The Relationship Between Wildfire and Welfare

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Summary

We used the well-being evaluation method, a technique for measuring individual utility, to study how people in the wildland urban interface of Colorado (USA) felt about their lives before and after two wildfire scenarios. Variables such as age, family size, fire frequency, and house value were found to affect initial well-being levels. However, after a significant life event, such as a wildfire, many variables that initially affected well-being were no longer significant. We found that after wildfire, the frequency of wildfire occurrence became the most important influence on well-being.

Keywords: well-being evaluation method, Colorado, happiness, wildland urban interface, wildfire intensity

Introduction

Utility, the measure of satisfaction or happiness someone gains from a good or service, is a fundamental concept in consumer and welfare economics. Part of received economic doctrine is that each individual is the best judge of what contributes to their own utility (Morawetz et al., 1977; Frey and Stutzer, 2002; Easterlin, 1974; Dixon, 1997; Bianchi, 2004; Ng, 1997). For decades, utility has been believed to be largely unobservable, but progress has been made for inferring utility by a variety of means.

One method of measuring utility is to ask people how they feel about their lives via a series of questions, the results of which yields a "happiness" or "well-being" rating. Psychologists have used happiness ratings as part of their research for many years; however, economists have only studied happiness since the 1960's (Dixon, 1997; Ng, 2003). Well-being ratings are still not commonly used by economists with only three researchers authoring the bulk of well-being studies: Yew Kwang Ng, Andrew Oswald, and Bob Frank (Dixon, 1997).

The well-being evaluation method (WBEM) is a non-monetary way of evaluating an individual's utility by asking questions about people's satisfaction with life or happiness[1] (van Praag and Baarsma, 2000; Ng, 1997; Frey and Stutzer, 2002). The WBEM has its origins in the 1960's when a researcher named Cantril wanted a method of evaluating life in which the respondents could select their own satisfaction

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[1] The terms happiness and well-being are used interchangeably.

level (Cantril, 1965). This was done by placing a question alongside a picture of a ladder. The ladder represented the best and worst possible life you could have, with the top of the ladder representing the best life (step 10) and the bottom representing the worst life (step 1) (Figure 1). The respondent could then circle the number on the ladder that they felt best represented their life. This questioning method was called the ladder of life method or the Cantril method.

Figure 1: The Ladder of Life Survey Method Developed by Cantril (1965)

| 10 |
9	The top of the ladder (step 10)
8	represents the best possible life
7	and the bottom of the ladder
6	(step 1) represents the worst
5	possible life.
4	Where on the ladder do you feel
3	your life is at this point in time?
2
1

Building on this approach, van Praag and Baarsma created the WBEM (van Praag, 1988; van Praag and Baarsma, 2000). Van Praag and Baarsma first asked respondents where they felt they were on the ladder of life scale; next they presented the respondents with a situation and then were asked how they would rate themselves on the well-being scale if the situation occurred. This additional information gives researchers current and after change information.

One example of this type of modeling is represented in van Praag and Baarsma's airport study. First, they asked residents living near an airport to rate their happiness levels. They then presented a situation: an airport expansion which would increase airport noise in the neighboring community, and asked how they would rate their happiness level after airport expansion. This was called the Schiphol experiment as it was conducted for the Amsterdam Schiphol Airport (van Praag and Baarsma, 2000).

Application of Well-being Evaluation Method to Wildfire

In our study, we use the well-being evaluation method to see how people currently feel about their life. Then we ask them how they would feel about their life after both a low-intensity wildfire and after a high-intensity wildfire. We focused on people living close to the forest at the wildland urban interface in Colorado.

Since Europeans settled in Colorado, wildfires have been significantly suppressed and this has led to an increase in ground litter which has subsequently led to infrequent large acreage high-intensity wildfires. High-intensity wildfires are a problem because many people have built their homes near public lands (the wildland urban interface), which in turn means the number of homes at risk of wildfire is also large (and continually increasing as more people move into the wildland urban interface).

Do people living close to the forest recognize this wildfire danger to their homes? Recently, Howell (2004) found that 77.5% of Colorado residents in Larimer and Boulder counties believe that their home is at risk of wildfire. In 2002, Higgason also studied survey responses of people in the wildland urban interface of Colorado. Higgason found 48% to 78% of respondents believed that their home was in danger of wildfire. So it seems that Colorado residents are knowledgeable about wildfire in their area. But how would they feel about their lives if a wildfire did occur in their area? We had two aims for this analysis. The first was to test the hypothesis that respondents will not feel as highly about their lives after wildfire. The second was to identify important variables that affected well being.

