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Behavioral Response To Endogenous Risk In The Laboratory

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BEHAVIORAL RESPONSE TO ENDOGENOUS RISK IN THE LABORATORY

by

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ABSTRACT

Risk is endogenous when an individual is able to undertake mitigation or self protection actions that reduce the risk that he faces. Most risky environments studied in economics involve endogenous risk. This dissertation studies the conceptual and behavioral implications of introducing endogeneity in the controlled environment of the laboratory. The dissertation consists of three different experiments designed to examine how endogeneity affects risk attitudes and risk perceptions in simple experimental set ups. All three experiments employ a virtual reality scenario where the subject is able to form his own beliefs, based on naturalistic cues provided by the virtual reality experience.

In the first experiment, a "short run" individual experiment, subjects experience several forest fires that allow them to form beliefs about the probability of a house in the simulated forest being destroyed by fire. The evidence suggests that endogenous risk settings do cause subjects to employ different subjective beliefs than they use in an exogenous risk setting, although risk attitudes appear stable across these settings.

Typically, the risk of natural disaster in any area is very small, and an adverse event like a forest fire occurs only once in a couple of decades. This has implications for self-protection expenditure where risk is endogenous. A "long run" individual experiment with several rounds of decision making allows the estimation of subjective beliefs about the risk of the property burning when a fire may occur. This design allows for the study of the effect of an actual experience of forest fire on a subject's beliefs.

Several mitigation options are collective in nature and require group contributions for the self-protection action to be provided. In an extension of the long run design, we study the effect

of an actual experience of fire on beliefs when the risk is faced by a group rather than an individual. This framework also allows us to compare behavior in a public goods game involving risk, with the standard public goods game.

To my father.

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1: HYPOTHESES AND LITERATURE REVIEW

Most risky environments allow the individual to undertake mitigation or self protection choices to alter the risk that is faced. Using the formal metaphor of economists, individuals get to choose which lottery to play out, within some bounds. Consider the mortality lottery, which has two known outcomes. By doing nothing, the individual faces one set of risky outcomes. However, if one engages in relatively healthy behavior the probabilities on those outcomes change, in ways that one may or may not discern well. And there might be some function relating mitigation efforts or expenditures and probability changes that one only knows approximately. As we expand the example to include the morbidity lottery, my mitigation expenditures might also change the final outcomes themselves: as I spend more money on health care, my income is changed for every possible health status. This methodological problem is central to virtually every important environmental social policy choice (e.g., towards global warming) as well as individual choice behavior (e.g., towards personal health).

All of these concerns raise important questions about understanding behavior towards risk that is "endogenous" in this sense. To what extent do the traditional methods of analysis towards "exogenous risk" change when we allow for such mitigation behavior? This turns out to imply delicate issues of inference, as emphasized in the older literature (e.g., Ehrlich and Becker (1972), Garen (1988), Shogren (1990), Shogren and Crocker (1991) (1994)). Do risk attitudes stay the same? Do the probabilities applied to final outcomes stay the same? Or do we find objective probabilities being replaced with subjective probabilities? If there is some uncertainty about the functional relationship between mitigation efforts and probabilities of final outcomes, does this raise questions about the validity of assuming that individuals behave as if they have a single subjective probability, rather than a density function of subjective beliefs? In that case, do we need to allow for "uncertainty aversion" as well as risk aversion? Do individuals exhibit a preference for earlier resolution of the uncertainty about the effects of risk mitigation on subjective probabilities?

The objective of this dissertation is to carefully study the conceptual and behavioral implications of introducing endogeneity in the controlled environment of the laboratory. The dissertation consists of three different experiments designed to examine how endogeneity affects risk attitudes and risk perceptions in simple experimental set ups.

In the first experiment, a "short run" individual experiment, subjects experience several forest fires that allow them to form beliefs about the probability of a house in the simulated forest being destroyed by fire. Each subject performs two tasks – one with the standard exogenous risk setup and the other with a endogenous risk setup. This allows us to test if beliefs remain constant across different task representations.

Typically, the risk of natural disaster in any area is very small, and an adverse event like a forest fire occurs only once in a couple of decades. This has implications for self-protection expenditure where risk is endogenous. A "long run" individual experiment with several rounds of decision making allows the estimation of subjective beliefs about the risk of the property burning down where fire may or may not occur in any particular year. This design allows for the study of the effect of an actual experience of forest fire on a subject's beliefs.

Several mitigation options are collective in nature and require group contributions for the self-protection action to be provided. In an extension of the long run design, we study the effect of an actual experience of fire on beliefs when the risk is faced by a group rather than an individual. This framework also allows us to compare behavior in a public goods game involving risk, with the standard public goods game.

This chapter provides a brief introduction to the thesis. It contains an overview of the experiments. Subsequently, it provides a review of the theoretical and empirical literature pertaining to endogenous risk. We begin with the theoretical extension of the expected utility model to include endogenous risk, followed by a review of the empirical papers studying behavioral response to risk in the field where risk is endogenous in nature and a review of experiments designed to address endogeneity of risk in the laboratory.

A. Structure of the Thesis

The thesis consists of 3 experiments:

1. Short run individual experiment.
2. Long run individual experiment.
3. Long run public goods experiment.

The experimental design, estimation method and results of these experiments are discussed in chapters 2, 3 and 4 respectively.

One central feature of the experiments is to elicit behavior in the context of tasks with real monetary consequences that are conducted in a laboratory environment, but that provide some of the naturalistic cues and context faced by decision makers in the real world. Field experiments are limited in their ability to implement necessary controls on experimental conditions and a wide range of counterfactual scenarios, and conventional laboratory experiments are often artefactual by design (Harrison and List (2004)). Our solution is to use virtual experiments (VX) introduced by Fiore, Harrison, Hughes and Rutström (2009) FHHR (p.

66): “A VX is an experiment set in a controlled lab-like environment, using typical lab or field participants, that generates synthetic field cues using Virtual Reality (VR) technology.”

Our basic experimental design is borrowed from FHHR, and each of the three experiments involve variations of this basic design. The subject is allotted a virtual house in the middle of a forest. We consider the risk that the house will burn down in a simulated forest fire. Each subject faces two alternative fire policy regimes: no prescribed burning and hence maintaining of the existing risk of forest fires, and the use of prescribed burning implying some reduction of the risk of forest fires.

In the short run individual experiment, the subject is not informed about the risk of fire with or without mitigation, and has to form his own belief about the probability of the house burning down. However, the subject gets to experience computer simulations of several scenarios of forest fires before making his decision, and these simulations are dynamically rendered in a graphic-intensive, naturalistic manner. Also, the instructions contain detailed statistical information about the risk of forest fires including graphical representations of this risk. Each subject is then asked to perform two tasks – a betting task that elicits the exogenous risk of the house burning and a WTP task that elicits the endogenous risk of the house burning. Standard theory does not predict any framing effect of moving from the exogenous to the endogenous risk setting. However, we find risk perceptions to be more extreme under endogenous risk than under exogenous risk.

A similar hypothesis test is done for risk attitudes. Subjects face two sets of tasks, the standard lottery tasks, where subjects are asked to choose between lottery pairs (exogenous risk setup) and the WTP task where subjects can pay upfront to reduce the risk of getting the lower payoff (endogenous risk setup). Risk attitude are found to be stable across tasks.

The long run individual experiment modifies this basic setup, where subjects face consecutive rounds of decision making. In each round the subject indicates his maximum WTP for prescribed burning. Next he rolls a die to pick the cost for that round. Prescribed burning is provided if WTP exceeds or equals cost and the cost is deducted from the initial credit given to the subject. Otherwise, prescribed burning is not provided and nothing is deducted from the initial credit. The risk of the house burning is lower when prescribed burn has been undertaken. Once the decision about prescribed burning has been taken the subject is informed whether or not a fire actually occurs in that round. If a fire occurs the background conditions for this fire are randomly picked by the rolling of the die, and a fire is simulated. Final payoff is determined by whether or not the house survives the fire. If no fire occurs the subject moves on to the next round of decision making.

Similar to the short run individual experiment, payment is determined by whether the house survives a simulated forest fire. The difference is that the risk of the house burning now depends on there being a fire. This drastically reduces the risk of the house burning since the frequency of fire is only 1-in-20 years or 5%. The additional criteria to be considered, frequency of forest fires, makes the decision in the long run experiment more difficult, but also closer to the real life decisions people face. Given that fire may or may not occur in any particular year, this design allows us to study how the actual occurrence of a fire affects perception about the risk of the property burning. There is no evidence that experience of a fire affects beliefs and contrary to expectations, experience of the house burning has a negative effect on risk perceptions.

Finally, the long run public goods experiment recognizes the fact that many of the risks are faced by a group or community rather than an individual and the mitigation effort has to be undertaken by the group as a whole. The experimental set up is very similar to the earlier experiment except the cost of prescribed burning is now fixed and announced as part of the instructions. Prescribed burning is only provided if the total contribution made by all members in the group exceeds cost. In the event that total contribution falls short of cost all contributions are returned and no prescribed burning is provided. As before, a fire occurs once in 20 years and in the event of a fire payoff is determined by whether or not the house burns down in the fire. There is no group effect on individual's risk perception. However, we do find a significant difference in trend between WTP in the public goods game with risk and the standard public goods game. While in the latter WTP barely fluctuates in the 20 years, in the former it falls drastically in the first few rounds and stabilizes at a much lower level.

Let us now review the literature on endogeneity of risk.

B. EU Model with Endogenous Risk

Suppose there are two states of nature: for example, ill health or good health, injury at work place or no injury, or natural disaster damaging your house or leaving it untouched. Let the probability of damage be ρ . Then the expected utility of an individual is given by:

$$EU = [1-\rho]U(Y)+\rho U(Y-d)$$

where Y is initial wealth, d is the loss experienced, and no mitigation is possible.

Ehrlich and Becker (1972) (EB) studied mitigation in the EUT framework. EB distinguished between two forms of mitigation – self insurance and self protection. Self insurance investment consists of expenditures made to reduce loss caused by the occurrence of the unwanted event (ill health, injury or disaster). Define the loss function as $L = L(d, c)$ where c is self insurance investment; $L'(c)$ is assumed to be negatively sloped, implying that loss decreases as self insurance rises. The agent's problem now is to choose c to maximize:

$$EU = (1-\rho)U(Y-c) + \rho U(Y - L(d,c) - c)$$

For self insurance investment to be positive $-L'(c) > 1$ must hold. Here risk is exogenous.

Self protection is investment made to reduce the probability of incurring any damages when the bad outcome occurs. Let $P = P(\rho, s)$ be the effective or endogenous risk function, where ρ is the exogenous risk of damage occurring, s is the expenditure on self protection, and $P'(s) < 0$. In the absence of market or self insurance the agent's problem is then to choose self protection investment s to maximize:

$$EU = [1 - P(\rho, s)]U(Y-s) + P(\rho, s)U(Y - d - s)$$

where l is the dollar damage caused. Self protection is the only available mitigation alternative in our experiments.

In this model the probability of damage, conditional on the bad outcome occurring, is itself a function of the investment made by the individual to reduce risk. Allowing for self protection makes risk endogenous, since here the risk P is affected by the mitigation activity undertaken by the individual.

A couple of observations can be made about this model. First, the utility function $U(.)$ is independent of risk being endogenous or exogenous. An individual has the same utility function, whether or not risk can be mitigated, although the level of utility may of course differ in the two cases. This implies that if the utility function, exogenous risk level, and endogenous risk function are known, it is possible to predict the optimal level of mitigation.

Second, in the case of self investment, an increase in exogenous risk leads to an increase in the level of mitigation:

$$\frac{\partial c}{\partial \rho} = -[U_c(y) - U_c(x)(L'+1)]/[(1-\rho)U_{cc}(y) + \rho U_{cc}(x) - \rho U_c(x)(L'')] \geq 0,$$

where $y = Y - c$ and $x = Y - L(d,c) - c$. In other words, self investment expenditure increases with an increase in risk.

Third, when risk is endogenous it is not possible to unambiguously sign the comparative statics relation $\partial s / \partial \rho$ without making an assumption about the sign of the cross partial derivative

$P_{s\rho}$

$$\frac{\partial s}{\partial \rho} = -\frac{P_\rho(\rho,s)\{U_s(y-s) - U_s(y-d-s)\} + P_{s\rho}(\rho,s)\{U(y-s) - U(y-d-s)\}}{U_{ss}(Y-s)(1-P) + U_{ss}(Y-d-s)P + 2P_s(U_s(Y-s) - U_s(Y-d-s)) + P_{ss}(U(Y-s) - U(Y-d-s)}$$

This comparative static relation has been studied in several theoretical studies; and whether or not the relation can be signed depends on the specific assumptions made. Berger, Blomquist, Kenkel and Tolley (1987) (BBKT) extend the self protection approach to the health literature. Given a health condition, such as a specific type of cancer, that does or does not occur, an individual's maximization problem is to choose *X*, preventive expenditure, to maximize:

$$EU = P_0(1 - H(X,E))U_0(M - X, 0) + P_1 H(X,E)U_1(M - X - Z, 1)$$

where H is the probability of contracting the condition, P_0 is the probability of survival if free of the condition, P_1 is the probability of survival with the condition, U_0 is utility free of the condition, U_1 is utility with the condition, *Z* is the cost incurred as a result of illness, and *E* measures environmental quality.

