Willingness to pay to reduce health costs associated with bushfire smoke

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Selected Paper prepared for presentation for the 2016 Agricultural & Applied Economics Association, Boston, MA, July 31-August 2.

Abstract

Invasion of gamba grass in Northern Territory increases fire fuel and bushfire smoke. Increase in bushfire smoke decreases air quality and have negative health impacts. The aim of this study is to assess people's willingness pay in order to control bushfire smoke and reduce its health risks. We also aim to assess what part of their willingness to pay is derived from altruism. To do this, we form two versions of a survey. The first version aims to assess willingness to pay which may consist of both altruism and personal benefits. The framing tells the respondents to assume that increases in bushfire smoke will affect their own personal health. In the second version of the survey that aims to assess only altruism, respondents will be limited to those who do not have asthma. We tell these respondents that increase in bushfire smoke will only affect people with asthma. Visual aides were used to enhance risk comprehension. Results showed that analysing altruistic value is important when valuing environmental assets. Altruistic value of statistical life is calculated at $5000,000. We showed that distinguishing paternalistic and non-paternalistic altruism is important.48% of WTP was non-paternalistic altruism. Paternalistic altruism is estimated at $2600,000.

Keywords: Willingness to pay; altruism, paternalistic, bushfire smoke, health

JEL code: Q51

Introduction

Gamba grass is a weed which can infest large area in northern parts of Australia. Gamba grass increases fuel load of infested sites by seven times (Rossiter et al. 2003). This results in a large increase in particular matter (PM) in the air emitted due to bushfire (Luhar et al. 2008). Increase in bushfire smoke decreases air quality and have negative health impacts. Many studies worldwide have shown that exposure to air pollution increases mortality rate (Chestnut 1997; Guo et al. 2014). The economic costs of negative health effects resulting from exposure to wildfire smoke should be given serious consideration in assessing the optimal wildfire management policy; however, the literature in this research area is thin (Kochi et al. 2010). Willingness to pay (WTP) estimates can assess people's valuation of health relate issues (Chowdhury et al. 2011; Connolly 2014). For WTP estimates, it is important to account for the contrast between self-interested behaviour guided by rational choice calculations and altruistic behaviour guided by normative considerations in the social sciences. The disjuncture between these two views is particularly important when the behaviours under study have impacts on environment (Kahneman and Knetsch 1992). Schwartz model suggests that altruistic behaviour occurs when individuals are aware of negative consequences for others (Schwartz 1977). It is also important to distinguish between paternalistic and non-paternalistic altruism. Non-paternalistic altruism refers to the situation where a given individual, the altruist, values the welfare of another, the beneficiary. Paternalistic altruism refers to the situation where the altruist values the beneficiary's consumption of a particular merit good, irrespective of the beneficiary's preferences. Based on Bergstrom's result, several studies have further concluded that non-paternalistic altruism can and should also be ignored for the generic, discrete changes encountered in benefit–cost analysis (Bergstrom 1982; Flores 2002; Rittmaster et al. 2006; Adamowicz et al. 2011). However, previous literature on WTP estimates of reducing health impacts associated with bushfire smoke has ignored these two important aspects: A) distinguishing between self-interest versus altruistic values B) separating paternalistic and non-paternalistic altruism (e.g. Rittmaster et al. 2006). This paper covers these two knowledge gaps.

Survey design, administration and data

We are interested in trade-offs that people are willing to make between money and death risks associated with air pollution from bushfire smoke. In this context, air quality is a commodity that can be described by mortality risks and the costs to the household of reduced death risk due to exposure to the bushfire smoke.

Survey

The goal of our survey is to estimate peoples' WTP in order to reduce the risk of death from bushfire smoke. We target a population ranging in age from 18 to 80 and collect extensive information on health status. We ask respondents to value annual risk reductions on the order of 10^{-4}. Risk changes are on the order of 1 in 10,000 per year. Environmental programs which reduce Gamba grass and bushfire risk can change the death risk.

Luhar et al. (2009) showed that increase in PM due to bushfire in Darwin results in increase of $PM_{2.5}$ by 13 μg m^{-3} for 8 months. Rossiter et al. (2003) showed that invasion of Gamba grass results in increase of bushfire smoke by seven times. The concentration of PM2.5 is proportional and has a linear relationship to the emission of PM2.5 (Luhar et al. 2008; Ashok Luhar per. com. 2014). It has also been found that the relationship between emission and fuel load is linear (Meyer et al. 2008 and Mick Meyer per. com. 2013). This means given that Gamba grass increases fuel load by seven times it would increase $PM_{2.5}$ by the same magnitude. Therefore, increase in $PM_{2.5}$ after the invasion of Gamba grass is about 35 μg m^{-3} for 8 months. Hence, increase in $PM_{2.5}$ due to invasion of Gamba grass is 30 μg m^{-3} for 8 months or 12.5 μg m^{-3} per year. Rittmaster et al. (2006) showed that 1 μg m^{-3} on average increases the chance of death by 0.00002. Thus, invasion of Gamba grass increases the death rate by 2.67 per 10,000 (i.e. 0.00002×12.5).

