $LVS_i = 1$, and a rejection by $LVS_i = 0$. With these

assumptions, the probability of saying "yes" to pay for the policy at the given level of

effectiveness is

$$Pr_i = Pr(LVS_i = 1) = Pr(LVS_i^* < lvs_i)$$

$$= Pr(x_i'\beta + \varepsilon_i < lvs_i)$$

$$= Pr(\varepsilon_i < lvs_i - x_i'\beta)$$

$$= Pr(z_i < (lvs_i - x_i'\beta)/\sigma) \tag{7}$$

where z_i is a standard normal random variable. The variation in the threshold offer (in terms of

lives saved), lvs_i, allows us to separately identify β and σ and assess the marginal contribution

to LVS^* for a change in each one of the variables.

3.   SURVEY DESIGN, SAMPLE, AND IMPLEMENTATION

With the assistance of Wyoming Survey and Analysis Center (WYSAC)[6], we administered a

computer-based questionnaire administered to a nationally representative web-based panel to test

our stated-preference survey instrument. The survey instrument was distributed across the

United States. Each respondent was categorized into five distinct geographic regions: Mexico

border, Canada border, Pacific Ocean border, Atlantic Ocean border, and Inland states to capture

areas with differing relative risk of an EID event. See Figure 1, which represents a worldwide

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[6]WYSAC is based out of the University of Wyoming and has been conducting surveys for over 30 years. WYSAC
fields their surveys in accordance with the best practices and latest findings from the survey research literature,
designed to achieve representative responses and unbiased results. wysac.uwyo.edu

map of predicted regions where new EIDs are most likely to originate (emerging disease 'hotspots'). Relative risk is demonstrated on this map such that lower values are denoted by green and higher values are denoted by red. Similar to findings from Viscusi (2009) examining risk perception of terrorist attacks, rural residents in Wyoming and other areas far removed from US borders may perceive little personal threat from a pandemic outbreak based on their observation of how pandemic outbreaks originate in the US.

This survey consists of seven parts: (1) definitions (of infectious diseases, zoonotic diseases, and a pandemic), (2) background questions (experience with vaccination and diagnoses of an infectious disease), (3) information on pandemic risks, (4) context to related risks (environmental disasters and terrorist attacks) and risk questions, (5) context to how we die in context of several risks (e.g., traffic accidents, heart disease, flu), (6) valuation questions, and (7) socioeconomic questions. To ensure that the order of the valuation questions would not influence or bias survey responses, half of the sample were given the risk-risk tradeoff questions first; while the other half of the sample were given the LVS questions first. This allows for the control for ordering effects.

To determine how respondents value risk from a pandemic relative to other uncertain catastrophic events, respondents were asked a series of tradeoff questions involving two different pairs of risks. Following Viscusi et al. (1991) and Viscusi (2009), the first set of trade-off questions were pandemic outbreak deaths versus environmental disaster deaths and the second set were pandemic outbreak deaths versus terrorism deaths. Pandemic outbreak deaths serve as the common reference point. A sample risk tradeoff question, replicating the actual survey, is presented in the top panel of Figure 2. This context allows the respondent to choose between two policies, one policy reduces the number of US deaths from pandemic outbreaks and the other policy reduces the number of US deaths from environmental disasters. The survey characterizes

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the nature of the two types of catastrophic risks by conveying to the respondent the expected number of deaths prevented by the policy. If the respondent chooses Policy #1 in the top panel, this implies a policy preventing 50 environmental disaster deaths is more valuable than preventing 100 pandemic outbreak deaths, and that environmental disaster deaths are more than twice as highly valued per death than pandemic outbreak deaths. Replicating the tradeoff pairs in Viscusi (2009), respondents considered a series of 6 different tradeoff combinations: (50,100), (250,25), (25,125), (125,100), (150, 50), and (100,100). The bottom panel of Figure 2 presents the comparable tradeoff question for pandemic outbreak deaths and terrorism deaths.

These questions give insight into how the US public values saving lives by reducing the fatality risks associated with catastrophic events. We next designed a set of valuation questions to determine how effective, also in terms of lives saved, a specific policy must be for taxpayers to be willing to pay for the policy. To determine the minimum LVS in the event of a catastrophe, such as a pandemic outbreak, it is first necessary to examine the cost of the policy to be implemented. The World Bank (2012) estimates that $3.4 billion per year will be required in addition to current spending for a high-prevalence policy.[7] This policy requires surveillance in 139 countries and meets standards set by the World Health Organization (WHO), while ensuring efficient reporting and response. The US currently contributes approximately 23% to the North Atlantic Treaty Organization's (NATO) and WHO's annual budget. (WHO, 2013 and the NATO website). Applying this same percentage to the required annual policy cost of $3.4 billion results in the US contributing $774 million per year. Dividing this number by the 2011 number of US taxpayers is approximately $5 per taxpayer. Respondents are asked in a referendum format whether they would pay $5 per year to prevent a randomly chosen number of deaths. McKibbon and Sidorenko (2006) predict US deaths from a pandemic outbreak would range from 22,000

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[7] Their strategy targets the interfaces among animals and humans within different ecosystems and uses different disciplines among different sectors to develop control and prevention measures. The strategy employs scenarios that assume low or high prevalence of diseases as a basis for development of preventive measures. (World Bank, 2012).

people for a mild pandemic to 1 million for a severe pandemic. With the uncertainty of the severity of the pandemic and the uncertainty as to the effectiveness of the policy, respondents are randomly assigned a number between 0 and 1 million from a uniform distribution for the number of deaths prevented from the implementation of the policy. The opportunity cost of voting yes for this policy is captured by telling respondents that if they choose to contribute $5 per year toward this policy, it implies taking money away from other programs such as those that reduce terrorism, flu, traffic accidents, cancer, and heart disease. Figure 3 presents an example of the valuation question from the actual survey.

After a year of pretests, WYSAC implemented the survey instrument in a national study. The sample is a nationally representative panel recruited by the online market research company, uSamp, based out of Los Angeles, California. Participants in the panel take surveys by computer. WYSAC secured a total of 321 surveys. After administering the survey, they provided a fully labeled data file in STATA format. Appendix A presents a complete example of the randomized survey.

Explanatory variables fall into two categories: experience with infectious diseases and socioeconomic characteristics. Further, there are variables describing the percentage of respondents in each region and the random number of deaths prevented from the implementation of the policy. Table 1 presents the descriptive statistics for the variables.

In Table 1, 95% of respondents reported being vaccinated and 19% had been diagnosed with an infectious disease. The common cold, seasonal flu, and chickenpox are all listed as examples of infectious diseases. This implies that 81% of the sample either believes they have never had the common cold or seasonal flu, or perhaps more likely, they did not understand the broad definition of an infectious disease. Of those respondents diagnosed with an infectious disease or had a family member diagnosed, the majority were sick for one week or less. For

those respondents with a friend diagnosed, the majority were sick for longer (one week to one month).

One would expect states closer to shipping terminals (Regions 1 and 2) to be more vulnerable to an outbreak and possibly require a more effective policy (i.e., have a lower minimum lives saved to vote for the policy). Further, considering the last pandemic originated in Mexico, states bordering Mexico (Region 3) may also feel more vulnerable to an outbreak and require less lives saved to implement the policy.