In this model the effect on preventive expenditure *X* of an environmental improvement (a change in E) cannot be unambiguously signed. However, if $H_{EX} > 0$, which is the case if X and E are substitutes, the effect on preventive expenditure of an environmental improvement is negative. Environmental quality and preventive expenditure are then likely to be substitutes. This gives the comparative statics relation: an improvement in environmental quality results in an increase in self protection expenditure.

Secondly, in this model the effect of an improvement in environmental quality on the probability of the adverse health condition H is ambiguous. It is not possible to sign:

$$\partial H / \partial E = H_x \partial X / \partial E + H_E$$

The direct effect (H_E) of an improvement in environmental quality is negative. The indirect effect ($H_x \partial X / \partial E$) may not be negative. Under plausible assumptions $\partial X / \partial E < 0$ and hence the indirect effect is positive (since $H_x < 0$). That is, an improvement in environmental quality may result in a reduction in self protection investment. The result may be an increase in the risk faced. As long as the indirect effect does not dominate the direct effect, however, improvement in environmental quality reduces probability of the adverse health condition.

Before reviewing studies that extend this important result, it is worth mentioning Shibata and Winrich (1983) (SW), which explores the endogeneity of the loss function by considering private actions undertaken by individuals that reduce the damages from pollution – a public bad. In spite of the public bad nature of pollution, it is possible in their model to mitigate the damage caused by undertaking private defensive investment. In short, SB deals with self insurance in the EB sense and its implication for the net disutility from pollution faced by individuals.

Shogren and Crocker (1991) (SC) consider both the endogeneity of health risk and the severity of the health outcome (endogeneity of the loss function) in their model. They note that full market insurance is not possible due to the existence of moral hazard and adverse selection problems. Hence self protection investment is likely.

Let the environmental risk be taken from a real interval R where $R = [\underline{r}, \bar{r}]$. Self protection investment is chosen from an interval s where $S = [\underline{s}, \bar{s}]$. Let $h(s, r)$ be the continuum of health outcomes space that occur for various levels of exogenous risk and self protection expenditure, and let $f(h; s, r)$ be the probability of the particular health outcomes. There exists a minimum cost function for each given health outcome. Conditional on the health outcome that occurs, we get the damage function:

$$C = C(h; s, r)$$

Therefore, the expected utility maximizing individual chooses s, self protection expenditure, to maximize

$$EU = \int U(W - C(h; s, r) - s) dF(h; s, r)$$

Notice here both the probability of ill health and the cost incurred in case of ill health are functions of the self protective investment chosen by the individual. This is a deviation from EB where self protection investment reduces risk and self mitigation investment reduces loss incurred. All the other models reviewed so far consider either self protection or self insurance but never both simultaneously.

Unlike BBKT, in the more general SC model the effect of an increase in risk on self protection expenditure cannot be signed even under the assumption of increased exposure to risk increasing marginal productivity of self protection. Self protection may decrease as exposure to hazard increases.

In a framework similar to SC, Quiggin (1992) establishes many of the results of the BBKT model when both risk and damage functions are endogenous and a continuum of health conditions are considered. Quiggin's (1992) model differs from SC by making two additional assumptions: decreasing absolute risk aversion and a separability assumption. Quiggin (1992) cites two reasons for making the decreasing absolute risk aversion assumption.

1. Based on "introspection" it seems plausible that individuals with higher income (wealth) are less risk averse.
2. It is necessary to extend some comparative statics relations, from choice under certainty to choice under uncertainty, and this assumption is commonly made in the literature.

The separability assumption basically requires that the self protecting investment only reduces endogenous risk and has no other health implication. It is a natural assumption to make, where private self protection is a perfect substitute for public action to reduce the risk that the individual is exposed to. Quiggin (1992) observes that when this separability assumption does not hold, the results are violated even for the certainty case. Notice that this assumption is similar to the one made in BBKT about environmental quality and preventive action being substitutes.

Breshnahan and Dickie (1995) extend this model to a multiple discrete states framework with an arbitrary number (*M*) of protective actions and an arbitrary, but finite, number of states of nature (*S*). Choices made in the markets for protective goods are sufficient to reveal preferences iff *M>S*, so the number of markets for protective goods exceed the number of possible health outcomes or states of nature. In other words, trade in contingent markets completely reveal preferences as long as a complete set of markets exist. It is the existence of contingent markets, and not separability that drives this result.

Thus, under certain assumptions, it can be shown that an increase in exogenous risk leads to increase in mitigation. This is an important theoretical result and much of the empirical literature attempts to test this basic result.

C. Empirical Implications of Endogeneity

One of the first studies to deal with endogeneity in empirical data is Garen (1988), who studied the effect of workplace risk on wages. To take his example, suppose q_i and r_i represent the probability of fatal and non-fatal injury, respectively, on a particular job. The wage y_i is a function of the risks faced at work $y_i = y_i(q_i, r_i)$. The wage function to be estimated is given by:

$$\ln y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 q_i + \beta_3 r_i + \varepsilon_i + \phi_{1i} q_i + \phi_{2i} r_i$$

where x_1 represents other determinants of earning, and ϕ_1 and ϕ_2 are unobservable individual heterogeneity effects that depend on fatal and non-fatal risks. For instance, individual attributes such as cool-headedness may make an individual more productive, or less at risk, in a riskier situation. As he puts it, “Because *q* and *r* are choice variables of individuals, the chosen value of *q* can depend on, and thus be correlated with ε, ϕ_1 and ϕ_2. Therefore, OLS may provide biased estimates.” (p. 10) The suggested solution is to estimate the equation jointly with regression equations for mortality risk and morbidity risk. These two equations are:

$$q = \pi_0 + \pi_1 x_1 + \pi_2 x_2 + \pi_3 z + \eta$$

$$r = \delta_0 + \delta_1 x_1 + \delta_2 x_2 + \delta_3 z + \mu$$

where x_2 is a variable which proxies the degree of risk aversion and z is non-wage income.

Several studies have tested the positive relation between the level of risk and mitigation expenditure. One of the earliest studies is by Kunreuther, Ginsberg, Miller, Sagi, Slovic, Borkan and Katzs (1978). In 1974 California witnessed a series of earthquakes. Geologists were of the opinion that the release of the pressure along the seismic fault line decreased the risk of future earthquakes in the region. A survey was conducted to test whether mitigation expenditure had decreased following the earthquake. Instead, they found an increase in the purchase of insurance following the earthquake, despite the presumed reduction in risk.

Later hedonic studies also find an increase in mitigation effort following a natural disaster. Loomis (2004) shows a significant drop in house price, using a difference-in-difference approach in his hedonic price model, in areas adjoining a community badly affected by a major fire. Falls in property price are hypothesized to reflect an upward adjustment in estimates of the risk from forest fires following the fire in the neighboring community.

Hallstrom and Smith (2005) (HS) use a similar approach in their hedonic price analysis of property markets in Lee County, Florida, before and after Hurricane Andrew. Lee County was not hit by Hurricane Andrew in 1992, but counties adjacent to it were affected. They find that the rise in prices of properties in the flood hazard zone adjacent to the areas most affected by hurricanes were 19 percent less compared to those outside these areas.

HS develop the idea that a hurricane can be treated as a quasi-experiment that conveys *new information* about risk of natural disaster *ceteris paribus*. HS hypothesize that the occurrence of the hurricane, after a considerable gap in which no hurricanes occurred, conveys new information to the residents of Lee County about the risk of hurricanes that they face. This information update results in a change in risk perception, which is reflected in a downward adjustment of property prices in a county.

Their basic hedonic price model is set up as follows:

$$V = p(r,I)U_H(r,h,m-R(r,h,i_o,p(r,I))-L(r,h,i_0))+(1-p(r,I))U_{NH}(r,h,m-R(r,h,i_0,p(r,I))$$

where m is the income less any hazard insurance; *h* the housing characteristics and site attributes not related to coastal amenities or risks; r the site attribute that reflects both the risk of storm hazards and coastal amenities, such as distance from the coast; *R*(.) the hedonic price function; i_0 the insurance rate per dollar of coverage; *L*(.) the monetary loss due to storm, net of insurance coverage with hurricane; and *p*(*r*, *I*) the household's subjective probability with the specific information set *I*.

Modifying our model to allow for belief to be a function of information we have:

$$EU = (1-P(\rho(I),s))U(Y-s)+P(\rho(I),s)U(Y-d-s)$$

Other things remaining constant, a change in *I* gives us the following comparative statics relation:

$$\frac{\partial s}{\partial I} = \frac{-[P_{SI}(U(Y-d-s)-U(Y-s))-P_I(U_s(Y-s)-U_s(Y-d-s))]}{U_{ss}(Y-s)(1-P)+U_{ss}(Y-d-s)P+2P_s(U_s(Y-s)-U_s(Y-d-s))+P_{ss}(U(Y-s)-U(Y-d-s)}$$

The above equation can be signed based on the sign of the cross partial P_{SI}. If it is zero, positive or negative, but has negligible magnitude, the relation is positive.[1] This implies that if new

[1] My prior here is $P_{SI} = 0$ since the relation between endogenous risk and mitigation expenditure should be technology driven and therefore not likely to be affected by information. For instance, the effectiveness of a vaccine is determined by clinical studies and not by the information set available to patients. This ensures $\partial s / \partial I > 0$.

information is conveyed about increased exogenous risk of disaster, we would see an increase in mitigation expenditure to reduce the endogenous risk faced by the individual. This is the basic relation we are testing in our long run experiments – an effect of information update on mitigation expenditure (assuming experience of a fire conveys new information).

One of the drawbacks of the HS approach is that the relatively slower rise in the rate of property prices may be the result of a host of different factors. To assume that it is only information regarding risk that changes is a tenuous assumption at best. An alternative is to use direct elicitation method to elicit risk perceptions or beliefs from residents of disaster prone areas. From the experimental point of view, a before-after treatment is most attractive for the amount of control it offers. However, use of direct elicitation methods to study perception of natural disaster risk before and after in the field is problematic given that the experimenter has no control over the actual occurrence of a natural disaster. When eliciting risk perception of residents in a high risk area there is no method to accurately predict that the same area will be hit by disaster in the near future, thus restricting the scope of a before-after analysis. The environment of the laboratory, with its increased control, naturally lends itself to such problems.

D. Experiments Investigating Effects of Endogeneity on Behavior

The identification problem discussed by Garen (1988) is intrinsic to the endogenous risk setting, and plagues much of the empirical literature on risks in a natural setting. An attractive alternative is the use of controlled laboratory experiments to tease out the effect of endogeneity on behavior. Very few laboratory experiments, however, have been designed to study the endogeneity issue. The striking exceptions are Shogren (1990) and Shogren and Crocker (1994).

The basic model in each case is a simple lottery with probability *p* of loss *L* and (1-*p*) probability of gain *G*. The EU of this lottery is:

$$EU = pU(M-L) + (1-p)U(M+G) .$$

In their experiments self protection is the certainty equivalent of this lottery, which is the value of *x* that solves:

$$U(M+G-x) = pU(M-L) + (1-p)U(M+G) .$$

This is the amount an individual is willing to pay with certainty to completely reduce the loss to zero. Self protection expenditure in this case guarantees a positive gain.

Self insurance in these experiments is the payment made in all states of nature to reduce loss to zero. That is, self insurance is given by the value of *z* that solves:

$$pU(M-z) + (1-p)U(M+G-z) = pU(M-L) + (1-p)U(M+G) .$$

Although self protection expenditure guarantees a gain, self insurance merely reduces loss to zero. It seems logical that self protection will be preferred to self insurance in this setup. In our design self protection does not guarantee a gain: it only reduces the probability of a loss. This makes it more comparable to self insurance.

The primary objective of the SC design is to test whether use of alternative risk-reduction mechanisms lead to difference in choices. In their design they have four different mechanisms available for mitigating risk: individual self protection, individual self insurance, collective self protection and collective self insurance. They find the maximum WTP for individual self protection and the minimum WTP for collective self insurance. SC recognize that the difference in these two valuations may be partly due to the presence of a free rider problem in the collective data, because of the public goods nature of collective risk. SC finds that risk-reduction mechanisms matter, and conclude that there exists a framing effect on risk mitigation behavior.