Data Collection

Our survey entitled "Managing Fires on Public Lands: What Do You Think?" was created, tested in focus groups, reviewed, pre-tested, re-revised, and then distributed. The finalized survey encompassed eight pages of questions including two color pictures (Figure 2). The first picture was taken one year after a low-intensity burn in a Colorado ponderosa pine (*Pinus ponderosa*) forest where most underbrush was killed; but standing trees survived (Figure 2a). This was a prescribed fire considered similar to low-intensity wildfires that occurred in Colorado prior to European settlement. The second picture was taken one year after a high-intensity wildfire where all underbrush and standing trees were killed (Figure 2b). The forests in these two pictures were similar in stand density (trees per hectare) and tree size (d.b.h. - diameter at breast height).

Figure 2: (2a.) Low-intensity burn (left) and (2b.) High-intensity wildfire (right).

Survey participants were contacted randomly by phone during the summer of 2001. In total, 361 homes were called. Of the homes that were called, 115 people had answered the phone, while the other 246 homes had no response (either an answering machine picked up or no one picked up). Of the people contacted, 103 agreed to do the survey, while 12 did not. Of the 103 that agreed to complete the survey, 99 people followed through. Therefore, the response rate of all contacted people was 86% and the response rate of those contacted that said they would complete the survey was 96%.

Model Specification

To estimate individual utility, we used the well-being evaluation method. Using this method, well-being was rated on a life satisfaction scale of zero through ten where zero represented the lowest possible life satisfaction and 10 represented the highest possible life satisfaction (Figure 3). Therefore, our well-being variable is an ordinal and ordered variable.

Figure 3: Well-Being Base Question

On a scale from zero to ten, where zero is very unhappy with your life and ten is the best possible life, how would you rate your satisfaction with your life?

Please circle the appropriate number.

0   1   2   3   4   5   6   7   8   9   10

$\leftarrow$-- $\rightarrow$

Lowest Life Satisfaction   Highest Life Satisfaction

Respondents were asked to rate their well-being under three different scenarios: the first was at the time of the survey, the second after a hypothetical low-intensity wildfire in their area, and the third after a hypothetical high-intensity wildfire.

Since well-being can only represent the numbers from 0 through 10, we see that:

$$WB = \begin{cases} 0 \text{ if } WB^* \leq \gamma_1 \\ 1 \text{ if } \gamma_1 < WB^* \leq \gamma_2 \\ 2 \text{ if } \gamma_2 < WB^* \leq \gamma_3 \\ 3 \text{ if } \gamma_3 < WB^* \leq \gamma_4 \\ 4 \text{ if } \gamma_4 < WB^* \leq \gamma_5 \\ 5 \text{ if } \gamma_5 < WB^* \leq \gamma_6 \\ 6 \text{ if } \gamma_6 < WB^* \leq \gamma_7 \\ 7 \text{ if } \gamma_7 < WB^* \leq \gamma_8 \\ 8 \text{ if } \gamma_8 < WB^* \leq \gamma_9 \\ 9 \text{ if } \gamma_9 < WB^* \leq \gamma_{10} \\ 10 \text{ if } \gamma_{10} < WB^* \end{cases}$$

Where WB represents our well-being variable and γ_i represents our cut-off points or threshold variables. This preserves the ordering such that $WB_1 < WB_2 < WB_{3 < \ldots}$ WB_{10} since the difference between a well-being of 1 and a well-being of 2 may not be the same as the difference between a well-being of 8 and a well-being of 9 which reflects the ordinal nature of the variable. The first question was the "lead-in" to the low-intensity and high-intensity wildfire questions. All of the follow-up well-being questions were compared to this baseline.

Since our data is an ordinal ranking, the most appropriate method to use in our analysis is an ordered probit model. According to Sy et al. (1997), there are two distinct advantages to using the ordered probit model over an ordinary least squares (OLS) regression in this situation. The first is that the heteroskedasticity problem

that would normally arise when performing a regression on a discrete dependent variable is eliminated (Sy et al., 1997; Aldrich and Nelson, 1984). The second is that the maximum likelihood estimates are asymptotically normal, asymptotically efficient, and consistent under general conditions (Sy et al., 1997; Judge et al., 1988).