Given persistent evidence of gender effects in choices under risk and uncertainty, one might expect that men and women will differ on how many more lives must be saved to vote yes for the policy (see for example, Booth and Nolen, 2012). For instance, men may feel they have a greater ability to self-protect without needing external government support. Flynn, Slovic, and Mertz (1994) find in their national survey of risk perceptions that in contrast to all other groups, white males tended to view risks are smaller and more acceptable. Nineteen percent of respondents have taken a course in disease education, which is a group that may require less lives saved to vote for the policy since they likely have a better understanding of the risk of an outbreak. Lastly, forty-three percent of respondents are affiliated with the Democratic Party, while thirty percent are affiliated with the Republican Party.

Figure 4 shows several additional respondent characteristics. Twenty-eight percent of respondents are primarily employed full-time and nearly all respondents have at least a high school degree. The majority of respondents make between $15,000 and $75,000 per year. For those respondents with Hispanic or Asian descent, they may require less lives saved to vote for the policy. The last two pandemic outbreaks originated in Hispanic and Asian countries. These respondents may have a better understanding of the negative effects of a pandemic outbreak and the benefits of mitigation policy. Regarding education, respondents with more education may

require less lives saved. They may have a better understanding of the relative costs and benefits of the pandemic policy. The benefits of preventing an outbreak are high relative to the cost of the policy. But more education might also indicate the person is more confident in his or her ability to self-protect. For respondents who took an economics course, they may require less lives saved to vote for the policy since they may have a better understanding of how the benefits compare to the costs. For income, one might expect that higher income respondents will require fewer lives saved to vote for the policy since the cost is flat and not progressive with income.

4. RESULTS AND DISCUSSION

For the risk-risk tradeoff analysis, we estimate a conditional logit regression based on the random utility model.[8] The dependent variable is coded as a "0" if the respondent chooses the pandemic outbreak policy and a "1" if they choose the terrorist attack or the environmental disaster policy. Following Viscusi (2009), we tested for transitivity by comparing the series of pairwise choices made by respondents.[9] For the set of trade-off questions comparing pandemic deaths to environmental disaster deaths, 202 of 321 observations passed the transitivity condition. For the trade-off questions comparing pandemic deaths to terrorist deaths, 217 out of 321observations passed. We restrict our analysis to respondents who passed these transitivity/consistency checks.[10] Including the respondents who did not pass the NOAA Blue Ribbon Panel's (see Arrow et al., 1993) transitive/consistent test did not substantially change our estimates. Table 2a and 2b report estimates that compare terrorist attack and pandemic policy (Policy Choice 1), and environmental disaster and the pandemic policy (Policy Choice 2). As

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[8]The estimated standard errors reported for the conditional logit models are robust and clustered by individual respondent because the analysis uses multiple observations per individual. The conditional logit model also includes fixed effects for each set of tradeoff questions (see Viscusi, 2009).
[9]A respondent choosing Policy 1 from the choice pair (50,100) has revealed relative values for the two groups that will be inconsistent if the respondent also picks Policy 1 for the choice pairs (250,25), (125,100), or (150,50).
[10]Note 133 respondents made identical choices between the set of trade-off questions where pandemic outbreak deaths are compared to environmental disaster deaths and set of trade-off questions where pandemic outbreak deaths are compared to terrorist attack deaths.

utility levels are defined only up to a positive linear transformation, we focus on the signs and statistical significance of the coefficients, which are all positive and statistically significant at the 0.01 level. The coefficient ratios provide information on the tradeoff rates between the different risk categories.

Table 3 reports relative valuations associated with the coefficient ratios implied by the results in Tables 2a and 2b. The tradeoff rates involve nonlinear combinations of coefficient estimates so the delta method is used for standard errors (Greene, 2008). Table 3 also reports the standard errors for these tradeoff rates and the associated 95% confidence intervals. Applying equation (4), the rate of tradeoff between terrorist attack policies and pandemic outbreak policies is 3.69. Lives saved by reducing terrorist attack deaths are valued more than three and a half times as lives saved by preventing pandemic outbreak deaths. From equation (5), the rate of tradeoff between environmental disaster policies and pandemic outbreak policies is 3.59. Lives saved by reducing environmental deaths are valued more than three and a half times as lives saved by preventing pandemic outbreak deaths.[11] From these two results, we can derive the risk-risk tradeoff between deaths prevented by environmental disaster policies and deaths prevented by terrorist attack policies. The rate of tradeoff between environmental disaster policies and terrorist attack policies is nearly 1:1 with respondents' slightly preferring lives saved by reducing terrorist attack deaths more than lives saved by preventing environmental disaster deaths. We find no statistical difference in the rate of tradeoff between environmental disaster and terrorism deaths.

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[11] People demand more lives for environmental disasters even though few people actually die from environmental disasters. In the domestic example given to respondents (Deepwater Horizon Oil Spill), no human lives were lost. However, there are many examples of foreign environmental disasters (Fukushima Daiichi nuclear disaster, Chernobyl disaster), where several thousand people died, that respondents could be referencing. Respondents may also be confusing environmental disasters (preventable) with natural disasters (non-preventable), such as Hurricane Katrina.

Next, we explore the heterogeneity of the risk-risk tradeoffs by examining the base result interactions with explanatory variables, reported in Table 4. We examine specific interaction terms to explore how socioeconomic and demographic factors affect perceived risk of each catastrophic event. For example, we can examine if respondents of different races value these risks differently. A number of interactions were investigated for each type of fatality. We found that the main effects[12] remained statistically significant with the exclusion or inclusion of the interaction variables for the tradeoff between environmental disaster policies and pandemic outbreak policies. With the tradeoff between terrorist attack policies and pandemic outbreak policies, however, only the coefficient for the terrorist attack main effect remained significant. Interaction terms capture most of the influence of the fatality risk of pandemics for this tradeoff. Of the interaction variables examined, we found significance in several of the variables when comparing deaths from an environmental disaster with deaths from a pandemic outbreak and comparing deaths from a terrorist attack with deaths from a pandemic outbreak. Appendix B provides the list of the interactions with the three main effects and the intuition for including these variables.

Table 4 shows the estimates for the regressions including the interaction variables. Because the dependent variable is coded as a "0" if the respondent chooses the pandemic outbreak policy and a "1" if they choose the terrorist attack or the environmental disaster policy, a negative coefficient can be interpreted as positive effect on the utility coefficient for lives saved from a pandemic policy. A positive coefficient can be interpreted as positive effect on the utility coefficient for lives saved from a terrorist attack or environmental disaster policy. While there are 22 interaction terms in total, we report only those that are statistically significant at the 0.10 level or better. Several interaction terms were excluded due to multicollinearity. Although

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[12] The main effects compare terrorist attack and pandemic policy (Policy Choice 1), and environmental disaster and the pandemic policy (Policy Choice 2) and can be interpreted as the effects of those respondents who responded '0' to the all of the explanatory variables in the model.

speculative in nature, these results provide some additional insight into how people react to these risks. Four points are worth stressing here. First, respondents who had been diagnosed themselves or had a friend diagnosed with an infectious disease or who had taken a disease-related course all have a positive effect on the utility coefficient for lives saved from a pandemic policy for both tradeoff analyses. These respondents are likely to know more about the objective risk of a pandemic outbreak. Second, retired respondents have a positive effect on the utility coefficient for lives saved from a pandemic prevention policy when compared to an environmental disaster prevention policy. But they have a negative effect on the utility coefficient for lives saved from a pandemic prevention policy when compared to a terrorist attack prevention policy. Retired respondents value pandemic prevention policies more than environmental disaster prevention policies, but less than terrorist attack prevention polices.