In SC a Vickrey sealed bid second price auction is used for the valuation of private risk reduction mechanisms. Each subject competes for self protection or insurance. The highest bidder gets the good at the price of the second highest bid. A "Smith auction" is used for the collective risk reduction mechanisms.[2] Each subject makes a bid to reduce risk, and if the sum of the bids exceeds or equals the price, the good is provided. The truth revealing property of the Vickrey auction is not supported by experimental evidence. Harstad (2000) in an induced value experiment and Rutström (1998) in a homegrown value experiment show significant difference in bidding behavior between the English auction and Vickrey auction even though in both mechanisms the dominant strategy is to bid equal to the true value. Bids are higher under the Vickrey auction possibly because it lacks the real time feedback of an English auction. To ensure that the true value is revealed we use simple lottery choice tasks instead of auctions.

Two studies most closely resemble our long run experiments, both for the individual and public goods experiments: McKee, Berrens, Jones, Helton and Talberth (2004) (MBJHT) and Talberth, Berrens, McKee and Jones (2006) (TBMJ). In their experimental design the subjects face 15 consecutive rounds where each round represents a year in household decision making. All individuals begin with an asset, described as their home, with a value of $150,000 (in lab dollars), with an annual increment of 5% of current value. Each period there is a risk from a forest fire. There are three possible events: no fire, small-scale fire, and large-scale fire. If a small-scale fire occurs the individual loses up to 35% of the property value while if a large-scale

[2] In a Smith auction (1980) each individual has to accept his share of cost by bidding that amount. The public good is only provided when there is unanimity about the quantity to be provided.

fire occurs the individual loses up to 90%. The magnitude of loss is determined by the level of protection bought by the individual.

The risk of forest fire is cumulative in nature. Increased incidence of small-scale forest fire reduces the probability of large-scale forest fire by reducing the quantity of fuel in the area. Thus excessive reduction in small-scale fires, through aggressive fire suppression, opens the door to a truly catastrophic event.[3] In their design, MBJHT and TBMJ capture this aspect of the dynamic risk of forest fire. The probabilities of fire are generated by randomly picking a bingo ball out of its cage. A white ball signifies no fire, an orange ball is for small-scale fire and a purple ball is for large-scale fire. In the first round there are 30 white balls, 15 orange balls and 5 purple balls. If a white ball is drawn, it is replaced prior to the start of the next round. When an orange ball is drawn one of the purple balls is removed and replaced with a white ball, indicating the reduced risk of a large-scale fire. If a purple ball is drawn three purple balls are replaced by white balls to indicate the reduction in risk.

In each round the subject makes decisions regarding expenditure on insurance and averting behavior. Subjects can choose between private and public averting activities. The private activities include replacing a roof with non-inflammable materials, clearing vegetation away from structures, constructing driveways and walkways that serve as fire breaks, installing fire-resistant landscaping, pruning dead vegetation and thinning inflammable trees and shrubs. Public averting activities were divided into "neighborhood" activities and "public land"

[3] This is similar to the risk of earthquake where incidence of an earthquake releases pressure along the seismic fault and reduces future risk of earthquake along that fault. Hurricane risk, on the other hand is dissimilar and the incidence of one hurricane does not affect the probability of another. For instance, in 2004, four major hurricanes hit Florida within the same hurricane season Charley, Frances, Ivan and Jeanne.

activities. These include prescribed burning, purchasing new fire fighting equipment, removing excessive vegetation along roads and restoring wildlife habitat.

In spite of the presence of private insurance, most subjects also chose to pay for private averting expenditure. WTP under the private regime significantly exceeded WTP under the public regime. This is not surprising as the public goods game is susceptible to free riding behavior. If the mitigation option is undertaken, no individual is excluded from its benefits, irrespective of whether or not he paid for it.

Our experiment uses a similar setup in which subjects start with an initial credit and ownership (or joint ownership in case of the public experiment) of a house in the forest. There are 20 rounds of decision making and in each round the subject has to make a choice about his WTP for the mitigation activity. To make the determination of lightning strike natural we use the historic lightning strike pattern from Central Florida region over a 20 years span.

The novelty of our experimental design is the use of computer simulations to determine whether the house burns in a fire. Once it is revealed that a fire has occurred in any particular round, we choose the background conditions for this fire by rolling a die. Based on the randomly selected background conditions, a simulation is played out. Outcome of this simulation determines whether or not the subject loses his house in the fire. This enables us to capture the subject's perception about the risk of the house burning when a fire may or may not occur, something that the experiments by MBJHT and TBMJ were not designed to address.

Our design also differs in two other ways. First, in MBJHT and TBMJ subjects are able to reduce potential damage by making an upfront expenditure but not able to affect the probability of the risky event. Conversely, in our experiment, subjects are able to reduce their risk but not able to reduce the potential damage. Second, these experiments were designed to test whether people are willing to pay for averting activities that are both public and private. The mitigation mechanisms offered under the private regime are not the same as those offered under the public regime. This allows for a more realistic setting but does not allow direct comparison between the two. In our design, we use the same averting mechanism for both public and private choices, which allows for direct comparison between the two.

E. Conclusion

The implications of introducing endogeneity in the basic EUT framework have been extensively studied. A sizeable literature exists exploring its effects on refutable hypotheses. Very few experiments, however, have attempted to study its effect on behavior in the controlled environment of the laboratory. This thesis is a first step towards addressing this gap in the literature.

2: SHORT RUN INDIVIDUAL EXPERIMENT: RISK ATTITUDES AND BELIEFS UNDER ENDOGENEITY.

We consider the effect of allowing for endogenous risk on behavior, in the simplest possible laboratory environment that allows us to identify effects on risk attitudes and subjective beliefs. Results suggest a significant difference in beliefs, though risk attitudes remain stable across treatments. The fact that even in the simplest settings we find an effect of endogeneity on subjective beliefs has strong implications for more complex settings where risk depends on the actual occurrence of the risky event, as in chapter 4 and where risk mitigation choices are made by a group rather than an individual, as in chapter 5. As we move away from the simple set up described in this chapter to the more complex but realistic scenarios in later chapters it is natural to expect that endogeneity will have a more significant effect on behavior. Studying behavior in the more complex settings brings us closer to the ultimate goal of studying behavior in the field where endogeneity is likely to be present.

This chapter has 3 sections – experimental design, estimation method and results.

A. Experimental Design

The experimental design is deliberately structured to allow conceptual and econometric identification of the effects of endogenous risk. The subject faces 11 decision tasks: a standard lottery task in the gain domain, a standard lottery task in the loss domain, four lottery tasks with endogenous probabilities in the loss domain, three WTP tasks, and two betting tasks. The subject picks one task at random out of the 11 that determines his earnings.[4]

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[4] A simple procedure is used to ensure that the subject believes that the process of choosing this task is random, using the following instructions: “The box in front of you has 11 envelopes and 11 cards numbered 1 through 11.

Each of the 11 tasks involves a series of binary choices. Once the task for payment has been decided, the subject is paid for one of these binary choices selected at random by rolling a die. This has the advantage of avoiding any "wealth or portfolio effect" that may arise if subjects are paid for multiple decisions made at the same time.[5]

The betting tasks and the WTP tasks are undertaken as part of a VR experiment. The objective is to compare the subject's perception of the risk of forest fire in a betting task, and the beliefs implied by their WTP to reduce this risk. Together they form the two belief elicitation tasks that allow the estimation of subjective beliefs. The risk of forest fire is carefully explained to the subject using different methods, including an opportunity to experience computer simulations and graphical rendering of forest fires.

A large part of our instrument deals with the instructions for the VR experiment, including the betting mechanism. Subjects first face the VR tasks, followed by the lottery tasks. There are two alternative treatments of the VR experiment, to check for order effects: either the subject faces the betting task first followed by the WTP task or the subjects face the WTP task first followed by the betting task.

First, we describe the VR scenario and the WTP table that the subject was given. Second, we describe the betting mechanism we use to directly elicit beliefs from subjects. This is followed by a description of the various lottery tasks we use in our experiment: the standard Holt

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Please put one card into each envelope and close the envelopes. We will now shuffle these envelopes. The envelopes have now been carefully shuffled and we ask that you pick one of them. The number on the card in the envelope you selected determines which task you will be paid for. But you will not know which one until the end of the experiment when you will be allowed to open the envelope." All experiments were conducted with one subject at a time.

[5] The experimental procedure of picking only one choice for payment, to avoid portfolio effects, has been widely used. It is not theoretically obvious that portfolio effects should always be avoided when eliciting risk attitudes, as explained in Harrison and Rutstrom (2008, p.117). For our purpose however, it is desirable to avoid any portfolio effects since payment for the betting tasks as well as choice tasks in VR are determined by the outcome of simulations of a forest fire with identical underlying distributions.

and Laury (2002) task in the gain domain, followed by similar tasks in the loss domain, and then by lottery tasks with endogenous risk.

I. WTP Task in the VR Experiment

The design of the VR choice task is taken from FHHR. Following their design, we pay subjects according to damages to their personal property, which is simulated as a virtual log cabin at the edge of Ashley National Forest, Utah. The subject is given an initial cash credit. With this credit he has the option of paying for a prescribed burn policy which would reduce the risk of his property burning down in the event of a fire. But this policy costs him some money up front – non-refundable in the event that his property does not burn. FHHR view fire management options as policy lotteries:

> Forest fire management options such as prescribed burn can be viewed as choices with uncertain outcomes. In the language of economists these options are "lotteries" or "prospects" that represent a range of final outcomes, each with some probability, and hence can be viewed as a policy lottery. One outcome in this instance might be "my cabin will not burn down in the next 5 years" or "my cabin will burn down in the next 5 years." Many more outcomes are obviously possible: these are just examples to illustrate concepts. (p. 73)

Using their experimental design, the choice in the policy lotteries presented to subjects is between a "risky lottery" with *no* prescribed burn and a "safe lottery" *with* a prescribed burn. If the risky lottery is chosen, and therefore no prescribed burn is undertaken, the probability of the house being destroyed by wild fire is relatively high. Undertaking a prescribed burn, or choosing the safe lottery, reduces the probability of the house being destroyed by fire. In short, the subject chooses the level of risk that he is willing to take, where risk is endogenous and chosen by the subject rather than being exogenously given to him.

Choosing a lower risk lottery, however, involves an upfront cost of prescribed burning. Prizes in both states of nature, where the house burns down and the house does not burn down, are higher for the risky lottery than for the safe lottery. But the probability of the worst outcome is higher in the risky lottery, implying that there exists a tradeoff between the level of risk that a subject faces and the amount of money he is willing to pay to reduce that risk. This is typical of models with endogenous risk where an individual is able to affect the level of risk he faces by investing in mitigation.

This is the only one of the three experiments, in which, the subject is able to experience computer simulations of the forest fire, before making his payment decision, in order to form his own beliefs about the probability of damage. As explained in FHHR:

> Contrary to decisions involving actual lottery tickets, a policy lottery has outcomes and probability distributions that are not completely known to the agent. We therefore expect the choices to be affected by individual differences not just in risk preferences, but also in risk perceptions. (p. 73)

Using a separate betting mechanism, described below, we directly elicit this risk perception.

The information about risks to their property that subjects receive is threefold. First, they are told that the background uncertainties are generated by (a) temperature and humidity, (b) fuel moisture, (c) wind speed, (d) duration of the fire, and (c) the location of the ignition point. They are also told that these uncertainties are binary for all but the last, which is ternary; hence there are 48 (2 x 2 x 2 x 2 x 2 x 3) background scenarios. They are also told the specific values for these conditions that are employed (e.g., low wind speed is 1 mph, and high wind speed is 5 mph). The instructions explain that these background factors will affect the wild fire using a computer simulation model, FARSITE, developed by the U.S. Forest Service to predict the spread of wild fire. Thus subjects could use this information, their own sense of how these factors play into wild fire severity, and their experiences and inferences from the VR experience (explained below), to form some probability judgments about the risk to their property. The objective is to provide information in a natural manner, akin to what would be experienced in the actual policy-relevant choice, even if that information does not directly "tell" the subject the probabilities.

Second, the subject is shown some histograms displaying the distribution of acreage in Ashley National Forest that is burnt across the 48 scenarios. The distributions that are presented to them are generated through Monte Carlo simulations using a computer simulation model, FARSITE, used by the U.S. Forest Service for this very purpose. Figure 1 shows the histograms presented to subjects. The scaling on the vertical axis is deliberately in terms of natural frequencies defined over the 48 possible outcomes, and the scaling of the axes of the two histograms is identical to aid comparability. The qualitative effect of the enhanced prescribed burn policy is clear: to reduce the risk of severe wild fires. Of course, the information here is about the risk of the entire area burning, and not the risk of their personal property burning, and that is pointed out in the instructions.