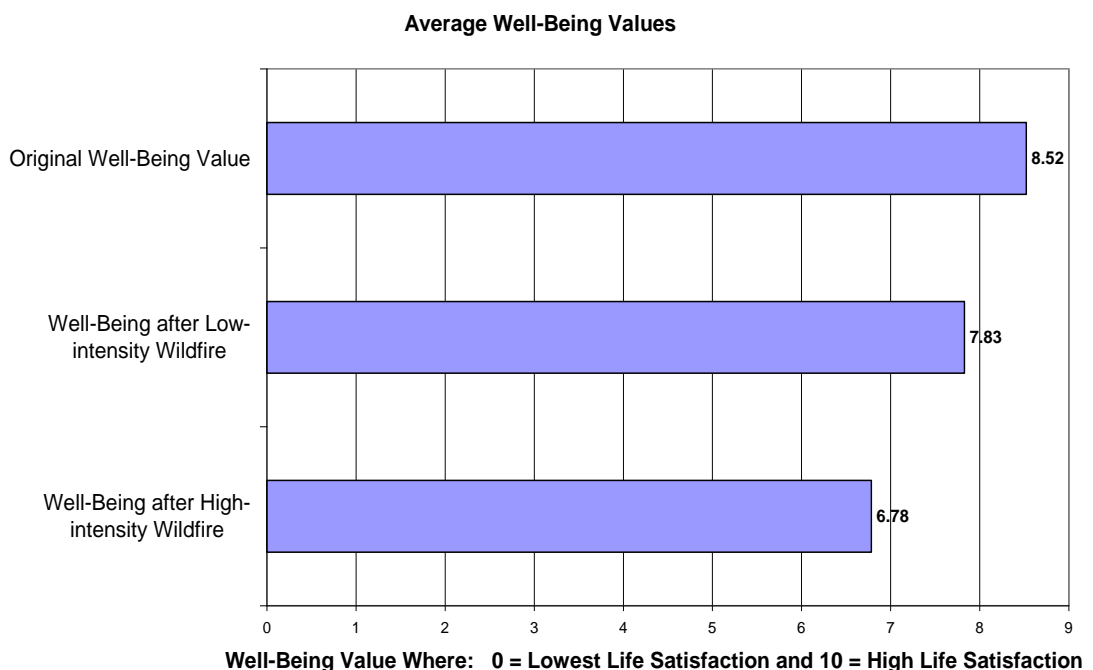The basic ordered probit model for well-being we used for this study at the current time period is:

$$WB^* = \beta x_i' + \varepsilon_i \quad \text{where } \varepsilon \approx N(0,1)$$

Our dependent variable, well-being (WB), depends on the explanatory variables X_i such as age and family size. The error term, ε_i, is independent and randomly distributed with a mean of zero. This is the basic format we will be following in our analysis.

Results

The mean overall response to how people currently feel about their life on the 0 to 10 well-being scale was 8.523. This was our base level. We then asked respondents to rate their happiness level after a low-intensity wildfire (Figure 2a) and after a high-intensity wildfire (Figure 2b) in their area (Figure 4). If a low-intensity wildfire occurred in their area their happiness level decreased from 8.523 to 7.830, a significant 0.7 point change (ANOVA, p=0.005). After high-intensity wildfire, their happiness level decreased from the original 8.523 to 6.784, an approximately 1.7 point change (ANOVA, p=0.000). These results show that people living in homes near public lands in Colorado feel pretty good about their lives. If a low-intensity or high-intensity wildfire were to occur, they would still feel good about their lives, just not as good as prior to the fire. A one way ANOVA test showed that these values were statistically different at the 99.99% level (ANOVA, p=0.000).

Figure 4: Average Well-being Values

Average Well-Being Values

Category	Value
Original Well-Being Value	8.52
Well-Being after Low-intensity Wildfire	7.83
Well-Being after High-intensity Wildfire	6.78

Well-Being Value Where: 0 = Lowest Life Satisfaction and 10 = High Life Satisfaction

To see the relationship between well-being and other variables, we used an ordered probit regression (Table 1).