Third, respondents living in Region 3 (Mexico Border states) had a positive effect on the valuation of environmental disaster prevention policies. Respondents living in Region 1 (Pacific Coast states) valued pandemic outbreak prevention policies more, whereas people in Region 2 (Atlantic Coast states) valued terrorist attack prevention policies more. For the pandemic interaction with Region 1, states bordering the Pacific Ocean, are closer to the countries where both SARS and H5N1 originated. Region 3 respondents are closer to Mexico, where the Deepwater Horizon Oil Spill occurred. Region 1 is closest to where the 9/11 Terrorist Attack took place. These results suggest that proximity matters when valuing risk of catastrophic events. Fourth, disabled respondents and respondents of Asian descent valued policies preventing death in an environmental disaster positively. Disabled respondents are more vulnerable in environmental disasters, while Asian descent respondents have specific experience with environmental disasters (Japanese Tsunami).

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These four observations illustrate that groups with experience or education with a particular catastrophic event place greater value on lives saved in that scenario. This point is related to Tversky and Kahneman's (1973) availability heuristic, in which more experience means easier recall of an undergone event when asked about some new event, related or otherwise. Proximity to a catastrophic event affects value of policies to prevent that event from occurring. Further, groups who may feel more vulnerable to a particular catastrophic event will value lives saved in that scenario greater. Both interactions lead us to believe that respondents will place higher value on lives saved the less abstract and more realistic the catastrophic event. Most US citizens likely believe they have a realistic perception of a terrorist attack based on the events of September 11, 2001, rather than an environmental disaster or a pandemic outbreak, resulting in a higher value on lives saved in a terrorist attack regardless the probability of the event occurring. Although the recent Fukushima Daiichi nuclear disaster was not a domestic incident, the aftermath of nearly 16,000 deaths was broadly covered in the media.

To verify our results in the risk-risk tradeoff analysis, we examine the minimum lives saved to avoid a pandemic outbreak. We ask respondents whether they are willing to pay $5 per year for a policy that reduces the chances of a pandemic. There is no guarantee that the pandemic is avoided even if they say "yes" to paying $5, but the severity can be reduced. Further, all respondents must contribute to implement the policy. Table 5 presents empirical results from the analysis of LVS.[13] The dependent variable is coded '0' if the respondent voted no for the pandemic prevention policy and '1' if the respondent voted yes for the policy. A negative sign on the coefficient indicates respondents, on average, do not favor the pandemic prevention policy. If respondents are vaccinated, which is significant at the 1% significance level, they require less lives to be saved to vote 'yes' for the policy. This suggests vaccinated

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[13] We include all collected variables in this model. We broaden the selection of variables included in this analysis. In our previous model, we are limited in the number of interactions to include due to high collinearity. We also modeled more limited specifications and found similar results.

people like to control the risk of illness, and since the risk of a pandemic is a social risk (without a preventive vaccine), they seem more in favor of a government policy. If respondents were diagnosed with an infectious disease, they require more lives saved to vote for the policy. But if their friends or family were diagnosed they will not require as many lives saved to vote 'yes' (only the *friend diagnosed with an ID* coefficient is significant requiring less lives saved). These results support a general notion that a person is more confident in the ability to self-protect than to protect immediate or distant friends and family. Hispanic respondents value the policy more (they will vote for a less effective policy such that less lives saved are required to vote 'yes'). This is not surprising considering the last major infectious disease outbreak, H1N1, originated in Mexico, a primarily Hispanic country. Respondents who are disabled also require less lives saved to vote for the policy. Those respondents who have not attained a high school degree and those respondents who have completed a 2-year degree both require more lives saved to vote 'yes'. Lastly, respondents with income levels between $15,000 and $25,000 require less lives saved to vote 'yes'; while those respondents with income over $200k require more lives saved to vote 'yes'.

The estimated mean LVS to vote for the policy is approximately 7.1 million lives saved over 15 years for the mean respondent, while the median LVS to vote for the policy is approximately 6.6 million lives saved over 15 years for the median respondent. To pay $5 each year over 15 years (ignoring discounting) the average respondent requires a minimum of approximately 457,000 lives saved per year in the event of a pandemic outbreak occurring. This is taking into account the opportunity costs of voting for this policy. If the policy is so effective that at least 457,000 lives would be saved in the event of a pandemic, the average respondent will vote for the policy knowing those taxpayer dollars will not be spent on other programs such as those to reduce terrorism, flu, traffic accidents, cancer, and heart disease. Considering the

estimated number of US deaths from a severe pandemic could reach 1 million deaths in one year, respondents are requiring a minimum 46% rate of effectiveness before they will vote for the policy.

5.   CONCLUSION

Opportunity costs exist in pandemic risk-reduction policy. Understanding the nature of these costs can help design a more rational risk-reduction policy—more risk reduction per dollar spent given competing threats like environmental disasters and terrorist attacks. Herein we use a stated-preference survey to estimate these opportunity costs based on (1) how people trade-off risk, and (2) risk effectiveness based on minimum lives saved for a given expenditure level. How can policy makers form more rational risk reduction policy based on our answers to these two measures of opportunity costs?

First, in the risk-risk tradeoff analysis, people say they need *more lives saved* if they are going to trade terrorist risk for pandemic risk. Like spread betting in gambling, the person has to get "points" when trading off terrorism risk for pandemic risk. If she is going to give up 1 terrorism life saved, she has to get 3.69 pandemic lives saved in return. Similarly for an environmental disaster—for 1 environmental life saved, she needs 3.59 pandemic lives in return. Lives saved by reducing deaths from terrorist attacks or environmental disasters are valued more than three and a half times as much as lives saved by preventing pandemic outbreak deaths. Although our estimates indicate that people say they value lives saved from terrorist attack and environmental disasters more than those saved from disease outbreaks, we believe that pandemic risks should not receive a lower value and that the differences in valuation likely reflect differences in risk beliefs. A life saved is a life saved. Instead, our estimates more likely reflect the point that people find it more difficult to quantify the risks associated with events such as pandemic outbreaks for which they have less experience. This is in contrast to the tangible risks

of terrorist attacks such as 9/11 and environmental disasters such as the 2008 Kingston Fossil Plant coal fly ash slurry spill, the 2010 Deepwater British Petroleum Inc. (BP) oil spill, or the 2011 Fukushima nuclear disaster. The value of statistical life (VSL), as reported by the US Department of Transportation is $9.1 million ($2013) for transportation related deaths. Using results from Viscusi (2008) on ratios between traffic deaths and terrorist attack deaths (natural disaster deaths), and applying the ratios computed in this paper, we find an average VSL of approximately $1.7 million for a life saved in a pandemic outbreak.[14] When considering the value of a statistical life saved, our respondents valued a life saved in a more certain traffic accident life saved five times as much as a life saved in an uncertain pandemic outbreak.