The subjects then experience 4 dynamic VR simulations of specific wild fires, 2 for each of the cases with and without previous prescribed burns, rendered from the information supplied by FARSITE simulations that vary weather and fuel conditions. We selected these simulations to represent a high and low risk of fire damage, and the subjects are told this. Figure 2 illustrates the type of graphical rendering provided, although static images such as these do not do justice to the VR "presence" that was provided. Some initial training in navigating in the environment is provided, which for this software is essentially the same as in any so-called "first person shooter" video game.[6] The mouse is used to change perspective and certain keys are designated for forward, backward, and sideward movements. The subject is then presented with the 4 scenarios and is then free to explore the environment, the path of the fire, and the fate of their property during each of these. Apart from the ability to move across space, subjects also have the option of moving back or forth in time within each fire scenario.[7]

Table 1 shows the payoff matrix that is implied by our VR instrument, assuming that the subject accurately infers the true probabilities of his own property burning. From the table we see that the true probabilities of the cabin burning are 0.06 if the prescribed burn policy is chosen and 0.29 if the subject chooses not to pay for the policy. All prizes are stated as losses from an initial credit, here $40. Lottery B gives a 29% chance of a loss of $18 and a 71% probability of no loss. Lottery B remains the same in all rows of this table, with a fairly high probability (0.29) of the property being damaged in a wild fire. It costs nothing if no damage occurs,[8] and this is the risky lottery. Lottery A is the safe lottery: in the first row, it offers only a 6% probability of a loss of $18, while there is a 94% probability of no loss occurring. Clearly, lottery A is preferred to lottery B in the first row. In the second row, lottery A has a 6% probability of a loss of $20 and a 94% probability of a loss of $2. In this case it costs $2 to undertake prescribed burning that reduces the probability of damage from 29% to 6%, but also results in both prizes being lower than in the risky lottery. As one moves down the table, the amount of money paid for prescribed

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[6] For student subjects this interface is second nature, and occasionally their Second Life.
[7] This points to another feature of the VR environment in settings where current action, or inaction, can lead to latent effects well into the future. The VR simulation interface can be used by subjects to "fast forward" and better comprehend those effects. The credibility of the future-generated scenarios is dependent on the credibility of the modeling of dynamic processes in the underlying simulation model, of course.
[8] The probabilities 0.29, 0.71, 0.06 and 0.94 are the ones used in the computer simulations of the wild fires.

burn increases and accordingly both prizes in lottery A decrease. Following this logic, the last row of this table corresponds to the maximum cost of prescribed burning, which, in our experiment, equals the value of the house. In this example the cost of prescribed burn varies from $0 to $18 (the value of the simulated house). This makes the instrument intuitive for subjects to follow and ensures that the switch point, from safe to risky lottery, falls within the range of the table.

For each choice task we present the subject with an array of possible costs for the policy, between $0 and $18 in increments of $2. In each case the subject is asked to simply say "yes" or "no" as to whether they wanted to contribute to the policy at that cost.[9] The subject is told that one of these costs would be selected at random, using a 20-sided dice, and if the prescribed burn had been selected for that cost it would be put in place, otherwise not. The subject is informed that after cost is selected at random, each of the background factors will be selected by rolling a die, so that one of the 48 background scenarios would be selected with equal probability. Thus the subject's choices, plus the uncertainty over the background factors affecting the severity of a fire, which depends on the chosen policy, would determine final earnings.

There are 3 such decision tasks that the subject faces. One is when the damage to the house results in a loss of $38 with an initial credit of $80, one is where the damage is $28 with an initial credit of $60, and the final one is where the damage is $8 with an initial credit of $20. The choice data generated in these three tasks can be analyzed as data from a Multiple Price List of discrete pairwise lottery options, apart from the fact that the subjective probabilities are not

[9] Instructions for this experiment are presented in Appendix A and the corresponding decision sheets are in Appendix B.

known and must be estimated. Using the betting task, described below, and this choice task we can jointly estimate subjective perception of risk and risk attitude.

II. Betting Task

The objective of the betting task is to directly recover the subject's belief that event A will occur instead of event B, where A and B are mutually exclusive. Assume that the subject is risk neutral and has no stake in whether A or B occurs other than the bets being made on the event. Let the subject be told that there are 9 bookies, each willing to take a bet at stated odds. Table 2 shows odds for the two events in the form that they are naturally stated in the field: what is the amount that the subject would get for a $1 bet if the indicated event occurred?

The subject is simply asked to decide how they want to bet with each of the 9 bookies: do they want to bet on A or B? Their "switch point," over the 9 bookies, is then used to infer their subjective belief. The basic experimental design and estimation strategy are borrowed from FHHR and Andersen, Fountain, Harrison and Rutström (2009).[10] Consider a subject that has a personal belief that A will occur with probability 0.75, and assume that the subject has to place a bet with each bookie, knowing that only one of these bookies will actually be played out. The odds offered by a particular bookie are shown on a given row, so different rows correspond to different bookies. The (risk neutral) subject would rationally bet on A for every bookie offering odds that corresponded to a lower house probability than 0.75 of A winning, and then switch over to bet on B for every bookie offering odds that corresponded to a higher house probability

[10] Familiar scoring rule procedures are formally identical, since each probability report implicitly generates a bookie willing to bet at certain odds. Thus when the subject makes a report in a Quadratic Scoring Rule, for example, the subject is in effect choosing to place a bet on the event occurring with payoffs given by odds that are defined by the scoring rule. By making one report instead of another, the subject is then choosing one bet over another, or equivalently in our design, one bookie over another.

than 0.75 of A winning. These bets are shown in Table 2, and imply gross earnings of \$10 or \$0 with the first bookie, \$5.00 or \$0 with the second bookie, and so on. The expected gross earnings from each bookie can then be calculated using the subjective belief of 0.75 that the subject stated. Hence the expected gross earnings from the first bookie are (0.75 × \$10) + (0.75 × \$0) = \$7.50, and so on for the other bookies. A risk neutral subject would bet on event A for the first 7 bookies and then switch to event B.

In the short run individual experiment, each subject faces 2 betting tasks . The first event is that the house in the VR environment burns down when the fuel load is low (or a prescribed burn is used); and the second event is that the house burns down when fuel level is high (or no prescribed burn is used). The subject is given a \$5 stake to bet with in each of the 2 betting tasks, and a bet has to be placed for each of the 9 bookies. The \$5 from one house is not transferable to other houses, and one of the bets will be selected at random to be actually played out. In effect, we "force feed" the subjects by requiring that they place a bet with each betting house, and do not allow them to change the \$5 stakes: all the subject can do is decide if they want to bet on event A or event B in each house.

III. Standard Lottery Task in Gains Domain

Holt and Laury (2002) devise a simple experimental measure for risk aversion using a Multiple Price List design. Each subject is presented with a choice between two lotteries, which we can call lotteries A or B. Table 3 illustrates the basic payoff matrix presented to subjects in our experiment.[11] The first row shows a choice between getting \$24 for certain and \$1 for

[11] The prizes for this standard lottery task have been adjusted to match our other tasks. Here the prizes are \$1, \$24, \$26 and \$50 instead of the original \$3.85, \$2.00, \$1.60 and \$0.10 in Holt and Laury (2002)

certain. The second row shows that lottery A offers a 90% chance of receiving $24 and a 10% chance of receiving $26. The expected value of this lottery is shown as $24.20, although the EV columns are not presented to subjects. Similarly, lottery B in the second row has the prizes $50 and $1, for an expected value of $5.90. Thus the two lotteries have a difference in expected values of $18.30. As one proceeds down the matrix, the expected value of both lotteries increase, but the expected value of lottery B becomes greater relative to the expected value of lottery A.

Each subject chooses A or B in each row, and one row is later selected at random for payment. The logic behind this test for risk aversion is that only risk loving subjects would take lottery B in the second row, and only very risk-averse subjects would take lottery A in the last row. Arguably, the first row is simply a test that the subject understood the instructions, and has no relevance for risk aversion at all. A risk neutral subject should switch from choosing A to B when the EV of each is about the same, so a risk-neutral subject would choose A for the first five rows and B thereafter. The standard lottery task is an example of exogenous risk. In each row, the subject is equally likely to get the bigger prize or the smaller prize. The only difference is the prize amount.

We take each of the binary choices of the subject as data, and estimate the parameters of a latent utility function that explains those choices using an appropriate error structure to account for the panel nature of the data. Once the utility function is defined, for a candidate value of the parameters of that function, we can construct the expected utility of the two gambles, and then use a linking function to infer the likelihood of the observed choice.

IV. Standard Lottery Task in the Loss Domain

The standard lottery task in the loss domain presents to the subject the same lottery choices discussed in the previous section, except that now they are framed as losses instead of gains. The basic hypothesis to be tested is that the risk aversion coefficient[12] in the gain and loss domains are identical. Holt and Laury (2008) report the results of similar experiments where prizes are stated as losses instead of gains. In their experiments the prizes in the loss domain are "reflections" of prizes in the gain domain, which simply means that the prize amounts remain unchanged but the signs are reversed. That is, instead of winning $16 the subject now loses $16 with the same probability as before. For the example considered in Table 3, the prizes after reflections would become -$24, -$26, -$0 and -$49.[13]

Our primary interest in restating the standard lottery task in the loss domain is to make it comparable with other tasks in our experiment. The VR task, discussed earlier, is different from the standard lottery task because the former deals with a loss from an initial credit, while the latter is designed as a gain with no initial credit. In the lottery task in the loss domain, the subject is given an initial credit of $50. Any loss is deducted from this initial credit, and the remaining amount is the subject's net earnings. For example, in the first row of Table 4 Lottery A offers a loss of $26 with certainty and lottery B a loss of $49 with certainty. The second row offers a choice between lottery A with a 90% chance of losing $26 and a 10% of losing $24 and lottery B with a 90% chance of losing $49 and a 10% chance of losing $0. To a risk neutral subject, with a reference point of $0, this is the same lottery choice as the one given in the first row of Table 3,

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[12] Or coefficients, in the case of EUT or non-EUT specifications that require the estimation of two or more structural parameters to characterize risk attitudes.

[13] Holt and Laury (2008) had their subjects earn their initial endowment in earlier experimental tasks, which averaged $43 and ranged from $21.68 to $92.08.

since lottery A gives a 90% chance of getting \$50 – \$26 = \$24 and a 10% chance of getting \$50 - \$24 = \$26; and lottery B gives a 90% chance of getting \$50 - \$49 = \$1 and a 10% of getting \$50 - \$0 = \$50.

These lotteries are, however, identical only to the extent that the assumption about the reference point is valid. As emphasized in Harrison and Rutström (2008; p.95), it is very difficult to determine the right reference point that the subject actually uses in a risk aversion task. It is possible, for instance, that the subject has a reference point of \$50, and integrates the \$50 credit into his wealth stream. In this case he views lottery A as a loss of \$26 rather than a gain of \$24. The difference in expected value of the lotteries for both \$0 and \$50 reference points are identical. Hence in both cases a risk neutral subject chooses lottery A for the first five rows and lottery B for the last five rows.[14]

Arguably, the reference point does not matter when comparing tasks in the loss domain where the initial credit and show up fee are identical, as long as reference points are not task specific. When comparing lotteries between the gain and loss domain, however, the indeterminacy of the reference point remains central. If the reference point is \$0, then the standard lottery choices in the gain domain and loss domain are identical and we expect behavior to be identical. If, on the other hand, the reference point is \$50 then the prize in Table 4, for instance, is viewed as a loss of \$26 and not as a gain of \$24. Allowing for loss aversion, it is possible that the subject makes different choices in Table 3 and 4. We test whether estimated

[14] Of course, \$0 and \$50 are not the only two possible reference points. If the subject integrates the show up fee of \$5 into his wealth coefficient, then the reference points are \$5 ands \$55 respectively. If he integrates his lifetime income or income outside the current experiment things get more complicated. Inferences about lotteries in the loss domain are very sensitive to assumptions about the reference point.

risk aversion coefficients in the gain and loss domains are identical and whether there is evidence of framing effect.

V. Lottery Task in the Loss Domain with Endogenous Risk

The lottery task with endogenous risk is the lottery version of the VR choice task. Table 1 describes the policy lottery that the subject faces, assuming that the subject is able to correctly infer the risk of the house burning down in the simulated forest fire. In the current task, the policy lottery is presented to the subject simply as a lottery choice without any of the contexts and visuals of the VR choice task. Notice though, that in this lottery version subjects are given the probabilities of the different prizes, while in the VR experiments they have to form their own beliefs.