We ask the respondents to make choices between alternative bushfire policies that will influence air quality, and hence the chance of death of individuals within the community. This is to assess their willingness to pay to reduce health risks due to bushfire smoke.

Representing risk changes:

Visual representation of death risk and its reduction due to policies is important. This would help respondents to understand the risk changes they are asked to value. Graphs are presented to the respondents containing 10,000 squares to communicate probability of dying (similar grid presentation to Krupnick et al. 2002). White squares represent chances of surviving, red squares represent chances of dying and reductions in the risk of dying are represented by changing red squares to blue. As we value *annual* risk, the graph represents the chances of dying (surviving) over a 10-year period with risks on the order of 10^{-4}.

For each choice, two options and for each option two graphs are presented side by side. The graph on the left represents the change of death without bushfire smoke with zero payment and the graph on the right represents the chance of death with bushfire control with a payment.

Description of the questionnaire

Respondents were able to move through the survey at their own preferred pace. To avoid interviewer effects, we chose a self-administered computer questionnaire. We delivered graphics with high quality, and provided age-specific risks and follow-up questions. The questioner had a number of parts. In Part A, we asked respondents personal questions such as their gender, age. In Part B, we introduce to them information that involved the idea of chance. For this, we first presented the probability of getting a head or tail when flipping a coin. Then we explained if they roll a dice, the chance any number coming up is one in six because there are 6 sides. We showed if they spin a fair roulette wheel, with 36 numbers, the chance of any number coming up is one in 36. Then we present a 10,000 grid graph to show them the probability of death for 0.005. For this we show them a graph with 5 red squares and 10,000 white grids (see Figure 1).