Second, for risk effectiveness, we asked people how effective a US/global risk reduction policy must be for them to pay for it (i.e., the One World, One Health Initiative). Respondents consider how effective (in terms of US lives saved) this policy must be while considering the opportunity costs associated with this value. We find the average respondent will pay $5/year for 457,000 saved lives—given she is fully aware of the opportunity cost of the tax dollars, and she assigns a higher value on lives saved from disasters and terrorist attacks (3.6 more). But what does this number mean? If we assume all 144 million taxpayers pay $5 each[15]—their fair share of costs, they would have to save at least 457,000 people for this annual $774m expenditure (which is about 0.005% of GDP in a US economy of $17.3 trillion in 2014). Considering respondents were told a pandemic outbreak could result in anywhere from 22,000 to 1 million deaths depending on the severity of the outbreak, the VSL bounds for this range of deaths would be $1.1 million for 22,000 deaths to $24,000 for 1 million deaths. We find that

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[14] In Viscusi (2009), respondents value a life saved in a traffic accident 1.1 times a terrorist death and 1.9 times a natural disaster death. Computing the VSL for terrorist deaths and natural disaster deaths results in $8.0M and $4.8M values. Applying these values to the ratios in our paper and then averaging the two results in a VSL of $1.7M for a pandemic life saved.

[15] We use 144 million taxpayers given this the number of individual returns submitted in 2011, which is available from the Internal Revenue Service (IRS) website, http://www.irs.gov/uac/SOI-Tax-Stats-Number-of-Returns-Filed,-by-Type-of-Return-and-State-and-Fiscal-Year-IRS-Data-Book-Table-3.

with a requirement of 457,000 lives saved in the event of a pandemic outbreak, a VSL of approximately $52,564 for a life saved in a pandemic outbreak.

With both measures, respondents are significantly undervaluing the risk of a pandemic outbreak. This is not surprising considering the abstract nature of a pandemic outbreak. The most recent pandemic resulted in approximately 12,500 U.S. deaths (Shrestha, et al., 2011) and the recent Ebola outbreak resulted in only 1 U.S. deaths (CDC, 2015). Although EIDs are on the rise and increasing the probability of a more severe outbreak, this type of catastrophe is likely too abstract and too uncertain for respondents to grasp. A terrorist attack may be less likely to occur, but U.S. citizen have experience with this happening on U.S. soil. The same is true for environmental disasters. Respondents likely are too heavily influenced by their prior beliefs. This idea, known as prospective reference theory, is demonstrated in Viscusi (1989). The basic assumption is that individuals' attitudes toward uncertain prospects are influenced by a reference risk level. The reference risk is the individual's prior probability. Note that this does not account for the large difference in VSL between the two measures. This difference is likely due to scaling and bounds established in the minimum lives saved analysis. In our risk-risk tradeoff analysis, we compared values ranging from 25 lives saved to 250 lives saved. If we used values closer to the predicted number of deaths in a severe outbreak (1 million) or even a mild pandemic (22,000) such as we did in the minimum required effectiveness analysis and examined the tradeoff between a pandemic death (an uncertain event) and a traffic accident death (a certain event), the respondent would always choose a traffic accident life saved because they would be certain to save the life. Regardless of the difference between the two estimates, both estimates clearly illustrate that respondents are undervaluing the risk of pandemic death, which in turn is contributing to our current lack of preparedness.

One final note: we administered this survey prior to the current Ebola outbreak. If we administered the survey again today, it is likely our results would require less of a trade-off spread, and the values would be lower in terms of minimum required effectiveness. This is the next step in our research agenda.

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Table 1: Descriptive Statistics

Variable	Definition	Obs	Mean	Min	Max
lvs	Proposed number of lives saved	321	507,060	12,613	995,786
LVS	Number of lives saved (=1 if yes)	313	0.674	0	1
vaccinated	Vaccinated (=1 if yes)	311	0.945	0	1
Respondent diagnosed with an infectious disease (ID)	Respondent diagnosed (=1 if yes)	309	0.194	0	1
Family diagnosed with ID	Family of respondent diagnosed (=1 if yes)	294	0.184	0	1
Friend diagnosed with ID	Friend of respondent diagnosed (=1 if yes)	269	0.227	0	1
Region 1	States bordering the Pacific Ocean (Including HI and AK)	302	0.195	0	1
Region 2	States bordering the Atlantic Ocean and the Gulf	302	0.169	0	1
Region 3	States bordering Mexico	302	0.219	0	1
Region 4	States bordering Canada	302	0.083	0	1
Region 5	States not bordering Mexico, Canada, the Pacific Ocean, the Atlantic Ocean, or the Gulf	302	0.472	0	1
Male	Male (=1 if yes)	318	0.349	0	1
Married	Married (=1 if yes)	319	0.445	0	1
Disease education	Class in disease at a college or technical school (=1 if yes)	321	0.193	0	1
Economics education	Class in economics at a college or technical school (=1 if yes)	321	0.386	0	1
Democrat	Affiliated with democratic party (=1 if yes)	319	0.432	0	1
Republican	Affiliated with republican party (=1 if yes)	319	0.304	0	1
Other political party	Affiliated with other party (=1 if yes)	319	0.263	0	1

Table 2a: Conditional Logit Estimates of Policy Choice 1

Deaths prevented by policy	Coefficient[1]		robust se
terrorist attack	0.099	***	0.025
pandemic outbreak	0.027	***	0.012

***Significant at the 0.01 level, two-tailed test

Table 2b: Conditional Logit Estimates of Policy Choice 2

Deaths prevented by policy	Coefficient[2]		robust se
environmental disaster	0.068	***	0.013
pandemic outbreak	0.019	***	0.007

***Significant at the 0.01 level, two-tailed test

[1]The coefficient can be interpreted as: deaths prevented by terrorist attack provide higher utility than those by pandemic outbreak.
[2]The coefficient can be interpreted as: deaths prevented by environmental provide higher utility than those by pandemic outbreak.