Each subject faces 4 lottery tasks with endogenous risk in the loss domain. The maximum WTP varies with the initial credit given. When the initial credit is \$80 (or \$20), the maximum WTP or value of the house is \$38 (or \$8).[15] The probability of incurring a loss in Lottery B, the risky lottery, is alternatively 0.29 or 0.59; the probabilities for the safe lottery remain unchanged.

Having both the standard lottery task and the lottery task with endogenous risk allows us to test for framing effect when risk is exogenous and endogenous. We test whether estimated risk aversion coefficients and subjective beliefs, recovered from the two tasks, are identical.

[15] In the WTP task in the VR experiment we have 3 treatments: initial credit of \$80 with house valued at \$38; initial credit of \$60 with the house valued at \$28; initial credit of \$20 with the house valued at \$18. In the lottery task with endogenous risk, we do not include the treatment with an initial credit of \$60 and maximum WTP of \$28.

B. Estimation Method

We first review the method of estimating risk attitudes using EUT. Then we discuss the procedure for jointly estimating belief and risk attitudes using the WTP and the betting mechanisms. This involves allowing beliefs to be subjective in the Subjective EUT (SEUT) sense.

I. Estimating Risk Attitude under EUT

Assume for the moment that utility of income is defined by

$$U(x) = x^{(1-r)}/(1-r)$$

where x is the lottery prize and $r \neq 1$ is a parameter to be estimated.[16] Thus, r is the coefficient of constant relative risk aversion (CRRA): $r = 0$ corresponds to risk neutrality, $r < 0$ to risk loving, and $r > 0$ to risk aversion. Let there be K possible outcomes in a lottery. If the probability of outcome k is p_k, expected utility (EU) is simply the probability weighted utility of each outcome in each lottery i:

$$EU_i = \sum_{k=1,K} (p_k \times U_k)$$

The choice depends on the difference in EU between the right and the left lotteries.

$$\nabla EU = EU_R - EU_L$$

where EU_R is the "right" lottery and EU_L is the "left" lottery as presented to the subject. This latent index, based on latent preferences, is then linked to the observed choices using a standard cumulative normal distribution function $\Phi(\nabla EU)$. This "probit" function takes any argument

[16] For r =1, assume $U(x) = \ln(x)$ if needed.

between $\pm\infty$ and transforms it into a number between 0 and 1 using the function shown in Figure 3. Thus we have the probit link function,

prob (choose lottery R) = $\Phi(\nabla EU)$

This function forms the link between the observed binary choices, the latent structure generating the index, and the probability of that index being observed. The logistic function is very similar to the probit, as illustrated in Figure 3, and leads instead to the "logit" specification.

In the standard lottery task the latent index is the difference in EU between the right and left lottery, and the observed choice is the choice of the right or left lottery. The conditional log-likelihood function is:

$$\ln L(r; y.X) = \sum_i [(\ln \Phi(\nabla EU) \times I(y_i = 1)) + (\ln(1 - \Phi(\nabla EU)) \times I(y_i = -1))]$$

where $I(.)$ is the indicator function and $y_i = 1$(-1) indicates the choice of right (left) lottery.[17] The only variable that has to be estimated from this log-likelihood function is r.

An important extension of the core model is to allow subjects to make errors in the decision process. The notion of error is one that has already been encountered in the form of the statistical assumption that the probability of choosing a lottery is not 1 when the EU of that lottery exceeds the EU of the other lottery. This is implicitly assumed when one adopts a link function, of the kind shown in Figure 3, to go from the latent index to observed choices. The contextual error specification, suggested by Wilcox (2009), introduces a normalizing term ν for each lottery pair, and a structural "noise parameter" μ to allow for error from the deterministic EU model:

[17] This ignores the possibility of indifference between the two lotteries.

$$\nabla EU = [(EU_R - EU_L)/\nu]/\mu$$

The normalizing term ν is defined as the maximum utility over all prizes in this lottery pair minus the minimum utility over all prizes in this lottery pair, and ensures that the normalized EU difference $(EU_R - EU_L)/\nu$ remains in the unit interval. This normalization allows one to define robust measures of "stochastic risk aversion," in parallel to the deterministic concepts from traditional theory. Notice that when $\mu = 1$ we return to the original specification without error. As μ increases, the above index falls until, at $\mu = \infty$, it collapses to zero, so that the probability of either choice becomes ½. In other words as the noise in the data increases, the model has less and less predictive power until at the extreme the prediction collapses to fifty-fifty or equal likelihood of both choices.

To allow for subject heterogeneity with respect to risk attitudes, the parameter *r* is modeled as a linear function of observed individual characteristics of the subject. For example, assume that we only had information on the age and sex of the subject, denoted age (in years) and female (0 for males, and 1 for females). Then we would estimate the coefficients α, β and η in $r = \alpha + \beta \times \text{age} + \eta \times \text{female}$.

In this design multiple responses are elicited from each subject. This may lead to clustering, or heteroskedasticity. Therefore while estimating the model it is essential to correct for clustering effects.[18]

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[18] Clustering commonly arises in national field surveys from the fact that physically proximate households are often sampled to save time and money, but it can also arise from more homely sampling procedures. At the time of estimation we need to allow for heteroskedasticity between and within clusters, as well as autocorrelation within clusters..

II. Jointly Estimating Belief and Risk Attitudes

The responses to the belief elicitation task can be used to estimate the subjective probability that each subject holds if we are willing to assume something about how they make decisions under risk.

If the subject is assumed to be risk neutral, then we can directly infer the subjective probability from the report of the subject. For instance, in Table 2 we can study the logic if we assume that the subjective belief about the probability of the house burning is 0.75. If the subject is risk neutral he chooses to bet on A until row seven where the expected value of A is 1.07 and the expected value of B is 0.24. Beyond this point the expected value of B exceeds the expected value of A and he chooses B over A. The switch occurs in the interval where the probability of A is between 0.7 and 0.8, since the true belief 0.75 lies in this interval. Thus assuming risk neutrality allows us to recover the interval in which the true subjective belief lies.

What happens when we allow for risk aversion in this model? If the subject reports θ his EU is given by

$$EU_{\theta} = \pi_A \times U \text{ (payout if A occurs | report } \theta)$$

$$+ (1-\pi_A) \times U \text{ (payout if B occurs |report } \theta)$$

where π_A is the subjective probability that A will occur. The example in the second row of Table 1 now becomes

$$EU_{safe} = (1-\pi_{safe}) \times (38)^{(1-r)} /(1-r) + \pi_{safe} \times U(20)^{(1-r)} /(1-r)$$

and

$$EU_{risky} = (1-\pi_{risky}) \times (40)^{(1-r)} /(1-r) + \pi_{risky} \times (22)^{(1-r)} /(1-r)$$

where π_{safe} is the subjective probability of the house burning down when prescribed burning is implemented and π_{risky} is the subjective probability that the house will burn down if no prescribed burning is implemented.

Now suppose, for example, that the subject is risk averse with a CRRA coefficient of 0.57. Figure 4 shows the difference between the true subjective belief and the reported switch point for this example. The risk neutral agent switches at the house probabilities equal to his beliefs while the risk averse subject switches at lower probabilities, when the true subjective belief is below 0.5, and higher probabilities when the true subjective belief is above 0.5. If the subject's true belief is 0.75, we can see from the Figure 4 that he will report the considerably higher value of 0.93. In order to avoid this distortion, we jointly estimate risk attitude and subjective beliefs. This extension is fairly simple.

The latent index in this problem is again the difference in EU from paying for prescribed burning and not paying for prescribed burning:

$$\nabla EU = [(EU_{safe} - EU_{risky})/\nu]/\mu$$

Apart from r we now need to estimate the two beliefs π_{safe} and π_{risky}. The joint maximum likelihood problem is to find the values of these parameters that best explain observed choices in the belief elicitation tasks as well as observed choices in the lottery tasks.

C. Results

The sample consists of 35 subjects recruited from the student population of the University of Central Florida. All experiments were conducted in May and June, 2009. First we present an analysis of raw data followed by formal statistical estimation.

I. Analysis of Raw Data

Our design tests whether there is a framing effect of presenting the tasks in the loss domain rather than the gain domain. Table 3 shows the instrument for the standard lottery task in the gains domain. The test for risk attitude is the interval in which a subject switches from the safe (left lottery) to the risky lottery (right lottery). A risk neutral subject will switch after row five, which is between the probabilities 0.5 and 0.4 for the safe lottery. A risk averse subject will switch later and a risk loving subject will switch earlier.

Holt and Laury (2008) find evidence of risk averse behavior in the gain domain and risk loving behavior in the loss domain. Our results do not show this "reflection effect." Risk attitudes are nearly identical in each domain in our data, as demonstrated in Figure 5. There is evidence of risk aversion in the population, with the highest concentration of switch points in the interval between 0.4 and 0.3 for the safe lottery. There is, however, sufficient heterogeneity around this point, with five of the choices being at the risk neutral 0.5 level and five choices in the gain domain and four in the loss domain in the 0.3 to 0.2 interval.

A majority of the subjects had consistent choice in the two domains: that is, they chose the same interval in the gain domain task and loss domain task. Beyond these 17 fully consistent subjects, 24 subjects were within a 0.1 probability interval of their choice in the gain domain when making their choice in the loss domain.

In addition to the standard lottery tasks, each subject completed lottery tasks with endogenous risk or WTP tasks where probabilities for the different prizes are given. These are identical to the WTP tasks in the VR scenario except for the fact that in the latter tasks the subjects form their own subjective beliefs about the risk of the house burning, while in the former tasks the risks are objectively given. Figure 6 compares the maximum WTP in the two treatments where the initial credit is $40 and the house is worth $38. A risk neutral subject will choose to pay a maximum of $8, beyond which the expected value of the risky lottery exceeds the expected value of the safe lottery. There is evidence of risk aversion in our data since the WTP peaks at $16.

The VR data is bi-modal. We find that 7 subjects have a maximum WTP of $18, slightly higher than the $16 reported in the lottery task. The more striking result is that 8 of the 35 subjects choose to pay $38, an amount equivalent to the value of the house. This suggests extreme subjective beliefs about the effectiveness of prescribed burning in reducing the risk of the house burning. It is almost as if the house is certain to burn without prescribed burning but is sure to be spared if prescribed burning is undertaken.

A different set of beliefs can be recovered from the betting tasks. Assuming risk neutrality again, we can estimate the subjective beliefs about the risk of the house burning directly from the choices made in the betting task. Figure 7 show the beliefs recovered from the betting tasks under the assumption, which we relax later. Beliefs for the high fuel load condition are clearly higher than beliefs for a low fuel load condition. Most bets are placed in the interval between 0.5 and 0.6 for the high fuel load condition and between 0.3 and 0.2 for the low fuel load condition, indicating that the subjective beliefs lay in that interval. In our VR simulation, the objective probabilities are 0.29 and 0.06, implying that the elicited subjective beliefs are higher than the objective beliefs. We turn now to the formal statistical estimation to check the results suggested by examining the raw data, without correcting for risk aversion.

II. Estimation

The covariates we use are all binary, except age, and reasonably self-explanatory. The variable wtp is a dummy for whether (=1) or not the task involves a WTP table, and hence reflects an endogenous risk setting; loss is a dummy variable for whether (=1) or not the task is presented in the loss frame; betfirst is a dummy for whether the WTP tasks came first (=1) or not; age is given in years over 17; female is a dummy for whether the subject is female (=1) or male; hispanic is a dummy for Hispanic heritage (=1); business is whether or not the subject is a business major (=1 if the subject is a business major); GPAhigh is for subjects with a self-reported GPA higher than 3.24 (=1); works is a dummy for whether (=1) or not the subject is employed. Female, hispanic, age, business, GPAhigh and works are demographic characteristics that we control for in the two later experiments as well.

Using the specification described in the earlier section for the lottery tasks, we find no evidence of framing effects, and evidence of modest risk aversion, consistent with a large body of existing literature (e.g., Holt and Laury (2002)(2005), Harrison, Johnson, McInnes and Rutström (2005) and Harrison and Rutström (2008)). Maximum likelihood estimates of the EUT model are presented in Table 5.[19] There is no framing effect of the task being presented in the loss frame rather than the familiar gain frame of standard lottery tasks.[20] Nor is there any evidence of an order effect between lottery tasks and betting tasks. The average predicted CRRA value for this sample is 0.32, implying modest risk aversion, but there is sufficient heterogeneity

[19] We also evaluated extensions of the CRRA utility specification to allow for increasing or decreasing RRA over the prize domain, using the expo-power specification employed by Holt and Laury (2002). There is no evidence of non-CRRA behavior in this domain. Nor are there any differences in the qualitative conclusions about framing effects and the role of endogenous risk. For these reasons we use the simpler CRRA specification throughout.