Table 1: Ordered Probit Results (With Significant Results in Bold)

Well-being Equations	Family	Family^2	INFreq	House	House^2	Age
1. Current Well-being Rating (Probability)	**-1.057** **(0.008)**	**0.128** **(0.030)**	0.015 **(0.053)**	**4.63E-06** **(0.014)**	**-3.50E-12** **(0.007)**	**0.025** **(0.004)**
2. Well-being after Low-intensity Fire (Probability)	-0.207 (0.534)	-0.003 (0.945)	**0.024** **(0.002)**	3.06E-06 **(0.095)**	-2.40E-12 **(0.057)**	0.003 (0.709)
3. Well-being after High-intensity Fire (Probability)	0.079 (0.811)	-0.020 (0.648)	**0.025** **(0.001)**	7.74E-06 **(0.004)**	-8.25E-12 **(0.004)**	0.002 (0.821)

Where:
Family = Number of individuals in the family that the reported household income supports
Family^2 = Family * Family
INFreq = Infrequency of Fire (i.e., once a year is 1, once every 10 years is 10)
House = Value of the Respondents Home
House^2 = House * House
Age = Age of Respondent

Equation 1 represents the current well-being or happiness level. In Equation 1, we find that the size of the family has an influence on the happiness level. In particular, this shows that as the size of the family increases, the level of well-being decreases. Then we looked at the variable fire infrequency. Fire infrequency represents how often the respondent believes that a high-intensity wildfire (Figure 2b) occurs in their area. If they believe a fire occurs once a year, this value would be "1," if it was twice a year, the value would be "0.5," and if it was once every 20 years, the value would be "20." In this equation, we find that as the infrequency of the fire increases, well-being increases. So, if they believed that a fire occurs once every 9 years and it will now only be occurring once every 10 years, the fire is occurring less often and their happiness level would increase. The house value variable represented the value of their home (including the property). Here we see that house value is a significant variable, indicating that as the house value increases,

well-being also increases. Age is the final variable in our equation, and here we see that as age increases, so does the well-being rating.

Equation 2 represents well-being or happiness levels after a hypothetical low-intensity fire occurred in their area (Figure 2a.). We used the same variables for this equation as we did in the first equation. Here, we find that after a low-intensity wildfire, family size, and age are no longer significant. The only variables that are significant in the equation are infrequency of fire and house value. As the infrequency of fire increases, the well-being increases. This result is more significant in Equation 2 than in Equation 1 (originally p=0.053 to p=0.002 now) and it has more weight (originally 0.015 to 0.024 now).

Equation 3 represents well-being or happiness levels after a hypothetical high-intensity wildfire in their area (Figure 2b). Again, we used the same variables here as we did in the original equation. In Equation 3, we see that family size and age are no longer significant. House value remains significant. As in Equation 2, wildfire infrequency is again significant. It is more significant than in any of the other Equations (p=0.001 as compared to p=0.002 or p=0.053) and is weighted slightly higher (0.025 as compared to 0.024 or 0.015).

So, it seems that when someone is thinking about their happiness, several variables come into play: age, family size, house value and frequency of wildfire. However, if something really significant occurs, such as a wildfire on the public land near their home, the frequency of wildfire, and, to a lesser degree, house value, now become the most important variables. The other variables are no longer significant.

Discussion and Conclusions

In this study, we analyzed how well-being or happiness perceptions change after a significant event, such as a wildfire, occurs. In comparing our results to past studies, there were some similarities. In this study, we found that Colorado residents living near public lands had an average well-being of 8.523 (where 0 is the worst possible life and 10 is the best). This is similar, although slightly higher, to the Frey and Stutzer report that people living in the United States have an average happiness ranking of 8.437[2] (Frey and Stutzer, 2002). This shows that Colorado wildland urban interface residents are generally happy with their lives.

Ordered probit regression results show that several variables were important to individual well-being: age, family size, house value, and frequency of fire. But, our results also show that if a significant life event occurs, such as a wildfire, many variables that would normally influence well-being, no longer do. In this study, the frequency of wildfire and, to a lesser degree, house value, became the most important variables after wildfire and other characteristics seemed not to be important anymore. Clark and Oswald, 2002, and Blanchflower and Oswald, 2000, also found that significant life events have an effect on well-being levels; from studies of events such as marriage and unemployment. We believe the well being measurement method may be a useful method for economists interested in estimating non-monetary measures of the change in utility associated with changes in environmental conditions.

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[2] In Frey's report, rankings were based on a scale of 1 through 10. Frey's reported average happiness ranking was 7.67. By converting 7.67 to the scale of 0 through 10, we obtain a ranking of 7.67*1.1=8.437.

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