Table 3: Relative risk valuations implied by tradeoffs

Fatality risk tradeoff category	Implied relative valuations	Standard error	95% confidence interval
Number of Pandemic Outbreak Deaths Equivalent to One Environmental Disaster Death	3.59	1.24	(1.17, 6.02)
Number of Pandemic Outbreak Deaths Equivalent to One Terrorist Attack Death	3.69	0.85	(2.01, 5.36)

Main effects	Policy Choice 1			Policy Choice 2		
	coefficient		robust se	coefficient		robust se
Pandemic outbreak deaths	0.033	***	0.007	0.015		0.015
Environmental disaster deaths	0.064	***	0.016			
Terrorist attack deaths				0.113	***	0.037
Pandemic outbreak deaths interactions						
Region 1				-0.424	***	0.104
Respondent diagnosed with ID	-0.529	***	0.065	-0.440	***	0.105
Friend diagnosed with ID	-0.622	***	0.051	-0.650	***	0.044
Retired	-0.626	***	0.058	0.060	***	0.015
Disease education	-0.653	***	0.051			
Environmental disaster deaths interactions						
Region 3	0.727	***	0.020			
Asian	0.693	***	0.033			
Disabled	0.734	***	0.023			
Terrorist attack deaths interactions						
Region 2				0.702	***	0.040
Income >$150,000				-0.088	***	0.036

***Significant at the 0.01 level, two-tailed test
**Significant at the 0.05 level, two-tailed test
*Significant at the 0.10 level, two-tailed test

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[16] The dependent variable is coded as a "0" if the respondent chooses the pandemic outbreak policy and a "1" if they choose the terrorist attack or the environmental disaster policy, a negative coefficient can be interpreted as positive effect on the utility coefficient for lives saved from a pandemic policy. A positive coefficient can be interpreted as positive effect on the utility coefficient for lives saved from a terrorist attack or environmental disaster policy.
[17] We discuss the selection of the interaction variables in the text and Appendix B.
[18] Other variables examined were (1) Income less than $35,000 for pandemic outbreaks, (2) Hispanic for environmental disasters, and (3) political party and White for terrorist attacks. Either no significance was found or multicollinearity between variables.

Table 5: Interval regression model estimates

Variable	β/σ#	σ		se	β	Median	Med*β	Mean	Mean*β
Proposed number of lives saved (lvs)	1.73×10^{-7}	5,780,347							
Region 1	0.013			0.323	142,162	0	0	0.203	28,925
Region 2	-0.257			0.359	-1,960,291	0	0	0.160	-313,986
Region 3	-0.202			0.328	-882,336	0	0	0.229	-202,441
Region 4	-0.713			0.416	-3,642,367	0	0	0.087	-315,356
Vaccinated	1.216		***	0.473	7,475,858	1	7,475,858	0.939	7,022,775
Respondent diagnosed with ID	-1.143		***	0.403	-7,121,426	0	0	0.130	-924,860
Family diagnosed with ID	0.109			0.407	553,746	0	0	0.147	81,504
Friend diagnosed with ID	1.015		***	0.381	6,298,093	0	0	0.225	1,417,752
Age	-0.003			0.011	-25,194	36	-907,000	38.996	-982,474
Male	-0.066			0.244	-243,188	0	0	0.403	-97,907
Married	0.285			0.284	1,775,781	0	0	0.433	768,736
Hispanic	1.070		*	0.577	6,564,019	0	0	0.082	539,898
Asian	0.905			0.613	5,259,935	0	0	0.082	432,635
Native American	-0.614			0.915	-4,592,005	0	0	0.017	-79,515
Black	0.346			0.639	1,894,659	0	0	0.082	155,838
White	0.010			0.473	32,302	1	32,302	0.810	26,149
Full time employment	0.249			0.348	1,408,023	0	0	0.303	426,674
Part time employment	0.528			0.359	3,109,936	0	0	0.130	403,888
>1 Part time employment	0.062			0.864	-309,870	0	0	0.022	-6,707
Self employed	0.204			0.516	1,262,609	0	0	0.052	65,590
Looking for employment	-0.288			0.359	-1,723,853	0	0	0.143	-246,265
Homemaker	-0.079			0.377	-470,143	0	0	0.134	-63,093
Full time school	-0.433			0.374	-2,841,407	0	0	0.117	-332,113
Part time school	0.930			1.090	5,622,153	0	0	0.030	170,368
Retired	-0.089			0.461	-455,266	0	0	0.113	-51,242
Disabled	0.933		*	0.511	5,457,948	0	0	0.069	378,040
No high school degree	-3.392		**	1.547	-21,587,543	0	0	0.022	-467,262
Completed high school	-0.285			0.535	-1,959,979	0	0	0.268	-526,055
Some college	-0.298			0.482	-1,823,110	0	0	0.290	-528,781
2yr degree	-0.708		*	0.535	-4,400,735	0	0	0.104	-457,219
4yr degree	0.206			0.485	1,255,859	0	0	0.229	288,141
Disease education	0.246			0.337	1,756,480	0	0	0.190	334,568
Economics education	0.390			0.271	2,346,014	0	0	0.377	883,564
Democrat	0.298			0.239	2,084,148	0	0	0.442	920,273
Income <$5,000	0.261			0.640	1,645,727	0	0	0.061	99,741
Income $5,000-$9,999	-0.418			0.700	-2,330,142	0	0	0.026	-60,523
Income $10,000-$14,999	-0.307			0.605	-2,003,704	0	0	0.061	-121,437
Income $15,000-$24,999	0.593		**	0.565	3,768,088	0	0	0.104	391,490
Income $25,000-$34,999	-0.268			0.576	-1,774,060	0	0	0.095	-168,958
Income $35,000-$49,999	-0.013			0.505	-164,420	0	0	0.203	-33,453
Income $50,000-$74,999	-0.631			0.498	-4,028,559	0	0	0.177	-715,026
Income $75,000-$99,999	-0.429			0.595	-2,758,741	0	0	0.074	-203,024
Income $100,000-$149,999	-0.802			0.627	-5,015,490	0	0	0.087	-434,242
Income $150,000-$199,999	-1.275			0.833	-8,244,605	0	0	0.022	-178,454
Income >$200,000	-1.778		*	0.979	-11,110,698	0	0	0.022	-240,491
Constant	-0.548			0.919	-3,161,888				
Mean and Median minimum LVS for $75 Contribution								6,383,023	6,850,702

***Significant at the 0.01 level, **Significant at the 0.05 level, *Significant at the 0.10 level. Based on two-tailed tests.

#The dependent variable is coded '0' if the respondent voted no for the pandemic prevention policy and '1' if the respondent voted yes for the policy. A negative sign on the coefficient indicates respondents, on average, do not favor the pandemic prevention policy.