[20] One could extend this analysis to include a formal estimation of loss aversion, but for reasons explained at length in Harrison and Rutström (2008; §3.2.3) and Harrison and Rutström (2009), we do not want to do so casually.

in the sample that one cannot rule out risk neutrality on average (the 95% confidence interval on the predicted CRRA is between -0.37 and 1.01). It would be inappropriate to assume risk neutrality for all subjects, because we want the risk attitudes of different subjects to condition their inferred subjective beliefs; to assume $r = 0$ for every subject, with no standard error, would mis-characterize the true distribution of risk attitudes across the sample.

Detailed estimates are contained in Tables 6 and 7, and displayed in Figures 4 and 5. In addition to the same covariates as in Table 5, we also employ interactions of the central wtp dummy with demographic characteristics. The estimates of the subjective probabilities reported here as pLO and pHI refer to a standard non-linear, log-odds transformation[21] to ensure that the latent probabilities π_{safe} and π_{risky}, respectively, fall between 0 and 1 while the estimated parameters pLO and pHI are unbounded; hence a value of 0 reflects a probability of ½, and a positive (negative) coefficient reflects a probability below (above) ½.

Table 6 assumes that the same risk attitudes and subjective beliefs apply to the exogenous and endogenous risk settings, and Table 7 allows each to vary with the setting. Our main hypothesis is that there is no effect from allowing these to vary with the setting. Figures 8 and 9 display kernel density functions of the predicted subjective probability for each subject in each setting. These densities do not reflect the standard errors in the parameter values, which are shown in Tables 6 and 7. Hence formal hypothesis tests must rely on the quantitative estimates, and not these pictures.

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[21] If we estimate the parameter τ then the transformation to the probability π is $\pi = 1/(1+\exp(\tau))$. So π_{safe} = 1/(1+exp(pLO)) and π_{risky} = 1/(1+exp(pHI)).

We find evidence of approximately linear utility functions, although the variability across the sample is large. The observed CRRA coefficient is smaller when there is endogenous risk, as shown by the coefficient on the dummy variable wtp in Table 7, but this is not statistically significantly different from zero and has a *p*-value of 0.68. So we conclude that risk attitudes are not source dependent.

Turning to subjective beliefs, we find a statistically significant effect from endogenous risk on each of the two subjective probability values estimated. Formally these involve hypothesis tests of the joint restriction that all of the wtp-interaction terms on pHI or pLO are jointly and simultaneously zero. The null hypothesis that these coefficients are all zero can be rejected for pHI, for pLO, and for pHI and pLO taken together. Figure 9 shows that the overall effect is to make the subjective belief distributions move towards the extremes as we allow for endogenous risk settings. It is as if the option of risk mitigation is *subjectively* moving a risky environment towards a non-risky environment, which is exactly what one wants to do when "managing" risk. On the other hand, the conversion to a non-risky environment is not complete, nor should it be if it is too subjectively costly in terms of EU to do so.

D. Conclusion

Risk attitudes and subjective beliefs are two fundamental determinants of decision making under risk. Virtually all settings in which there is risk involve what we refer to here as endogenous risk, rather than the exogenous risk that is commonly studied. Our results provide evidence that behavior is different in these two environments. There do not appear to be significant differences in attitudes to risk, but subjective beliefs are very different. Our design provides the simplest setting in which these structural effects can be untangled.

Table 1. Inferred WTP Instrument when Initial Credit is $40 and the House is Valued at $18

Lottery A				Lottery B				EV^A	EV^B	Difference
p(safe)		p(burn)		p(safe)		p(burn)				
0.06	-18	0.94	0	0.29	-18	0.71	0	-1.08	-5.22	4.14
0.06	-20	0.94	-2	0.29	-18	0.71	0	-3.08	-5.22	2.14
0.06	-22	0.94	-4	0.29	-18	0.71	0	-5.08	-5.22	0.14
0.06	-24	0.94	-6	0.29	-18	0.71	0	-7.08	-5.22	-1.86
0.06	-26	0.94	-8	0.29	-18	0.71	0	-9.08	-5.22	-3.86
0.06	-28	0.94	-10	0.29	-18	0.71	0	-11.08	-5.22	-5.86
0.06	-30	0.94	-12	0.29	-18	0.71	0	-13.08	-5.22	-7.86
0.06	-32	0.94	-14	0.29	-18	0.71	0	-15.08	-5.22	-9.86
0.06	-34	0.94	-16	0.29	-18	0.71	0	-17.08	-5.22	-11.86
0.06	-36	0.94	-18	0.29	-18	0.71	0	-19.08	-5.22	-13.86

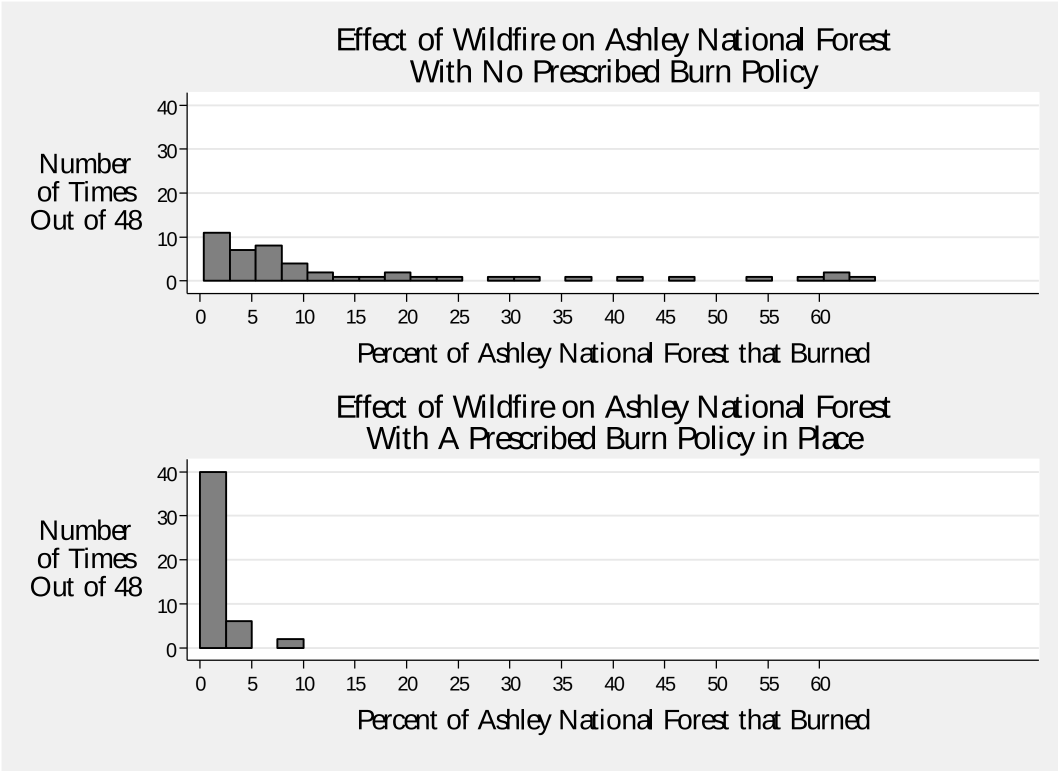

Figure 1. Histogram Displaying Distribution of Forest that Burned

Figure 2. Illustrative Images from VR Interface

Table 2. Betting Task with Stake of $1

Assume subject has a personal belief that A will occur with probability 0.75

Bet on A and…				Bet on B and…				Gross expected value of betting		
	A occurs		B occurs		A occurs		B occurs	on A	B	
0.75	$10	0.25	$0	0.75	$0	0.25	$1.11	7.50	0.28	7.22
0.75	$5	0.25	$0	0.75	$0	0.25	$1.25	3.75	0.31	3.44
0.75	$3.33	0.25	$0	0.75	$0	0.25	$1.43	2.50	0.36	2.14
0.75	$2.5	0.25	$0	0.75	$0	0.25	$1.67	1.88	0.42	1.46
0.75	$2	0.25	$0	0.75	$0	0.25	$2	1.50	0.50	1.00
0.75	$1.67	0.25	$0	0.75	$0	0.25	$2.5	1.25	0.63	0.63
0.75	$1.43	0.25	$0	0.75	$0	0.25	$3.33	1.07	0.83	0.24
0.75	$1.25	0.25	$0	0.75	$0	0.25	$5	0.94	1.25	-0.31
0.75	$1.11	0.25	40	0.75	$0	0.25	$10	0.83	2.50	-1.67

Table 3. Standard Lottery Task in Gains Domain

Lottery A				Lottery B				EV^A	EV^B	Difference
p($24)		p($26)		p($1)		p($50)				
1	24	0	26	1	1	0	50	24	1	23
0.9	24	0.1	26	0.9	1	0.1	50	24.2	5.9	18.3
0.8	24	0.2	26	0.8	1	0.2	50	24.4	10.8	13.6
0.7	24	0.3	26	0.7	1	0.3	50	24.6	15.7	8.9
0.6	24	0.4	26	0.6	1	0.4	50	24.8	20.6	4.2
0.5	24	0.5	26	0.5	1	0.5	50	25	25.5	-0.5
0.4	24	0.6	26	0.4	1	0.6	50	25.2	30.4	-5.2
0.3	24	0.7	26	0.3	1	0.7	50	25.4	35.3	-9.9
0.2	24	0.8	26	0.2	1	0.8	50	25.6	40.2	-14.6
0.1	24	0.9	26	0.1	1	0.9	50	25.8	45.1	-19.3

Table 4. Standard Lottery Task in the Loss Domain with Initial Credit of $50

Lottery A				Lottery B				EV^A	EV^B	Difference
p(-$26)		p(-$24)		p(-$49)		p(-$0)				
1	-26	0	-24	1	-49	0	-0	-26	-49	23
0.9	-26	0.1	-24	0.9	-49	0.1	-0	-25.8	-44.1	18.3
0.8	-26	0.2	-24	0.8	-49	0.2	-0	-25.6	-39.2	13.6
0.7	-26	0.3	-24	0.7	-49	0.3	-0	-25.4	-34.3	8.9
0.6	-26	0.4	-24	0.6	-49	0.4	-0	-25.2	-29.4	4.2
0.5	-26	0.5	-24	0.5	-49	0.5	-0	-25	-24.5	-0.5
0.4	-26	0.6	-24	0.4	-49	0.6	-0	-24.8	-19.6	-5.2
0.3	-26	0.7	-24	0.3	-49	0.7	-0	-24.6	-14.7	-9.9
0.2	-26	0.8	-24	0.2	-49	0.8	-0	-24.4	-9.8	-14.6
0.1	-26	0.9	-24	0.1	-49	0.9	-0	-24.2	-4.9	-19.3