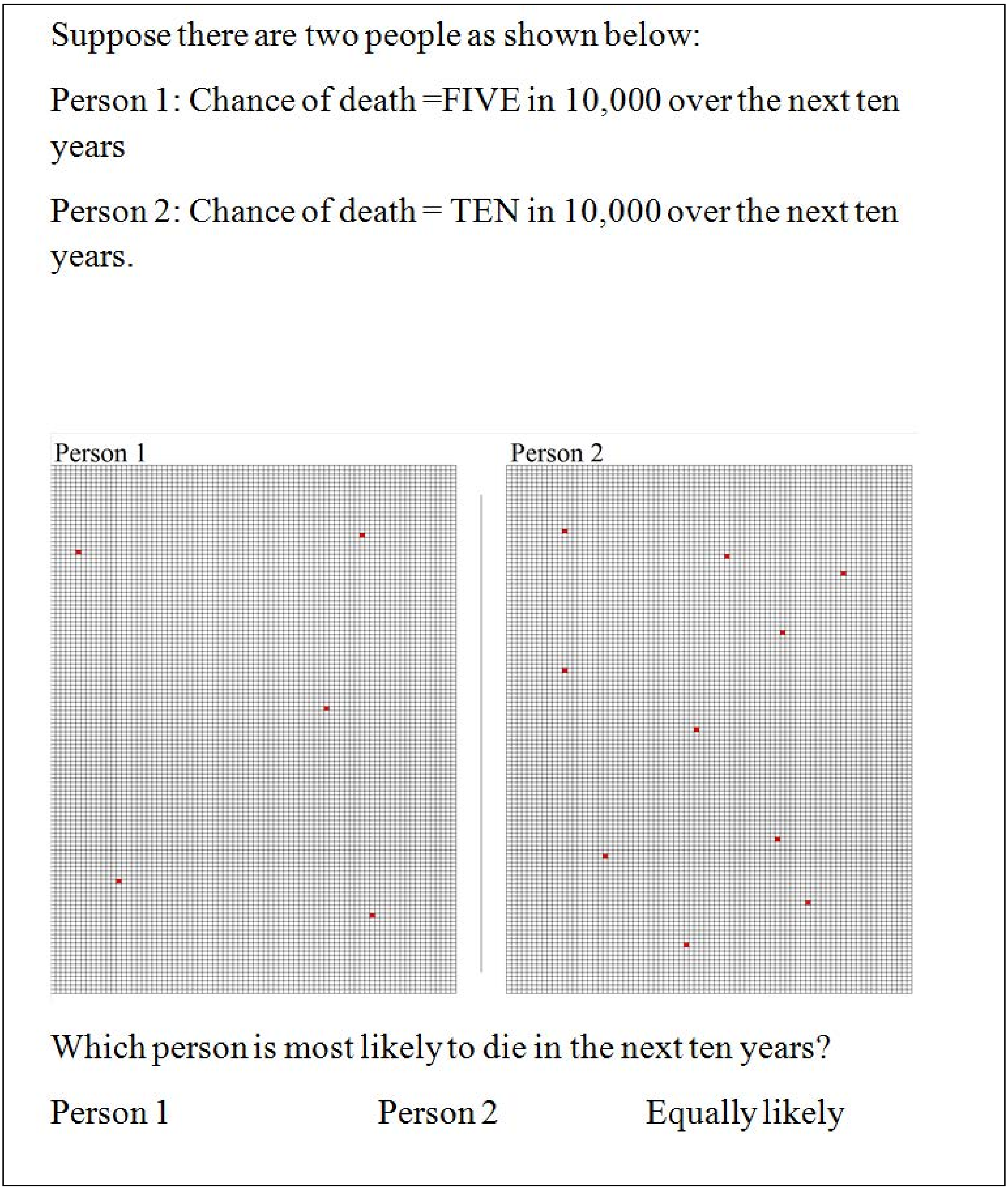

Figure 1. presentation of probability of death in a graph

In order to test whether the respondents understood our presentation of probabilities, we show them the chance of death for 0.005 and 0.01 and ask them which one of these probabilities they prefer as their own chance of death. If they preferred to be the person with a higher chance of death we present them a follow up question clarifying to them that they preferred to have a higher chance of death and asked them again if they still prefer to have a higher chance of death.

Method:

We first estimate increase in PM due to invasion of Gamba grass. Then we assess the human health impacts of the increase in PM and estimate WTP to reduce the health impacts. For this, we conduct a choice experiment and a double bounded survey. In order to assess what part of people's WTP is derived from altruism, two versions of a choice experiment survey has been sent to respondents. The first version aimed to assess willingness to pay which may consist of both altruism and personal benefits. The framing told the respondents to assume that increases in bushfire smoke will affect their own personal health. In the second version of the survey that aimed to assess only altruism, respondents were limited to those who do not have asthma. Visual aides were used to enhance risk comprehension. To analyse this we applied a choice experiment survey. We considered four levels of increase in the chance of death due to bushfire smoke 8, 14, 20, 26 in 10,000 in ten years. We also accounted for four cost levels $50, $100, $350, $500 for each of these increase death probabilities. A full factorial analysis was considered consisting of 16 choice sets where each respondent answered 8 choice sets. Survey was sent to 2000 respondents. We estimated a random affect logit model. As there was repeated information, we allowed some correlation to occur for the choices that people make across the questions. We considered two options where the utility for option 1 (no bushfire control) is constant because their attribute never change. Utility associate with options 2 (bushfire control) depended on risk and payment. There was a random affect for opting for the policy. We used a double bounded survey to assess which part of WTP should be accounted for paternalistic altruism. Respondents could either choose to pay or reduction of bushfire smoke or provide funding to asthma sufferers to manage the risk themselves.

Two subversions for each of the versions of the surveys are developed. In the first subversion, we present age-specific death risk and in the other, we present average age death risks to assess whether the WTP estimates would differ between the two. For the average age group, we state that according to Australian Bureau of Statistics, an average Australian has a chance of death over the next ten years of 550 in 10,000 (i.e. average chance of death for an Australian). For other age-specific subversion, we specify the chance of death for their own age groups. We explain that bushfire is an increasing problem in Australia and apart from direct damages to properties and lives, bushfire increases air pollution. Air pollution caused by bushfire can affect the health and increase chance of death. Then we state that bushfire smoke will increase the chance of death for Asthmatic people from

Results:

This paper conducts a choice experiment analysis to estimate WTP value of reducing risk of death associated with bushfire smoke. WTP estimate distinguishes between self-interest versus altruistic values and separates paternalistic and non-paternalistic altruism. Results show that altruistic value of statistical life is $5,000,000. We showed that 48% of this WTP estimate was non-paternalistic altruism. Therefore, paternalistic altruism is estimated at $2600,000. This means that 48% of the WTP estimate is represented analytically by the entry of the beneficiary's utility function into an aggregation function that represents the altruist's preferences over own-good consumption and the beneficiary's utility. This shows that distinguishing between paternalistic and non-paternalistic altruism is important. However, most previous studies did not distinguish between paternalistic and non-paternalistic altruism. As paternalistic altruism can and should also be ignored for the generic, discrete changes encountered in benefit-cost analysis (Bergstrom 1982), no ignoring paternalistic altruism can result in double counting. Therefore, a big part of WTP estimates of previous studies can be subject to double counting.

Conclusions:

The spread of Gamba grass increases bushfire smoke and results in increased death risks associated with its health effects. We estimated WTP to control the spread of Gamba grass and reduce the death risks associated with it. This paper estimated the altruistic value of statistical life at $5,000,000. We distinguished between self-interest versus altruistic values and separated paternalistic and non-paternalistic altruism. We showed that 48% of the $5,000,000 WTP estimate was non-paternalistic altruism. Therefore, in our case, including non-paternalistic altruism in WTP estimates can result in overestimating WTP value by 48%. Policy makers should be informed about the part of the WTP estimate that is non-paternalistic. We recommend policy makers to use $2,600,000 as WTP estimate for the public benefit of reduced health damages associated with the control of Gamba grass.

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