FIGURE 1
Global distribution of relative risk of an EID event.
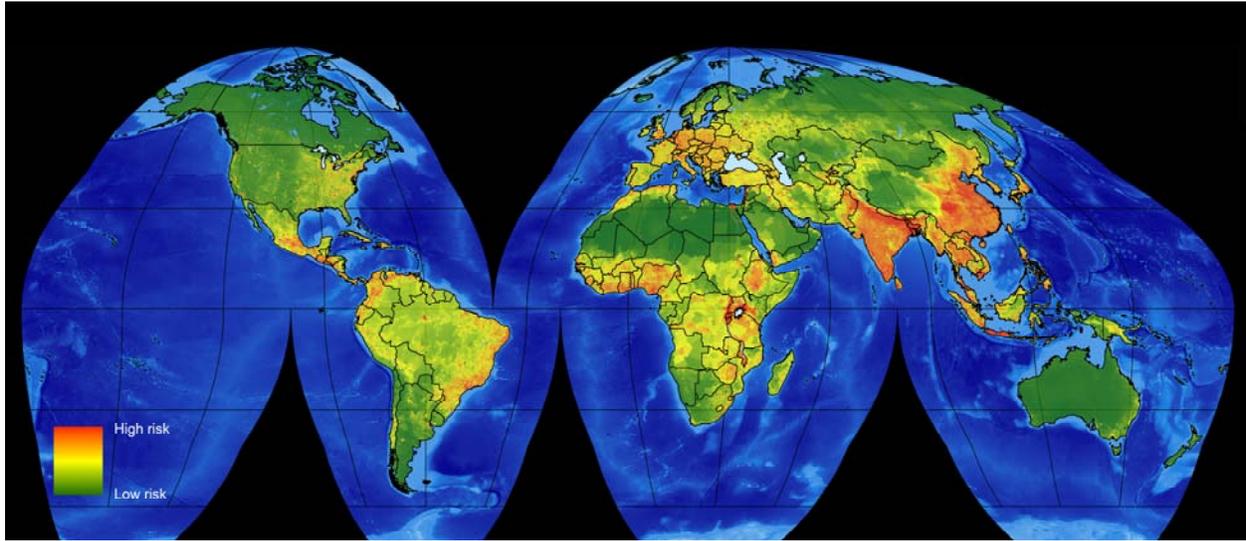
Legend: Global hotspot map of emerging infectious diseases. This map illustrates the relative risk of a zoonotic emerging infectious disease of wildlife origin spilling over into the human population. It was produced by analyzing with logistic regression the presence/absence of all known wildlife-origin EIDs since 1940 against a series of known drivers, including human population density, change in human population density and wildlife diversity (mammalian species richness), gridded at 1km2 resolution, and corrected for reporting bias by including a measure of the global distribution of infectious disease researchers.   Map produced by EcoHealth Alliance, and research funded by USAID-EPT PREDICT.

FIGURE 2
Examples of risk tradeoff questions

Now suppose you can vote for one of two policies that cost the same amount but reduce different kinds of risks.

- Policy #1 prevents 50 deaths caused by an environmental disaster.
- Policy #2 prevents 100 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____environmental disaster policy
_____pandemic outbreak policy

- Policy #1 prevents 250 deaths caused by a terrorist attack.
- Policy #2 prevents 25 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____terrorist attack policy
_____pandemic outbreak policy

FIGURE 3
Minimum Lives Saved (LVS) question

Suppose a pandemic outbreak from diseased animals will reach the US in the next 15 years. The pandemic could be mild, medium, or severe, in terms of predicted deaths.   Predicted US deaths for a <u>mild</u> pandemic are 22,000 more deaths in a year, for a <u>medium</u> pandemic are over 200,000 more deaths in a year, and for a <u>severe</u> pandemic are over one million more deaths in a year.

Suppose a US/global policy exists to reduce the probability of a pandemic outbreak from interactions with diseased animals; this policy would prevent _____ expected US deaths. This policy would cost your household $5 more each year. If you vote in favor of this policy it implies taking money away from other programs to reduce terrorism, flu, traffic accidents, cancer, and heart disease. Would you vote in favor of this policy?

      _____yes   _____no

FIGURE 4
Descriptive Statistics
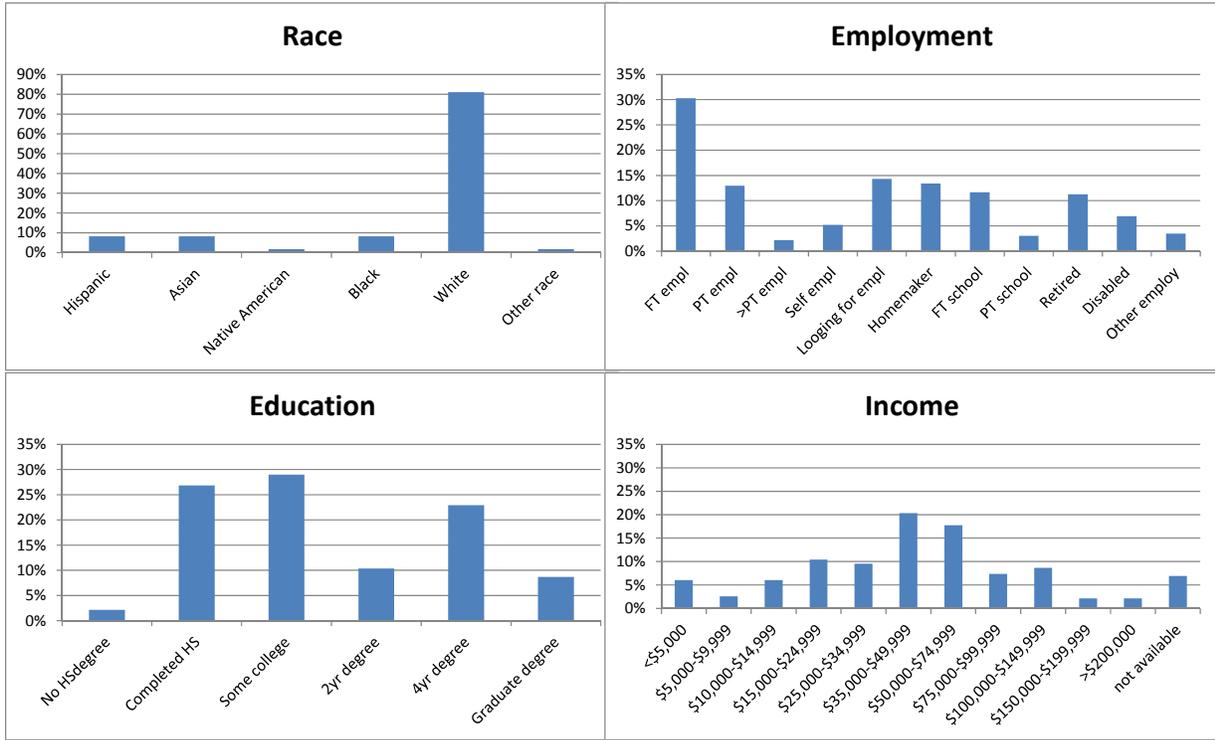
APPENDIX A

Thank you for participating in our survey on the value of avoiding a pandemic outbreak of an infectious disease.   Your answers and the answers of many other people will be used to help researchers and policy makers understand what you and others think about the impacts of a potential pandemic outbreak reaching the United States. This survey is designed to give you background information on infectious diseases and similar types of risky events followed by asking your opinion.

This survey consists of eight parts:

1. Definitions
2. Background questions
3. Information of pandemic risks
4. Context to related risks and questions
5. Context to how we die
6. Valuation questions
7. Socioeconomic questions

Infectious Disease: Diseases caused by pathogenic organisms such as bacteria, viruses, fungi or parasites. Infectious diseases can be passed from person to person or transmitted via bites from insects or animals or acquired by ingesting contaminated food or water or other exposures in the environment.

Zoonotic Diseases (also called Zoonoses): Infectious diseases of animals that can cause disease when transmitted to humans. The majority of newly discovered infectious diseases are zoonotic and are rising in frequency.

Pandemic: An epidemic of infectious disease that is spreading rapidly through the human populations across a large region. When a pandemic occurs, little or no immunity to the disease exists in the population. A global pandemic outbreak occurs every 10-20 years. Most of the recent pandemics (e.g. SARS, influenza A/H1N1) are zoonotic.