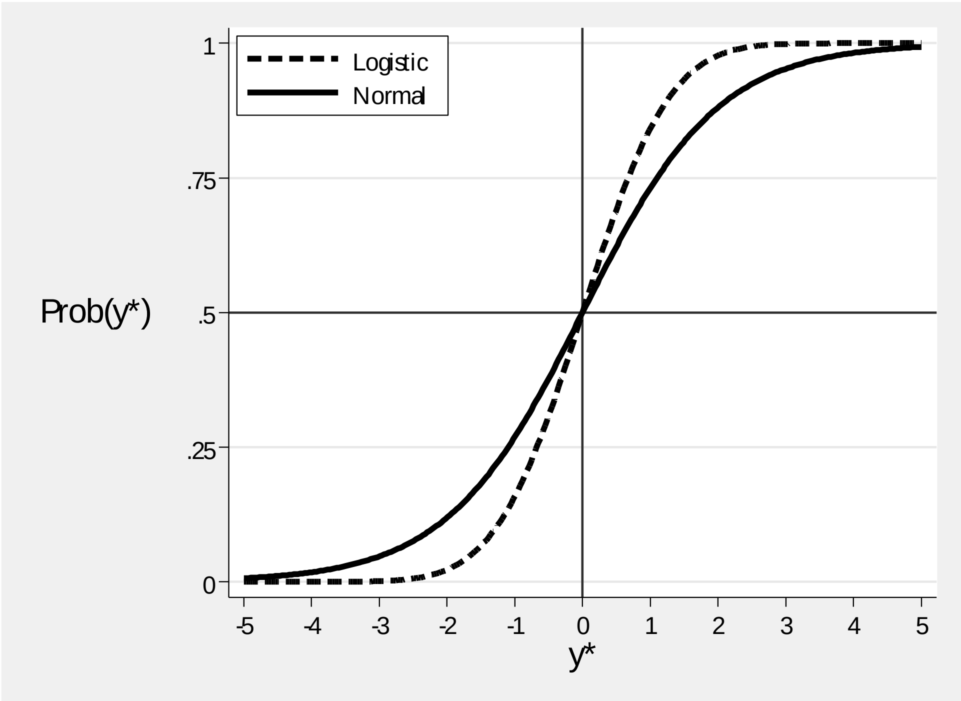

Figure 3. Normal and Logistic Cumulative Density Function

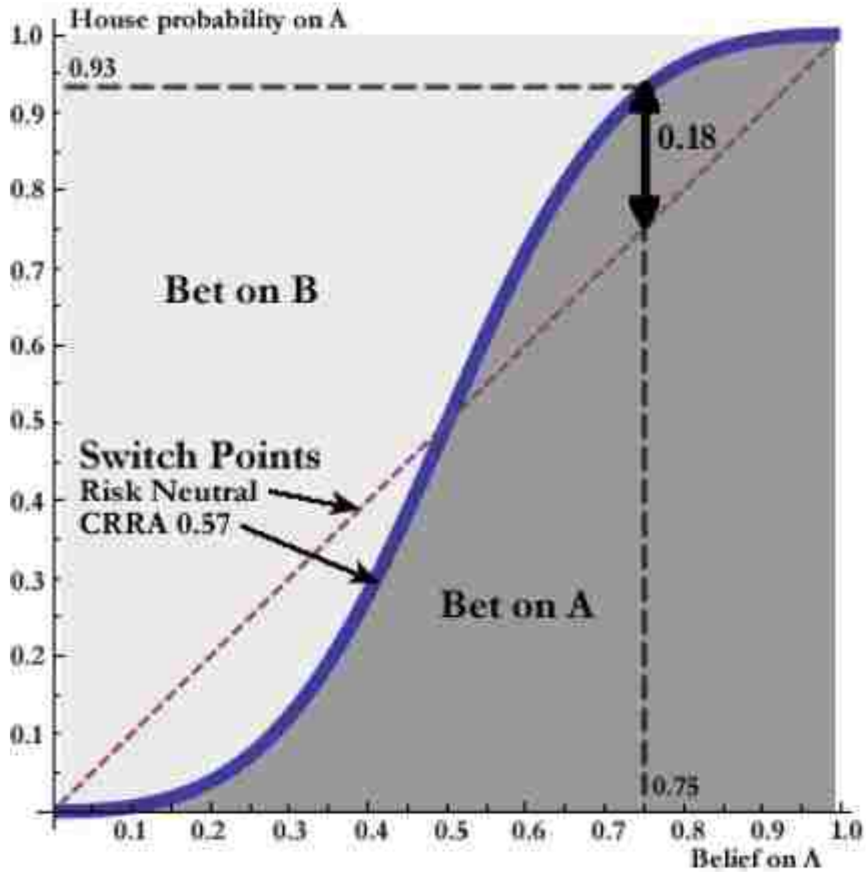

Figure 4. Report of the Risk Averse Individual with true belief 0.75

Figure 5. Comparison of Lottery Choices made in the Gain and Loss Domains

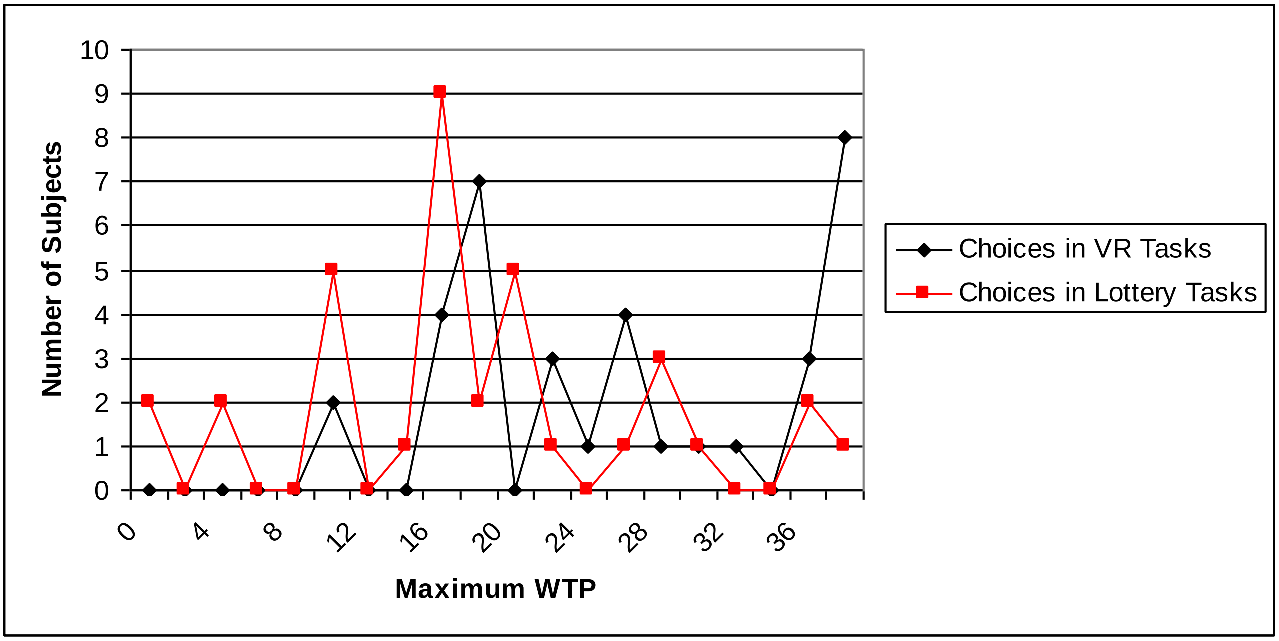

Figure 6. Comparison of Maximum WTP in VR and Lottery Tasks

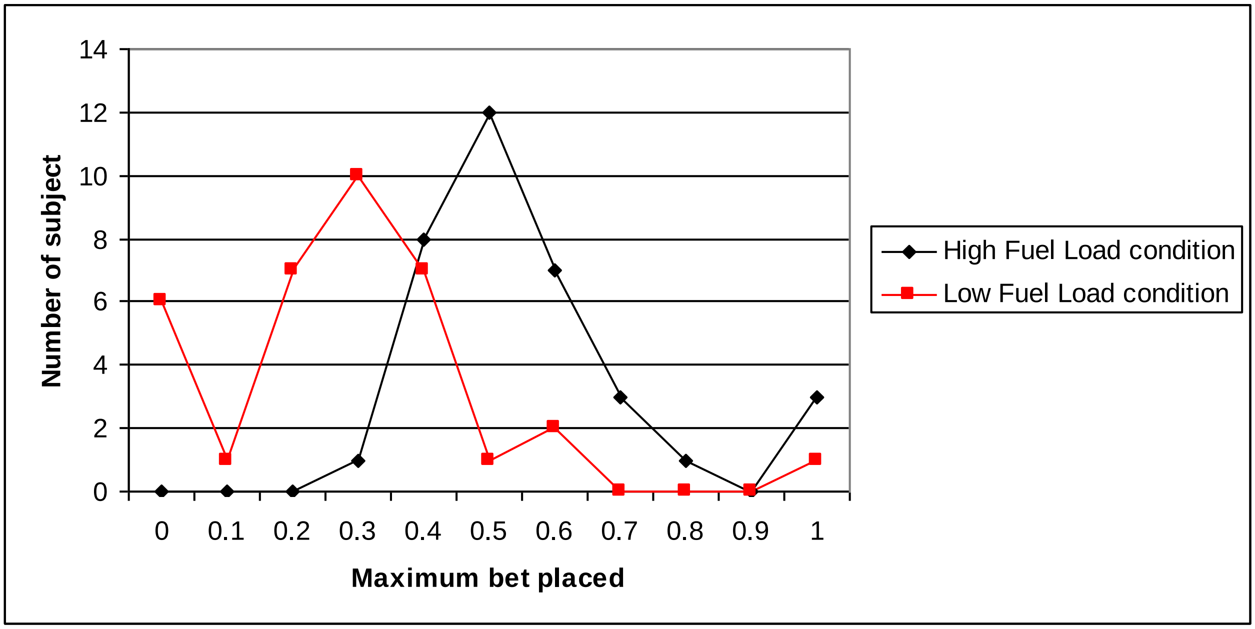

Figure 7. Beliefs recovered from Betting Tasks assuming Risk Neutrality

Table 5. Maximum Likelihood Estimate of Risk Attitudes

Parameter	Variable	Point Estimate	Standard Error	p-value	Lower 95% Confidence Interval	Upper 95% Confidence Interval
r	Constant	0.32	0.35	0.36	-0.37	1.01
	Loss	0.03	0.16	0.84	-0.28	0.34
	Betfirst	0.20	0.22	0.36	-0.23	0.62
	Age	0.02	0.02	0.20	-0.01	0.06
	Female	-0.17	0.18	0.34	-0.52	0.18
	Hispanic	0.04	0.33	0.91	-0.62	0.69
	Business	-0.14	0.19	0.45	-0.51	0.23
	GPAhigh	0.33	0.27	0.23	-0.21	0.87
	Works	-0.56	0.26	0.03	-1.07	-0.06
μ	Constant	-1.29	0.20	0.00	-1.69	-0.89

Table 6. Joint Estimate of Risk Attitudes and Subjective Beliefs

Parameter	Variable	Point Estimate	Standard Error	p-value	Lower 95% Confidence Interval	Upper 95% Confidence Interval
r	Constant	0.20	0.25	0.43	-0.30	0.70
	Age	0.01	0.02	0.53	-0.03	0.05
	Female	-0.14	0.15	0.34	-0.44	0.15
	Hispanic	-0.01	0.20	0.94	-0.41	0.39
	Business	-0.26	0.17	0.12	-0.59	0.07
	GPA high	0.32	0.22	0.15	-0.11	0.75
	Works	-0.41	0.23	0.04	-0.81	-0.02
pHI	Constant	-1.16	0.34	0.00	-1.82	-0.50
	Age	0.05	0.02	0.02	0.00	0.09
	Female	0.43	0.47	0.37	-0.50	1.35
	Hispanic	0.55	0.37	0.13	-0.16	1.27
	Business	-0.87	0.43	0.04	-1.71	-0.02
	GPA high	0.12	0.45	0.79	-0.77	1.01
	Works	-0.18	0.53	0.73	-1.22	0.85
pLO	Constant	15.48	10.46	0.14	-5.02	35.99
	Female	-0.71	0.94	0.45	-2.55	1.14
	Hispanic	14.35	10.85	0.19	-6.92	35.61
	Business	-1.11	1.57	0.48	-4.20	1.97
	GPA high	-13.11	10.01	0.19	-32.72	6.51
	Works	-0.29	1.17	0.80	-2.60	2.00
μ	Constant	-0.94	0.19	0.00	-1.31	-0.57
	Risk	-0.29	0.31	0.35	-0.90	0.32

Table 7. Joint Estimate of Risk Attitudes and Subjective Beliefs

Parameter	Variable	Point Estimate	Standard Error	p-value	Lower 95% Confidence Interval	Upper 95% Confidence Interval
r	Constant	0.17	0.25	0.50	-0.32	0.67
	WTP	-0.23	0.56	0.68	-1.33	0.87
	Age	0.01	0.02	0.45	-0.02	0.05
	Female	-0.16	0.14	0.26	-0.44	0.12
	Hispanic	-0.12	0.19	0.55	-0.50	0.26
	Business	-0.21	0.15	0.16	-0.50	0.08
	GPA high	0.43	0.24	0.08	-0.48	0.91
	Works	-0.40	0.19	0.03	-0.78	-0.03
pHI	Constant	1.06	0.27	0.00	-1.60	-0.53
	WTP×age	0.00	0.03	0.99	-0.06	0.06
	WTP×female	-0.72	0.81	0.38	-2.31	0.88
	WTP×hispanic	-0.11	0.98	0.91	-2.04	1.81
	WTP×business	-2.48	1.56	0.11	-5.54	0.58
	WTP×GPA high	-0.09	0.67	0.90	-1.40	1.22
	WTP×works	0.87	0.63	0.17	-0.36	2.11
	Age	0.03	0.02	0.08	-0.00	0.06
	Female	0.51	0.25	0.04	0.01	1.00
	Hispanic	0.27	0.08	0.32	-0.27	0.82
	Business	0.25	0.31	0.41	-0.35	0.85
	GPA high	0.12	0.36	0.75	-0.60	0.83
	Works	-0.12	0.27	0.66	-0.64	0.40
pLO	Constant	15.23	0.97	0.00	13.33	17.13
	WTP×age	0.79	0.42	0.06	-.03	1.61
	WTP×female	-3.07	1.30	0.02	-5.61	-0.53
	WTP×hispanic	0.00	1.53	1.00	-3.00	3.00
	WTP×business	-1.82	1.40	0.19	-4.56	0.91
	WTP×GPA high	0.22	1.51	0.88	-2.75	3.19
	WTP×works	4.24	1.73	0.01	0.84	7.64
	Age	0.01	0.02	0.69	-0.03	0.04
	Female	-0.45	0.28	0.11	-1.00	0.11
	Hispanic	14.34	.	.	.	.
	Business	-0.96	0.61	0.12	-2.16	0.25
	GPA high	-13.36	.	.	.	.
	Works	-0.47	0.47	0.31	-1.40	0.44
μ	Constant	-1.10	0.17	0.00	-1.44	0.76
	Risk	-0.11	0.30	0.72	-0.70	0.48