PART II: WHAT IS YOUR KNOWLEDGE OF INFECTIOUS DISEASE?

1. Have you ever been vaccinated?

    _____yes   _____no

2. Have you ever been diagnosed with an infectious disease?

    _____yes   _____no

    *If yes, were you sick for: _____1 week
                                                 _____1 month
                                                 _____1 year
                                                 _____Other

    If yes, how long ago was the illness?   _____Less Than 3 Months Ago
                                                 _____Between 3 and 6 Months Ago
                                                 _____Between 6 Months and 2 Years Ago
                                                 _____More than 2 Years Ago

3. Have any of your immediate family members ever been diagnosed with an infectious disease?

    _____yes   _____no

    *If yes, was your family member sick for: _____1 week
                                                 _____1 month
                                                 _____1 year
                                                 _____Other

    If yes, how long ago was the illness?   _____Less Than 3 Months Ago
                                                 _____Between 3 and 6 Months Ago
                                                 _____Between 6 Months and 2 Years Ago
                                                 _____More than 2 Years Ago

4. Have any of your friends ever been diagnosed with an infectious disease?

    _____yes   _____no

    *If yes, was your friend sick for: _____1 week
                                                 _____1 month
                                                 _____1 year
                                                 _____Other

    If yes, how long ago was the illness?   _____Less Than 3 Months Ago
                                                 _____Between 3 and 6 Months Ago
                                                 _____Between 6 Months and 2 Years
Ago   _____More than 2 Years Ago

If diagnosed more than once, use most recent example.

PART III: INFORMATION ON PANDEMIC RISKS

The United States government currently invests about $6.4 billion each year in disease control, research, and training—and yet emerging infectious diseases of animals are still increasing. Because emerging infectious diseases of animals are still increasing, it is more likely that a pandemic outbreak will occur within the next 10-20 years.

Historical examples of pandemic outbreaks include:

1. Smallpox killed nearly 400,000 Europeans per year during the closing years of the 18th century. During the 20th century, it is estimated that smallpox was responsible for 300–500 million deaths. An estimated 50 million cases of smallpox occurred in the world each year during the early 1950s.

2. The "Spanish flu" was first identified in March 1918 and by October 1918, it had spread to become a worldwide pandemic on all continents, and eventually infected about one-third of the world's population. In six months, some 50 million were dead; some estimates put the total of those killed worldwide at over twice that number.

3. HIV spread to the United States and much of the rest of the world beginning around 1969. HIV, the virus that causes AIDS, is currently a pandemic, with infection rates as high as 25% in southern and eastern Africa. AIDS could kill 31 million people in India and 18 million in China by 2025, according to projections by U.N. population researchers. AIDS death toll in Africa may reach 90-100 million by 2025.

Some of the personal risks and consequences of a pandemic outbreak include:

     a. You may become infected resulting in illness and possibly death.
     b. Your child, parent, siblings, and/or other relatives may become infected resulting in illness and possibly death.
     c. Your friend(s) may become infected resulting in illness and possibly death.
     d. Hospitals may become overloaded resulting in turning down infected victims.
     e. There may be an inadequate supply of vaccines.
     f. You will need to reduce face-to-face contact by staying home, not going to work, and not sending children to school which likely will result in an income reduction.
     g. A negative shock to the economy may occur leading to a possible recession.

Pandemic outbreaks are one of many types of uncertain and potentially catastrophic events. For example, environmental disasters and terrorists attacks are both events with uncertainty as to when and where they will occur and they have similar risks and consequences to a pandemic outbreak. These events pose risks to life and limb for yourself, friends, and family. All these events can significantly slow down the economy.

PART IV: SIMILAR RISKY EVENTS and YOUR PREFERENCES FOR POLICIES TO REDUCE THESE RISKS.

SIMILAR RISKY EVENT 1 - ENVIRONMENTAL DISASTER EXAMPLE

An example of an environmental disaster would be the 2010 Deepwater Horizon Spill (also known as the Gulf of Mexico Oil Spill or the BP Oil Spill). The Deepwater Horizon oil spill is the largest marine oil spill in history. The spill was caused by an explosion on the Deepwater Horizon offshore oil platform about 50 miles southeast of the Mississippi River delta on April 20, 2010. Eleven workers died in the accident.

On May 30, 2010, the Unified Area Command published its first "Consolidated Fish and Wildlife Collection Report." According to the report, 1,014 birds were visibly oiled and 997 died; 400 sea turtles died; 47 mammals died. Wildlife biologists believe that more wildlife were killed by the oil, but their toll is hidden because their bodies have sunk in the open ocean or they were eaten by scavengers.

In a study by Moody's Analytics, it is estimated that nearly $1.2 billion in output and 17,000 jobs would be lost in the Gulf Coast states by the end of 2010. The output loss across the five Gulf Coast states amounts to less than 0.1% of national GDP.

On July 5, 2010, BP reported that its own expenditures on the oil spill had reached $3.12 billion, including the cost of the spill response, containment, relief well drilling, grants to the Gulf states, claims paid, and federal costs. The United States Oil Pollution Act of 1990 limits BP's liability for non-cleanup costs to $75 million unless gross negligence is proven. BP has said it would pay for all cleanup and remediation regardless of the statutory liability cap.

We are interested in your opinion about a new US policy to reduce the risk of a global pandemic. To better understand how you think about this policy relative to other risks, please answer the next two questions.

5. Now suppose you can vote for one of two policies that cost the same amount but reduce different kinds of risks.

- Policy #1 prevents 50 deaths caused by an environmental disaster.
- Policy #2 prevents 100 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____environmental disaster policy
_____pandemic outbreak policy

- Policy #1 prevents 250 deaths caused by an environmental disaster.
- Policy #2 prevents 25 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____environmental disaster policy
_____pandemic outbreak policy

- Policy #1 prevents 25 deaths caused by an environmental disaster.
- Policy #2 prevents 125 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____environmental disaster policy
_____pandemic outbreak policy

- Policy #1 prevents 125 deaths caused by an environmental disaster.
- Policy #2 prevents 100 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____environmental disaster policy
_____pandemic outbreak policy

- Policy #1 prevents 150 deaths caused by an environmental disaster.
- Policy #2 prevents 50 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____environmental disaster policy
_____pandemic outbreak policy

- Policy #1 prevents 100 deaths caused by an environmental disaster.
- Policy #2 prevents 100 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____environmental disaster policy
_____pandemic outbreak policy

SIMILAR RISKY EVENT 2 – TERRORIST ATTACK EXAMPLE

The September 11 Terrorist Attacks were a series of four suicide attacks that were committed in the United States on September 11, 2001, coordinated to strike the areas of New York City and Washington, D.C. Nearly 3,000 people died in the attacks.

The stock exchanges did not open on September 11 and remained closed until September 17. Reopening, the Dow Jones Industrial Average (DJIA) fell 684 points, or 7.1%, to 8921, a record-setting one-day point decline. By the end of the week, the DJIA had fallen 1,369.7 points (14.3%), at the time its largest one-week point drop in history. In 2001 dollars, US stocks lost $1.4 trillion in valuation for the week.

In New York City, about $2.8 billion dollars in wages were lost in the three months after the attacks. The city's GDP was estimated to have declined by $27.3 billion for the last three months of 2001 and all of 2002. The US government provided $11.2 billion in immediate assistance to the Government of New York City in September 2001, and $10.5 billion in early 2002 for economic development and infrastructure needs.

The September 11 attacks also led indirectly to the US wars in Afghanistan and Iraq, and additional homeland security spending, totaling at least $5 trillion.

Hundreds of thousands of tons of toxic debris resulted from the collapse of the Twin Towers containing more than 2,500 contaminants, including known carcinogens. Approximately 18,000 people have been estimated to have developed illnesses as a result of the toxic dust.

We are interested in your opinion about a new US policy to reduce the risk of a global pandemic. To better understand how you think about this policy relative to other risks, please answer the next two questions.

6. Again suppose you can vote for one of two policies that cost the same amount but reduce different kinds of risks.

- Policy #1 prevents 50 deaths caused by a terrorist attack.
- Policy #2 prevents 100 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____terrorist attack policy
_____pandemic outbreak policy

- Policy #1 prevents 250 deaths caused by a terrorist attack.
- Policy #2 prevents 25 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____terrorist attack policy
_____pandemic outbreak policy

- Policy #1 prevents 25 deaths caused by a terrorist attack.
- Policy #2 prevents 125 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____terrorist attack policy
_____pandemic outbreak policy

- Policy #1 prevents 125 deaths caused by an terrorist attack.
- Policy #2 prevents 100 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____terrorist attack policy
_____pandemic outbreak policy

- Policy #1 prevents 150 deaths caused by a terrorist attack.
- Policy #2 prevents 50 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____terrorist attack policy
_____pandemic outbreak policy

- Policy #1 prevents 100 deaths caused by a terrorist attack.
- Policy #2 prevents 100 deaths caused by a pandemic outbreak.

Which of the two policies would you prefer?
_____terrorist attack policy
_____pandemic outbreak policy

PART V: HOW DO PANDEMICS RELATE TO HOW WE DIE?

According to the National Institute of Health, infectious diseases kill more people worldwide than any other single cause. Over 14 million people per year die of infectious diseases. In the United States, on average 609 in 100,000 people are diagnosed with an infectious disease annually and approximately 55 per 100,000 people die of infectious diseases annually.

The Center for Disease and Pollution Control cites that "in the absence of any control measures (vaccination or drugs), it has been estimated that in the United States a medium–level pandemic could cause 89,000 to 207,000 deaths, 314,000 and 734,000 hospitalizations, 18 to 42 million outpatient visits, and another 20 to 47 million people being sick. On average the number of people who die from infectious diseases could more than double (123 in 100,000) in one year and the number of people infected could rise to over one-third of the population being infected.

To put this in perspective:

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On average 794 per 100,000 people die annually in the United States

- If the terrorist attacks of 2001 were repeated annually, less than 1 per 100,000 people in the United States would die annually
- 12 per 100,000 people in the United States die from the flu annually
- 14 per 100,000 people in the United States die in traffic accidents annually
- 195 per 100,000 people in the United States die from heart disease annually. Heart disease is the leading cause of death in the United States. Heart disease is not an infectious disease.

PART VI: HOW MUCH ARE YOU WILLING TO PAY TO REDUCE THE NUMBER OF DEATHS FROM A PANDEMIC?

Suppose a pandemic outbreak from diseased animals will reach the US in the next 15 years. The pandemic could be mild, medium, or severe, in terms of predicted deaths.   Predicted US deaths for a mild pandemic are 22,000 more deaths in a year, for a medium pandemic are over 200,000 more deaths in a year, and for a severe pandemic are over one million more deaths in a year.

1. Suppose a US/global policy exists to reduce the probability of a pandemic outbreak from interactions with diseased animals; this policy would prevent _____ expected US deaths. This policy would cost your household $5 more each year. If you vote in favor of this policy it implies taking money away from other programs to reduce terrorism, flu, traffic accidents, cancer, and heart disease. Would you vote in favor of this policy?

    _____yes   _____no

PART VIII: DEMOGRAPHICS

2. How old are you?   _____

3. Are you   _____male   _____female

4. Are you currently   _____married   _____not married

5. How would you describe the people in YOUR HOUSEHOLD? (Mark ALL boxes that apply.)
    _____Hispanic or Latino
    _____Asian or Pacific Islander
    _____Native American or Native Alaskan
    _____Black or African American
    _____White
    _____Other

6. Which of the following describes your own current employment? (Please mark ALL boxes that apply.)
    _____Employed full-time in one job
    _____Employed part-time in one job
    _____Employed part-time in two or more jobs
    _____Self-employed
    _____Looking for a job
    _____Homemaker
    _____Enrolled in school as a full-time student
    _____Enrolled in school as a part-time student
    _____Retired
    _____Disabled
    _____(None of these)

7. What is the highest level of education you have completed? (Mark only one.)
    _____Did not complete high school
    _____High school diploma or G.E.D.
    _____Some college or technical school, no degree
    _____Degree from a 2-year college or technical school
    _____Degree from a 4-year college or university (B.A. or B.S.)
    _____Post-graduate or professional degree (Masters, Ph.D., M.D., etc.)

8. Have you completed any courses in disease at a college or technical school?
    _____yes   _____no

9. Have you completed any courses in economics at a college or technical school?

      _____yes   _____no

10. Which do most likely affiliate with

                    _____Republican Party

                    _____Democratic Party

                    _____Other

11. Which one of the following categories best describes your household's total income during 2011, before taxes and other deductions? (Please include all income to the household such as wages, social security, interest, welfare payments, child support, etc. If you're not sure, please give us your best guess. This information is needed for statistical purposes, and will be kept confidential.)

_____$4,999 or less	_____$50,000 to $74,999
_____$5,000 to $9,999	_____$75,000 to $99,999
_____$10,000 to $14,999	_____$100,000 to $149,999
_____$15,000 to $24,999	_____$150,000 to $199,999
_____$25,000 to $34,999	_____$200,000 or more
_____$35,000 to $49,999	_____(Don't know)
	_____(Prefer not to answer)

Table A1: Interactions with main effects

Main effect	Explanatory variable	Reasoning for interest
Pandemic outbreak interactions		
	Region 1	Closer to Asian countries with history of outbreak
	Respondent diagnosed with ID	Risk more realistic
	Family diagnosed with ID	Risk more realistic; may feel inability to protect
	Friend diagnosed with ID	Risk more realistic; may feel inability to protect
	Retired	More severe on elderly
	Disease education	Understand risk better
	Income <$35,000	Favor more regulation
Environmental disaster interactions		
	Region 3	Expereince with Hurricane Katrina
	Hispanic	H5N1 originated in Mexico - Hispanic country
	Asian	Japan Tsunami
	Disabled	More severe on disabled
Terrorist attack deaths interactions		
	Region 2	Closer to 9/11
	White	Prejudice issues
	Republican	More in favor of terrorist policy
	Income >$150,000	Less regulation