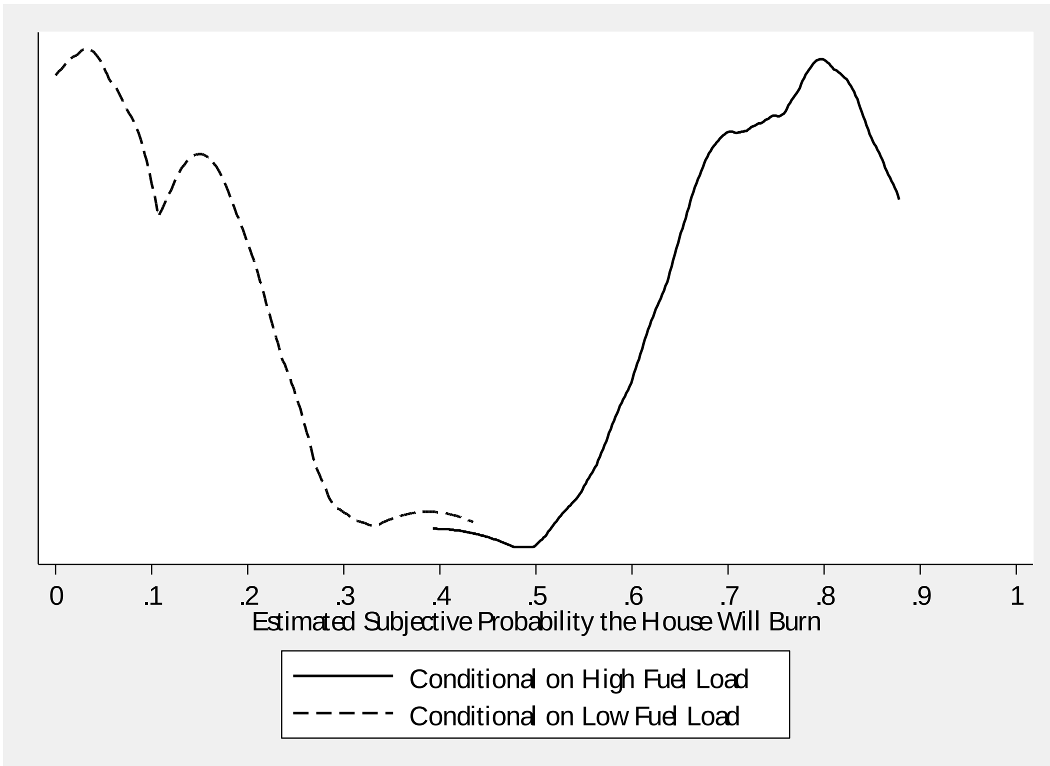

Figure 8. Estimated Subjective Probabilities of House Burning if Homogeneous Beliefs and Risk Attitudes Assumed

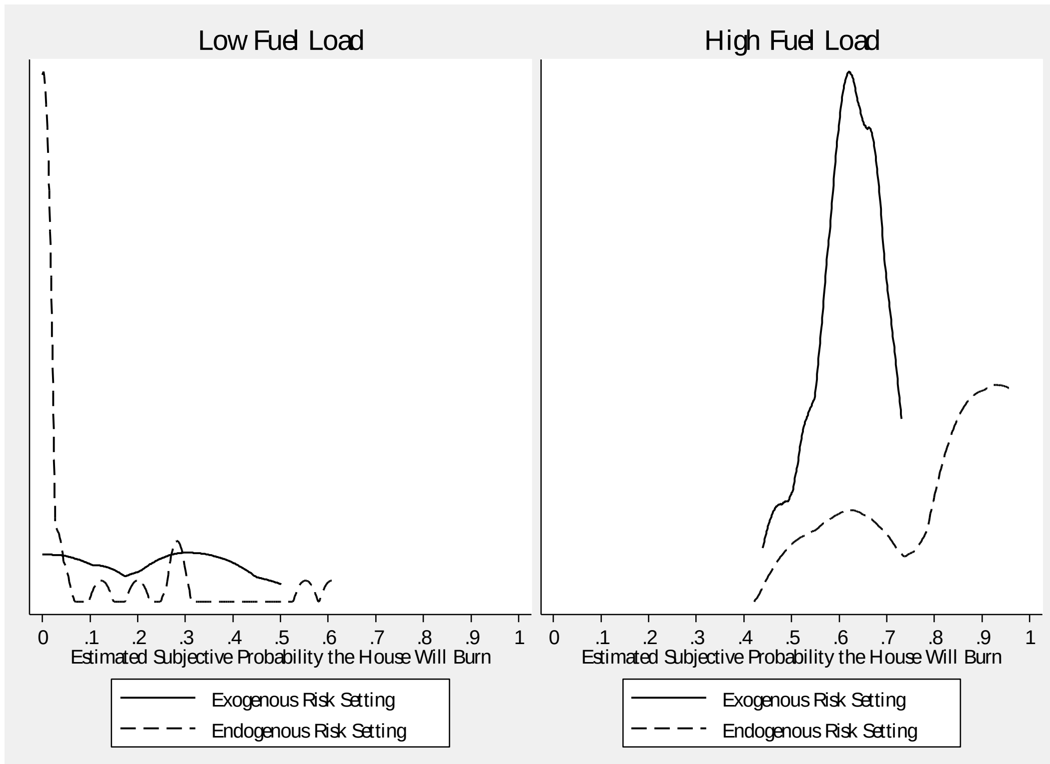

Figure 9. Estimated Subjective Probabilites of House Burning if Heterogeneous Beliefs and Risk Attitudes Allowed

3: LONG RUN INDIVIDUAL EXPERIMENT: EFFECT OF EXPERIENCE ON BELIEFS.

This chapter reports the long run individual experiment where subjects are able to form their own beliefs about the risk of property burning when there may or may not be a fire in any round. As discussed in the previous chapter, a fire *always* occurs in the short run individual experiment. Therefore, the subject has to only consider the risk of the property burning in a fire and not the frequency of forest fires. Natural disasters, however, are infrequent events. For instance, in any particular city, township or location in Central Florida a major forest fire occurs once every 20 years or so. This implies that in any given year there is only a 5% probability of a fire. The additional criteria to be considered, frequency of forest fires, makes the decision in the long run experiment more difficult, but also closer to the real life decisions people face. Given that fire may or may not occur in any particular year, this design allows us to study how the actual occurrence of a fire affects perception about the risk of the property burning. Risk is endogenous, as before, and paying for prescribed burning reduces the risk of the house burning in the event of a fire.

This chapter has two sections – experimental design and results.

A. Experimental Design

All subjects participating in this experiment are required to attend two sessions: an individual session where they make economic decisions that have monetary consequences only for themselves, and a group session where their decisions have consequences for other people in the group as well. This chapter reports the results for the individual sessions, while the results for the group sessions are reported in the next chapter. In order to control for order effects, some subjects face the individual experiment before the group experiment while others face the group experiment first followed by the individual experiment. To ensure that subjects come back for the second session, subjects are paid for both sessions at the end of the second session. The only payment made at the end of the first session is the $5 show up fee for that session.

The risk of the house burning in any particular year depends on both the probability of the house burning when a fire always occurs and the probability of a fire in any particular year. To continue with the example of Central Florida, this modifies the original model set up in chapter 1 as follows:

$$EU = 19/20*[[1-P(\rho,s)]U(Y-s)]+1/20*[P(\rho,s)U(Y-d-s)]$$

where *s* is the self protection expenditure made. This substantially alters the odds of the house burning and is likely to have an effect on the WTP for prescribed burning.

Table 8 further illustrates this point. It is worth noting that when a fire *always* occurs, there is a substantial difference in the probability that the house will burn with and without prescribed burning, making it likely that subjects pay for prescribed burning. However, in our long run individual experiment a fire occurs only once in 20 years. This drastically alters the probability of the house burning. While prescribed burning reduces the risk of the house burning from 65% to 27% when a fire always occurs, and this information is given to the subjects as part of their instructions, the risk of the house burning down when a fire may or may not occur only reduces from 3% to 1%. There are interesting behavioral implications of this change and how it affects the WTP of a subject to reduce the risk. Given that the risk is so low, do they simply choose to ignore it? We test to check how accurate these beliefs are, and if subjects overlook the risk altogether.

Hallstrom and Smith (2005) (HS) model hypothesize that an actual experience of a natural disaster conveys new information to the subjects and increases their WTP to reduce the risk of damage, i.e., $\partial s / \partial I > 0$. Our current experimental set up allows us to test this hypothesis. We simply need to test if the belief about the risk of the house burning in rounds following the actual fire is higher than the comparable belief about the risk of the house burning before the fire.

Belief about the risk of the house burning depends on the risk of the house burning when a fire always occurs and the frequency of fires. Subjects perform an additional task to allow us to identify their beliefs about the risk of the house burning when a fire always occurs. This is the betting task used in the earlier experiment for the same purpose, for eliciting beliefs about the house burning when a fire *always* occurs. As before, subjects bet on the probability of the house burning with and without prescribed burning. The 2 betting tasks – one with and one without prescribed burning are performed together; once at the beginning of the experiment to elicit beliefs before experiencing a fire, and once immediately after the fire to elicit beliefs after experiencing a fire.

Inorder to control for risk attitudes, we also elicit subject's risk attitudes. Along with the standard lottery task used to elicit individual risk attitude we also elicit social risk attitude. This elicits risk attitude where the lottery choices made affects not only the individual making the choices but also two others in his group. Subjects are paid for one task picked at random.[22]

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[22] The procedure for picking the task to be paid is identical to that described in the previous chapter. Subjects face 24 envelopes numbered 1 through 24 and 24 empty envelopes. Each card is placed in one of the unmarked

I. WTP Tasks in 20 Rounds of the Long Run Individual Experiment

The WTP tasks are very similar to the ones in the short run individual experiment. There are two alternative treatments which differ in the prize amounts. In the lower treatment, each subject is given an initial endowment of $40 and "ownership" of the house valued at $40 that is the total endowment is $80. In each round there is some possibility of a fire occurring. If no fire occurs or a fire does occur but the house does not burn, the subject sells his property at the end of the round and earns $40. On the other hand, if the house burns the subject cannot sell the house and he loses the $40.

Each subject can make an upfront payment for prescribed burning from their initial credit of $40. The subject can choose to pay the full $40 or nothing at all or anything in between in increments of $5. Paying for prescribed burning reduces the risk of the house burning. However, the decision to pay for prescribed burning has to be taken before the subject knows whether or not a fire occurs in a particular round. There is thus a trade off between forfeiting part of the initial credit to protect against the risk of the house burning or retaining the initial credit but facing a higher risk of the fire burning the house.

The treatment with the higher payoff is identical except now the house is worth $80 and the initial credit is $80, that is the total prize is $160. Like before, the subject is able to pay all or part of this initial credit for prescribed burning that reduces the risk of the house burning. If the house burns the subject loses the value of the house, $80.[23]

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envelopes and then the envelopes are shuffled. The subject picks one envelope that he opens at the end of the experiment to reveal the task he is paid for.

[23] The instructions for this experiment can be found in Appendix C. Appendix F contains a sample each for the $40 credit treatment and the $80 credit treatment.

There are 20 rounds of decision making. In each round, the subject first has to decide how much, if anything, to pay for prescribed burning. Next, it is revealed whether a fire occurs in that round. The mechanism for this is as follows: we have 20 envelopes numbered from 1-20 arranged in ascending order. In each round one of the envelopes is opened. If the card inside is red a fire occurs, and if it is white there is no fire. If a fire occurs the subject gets to roll a die to pick the background conditions of the fire we simulate. Payoff is determined by whether or not the house in the forest burns in this fire. If no fire occurs the subject moves on to the next round of decision making. The subject has to take a decision about how much to pay for prescribed burning before he knows whether a fire will occur in that round. Also, any payment made towards prescribed burning cannot be retrieved, even when a fire does not occur. The transaction is similar to purchasing insurance, except here the risk is reduced but not eliminated.

Rather than use an artificial devise like rolling of the die to determine the lightning pattern, we use the historic lightning strike pattern from the Lake Diaz area of Central Florida in the period between 1980-2009 to determine when lightning strikes. The instructions given to subjects clearly state this. We use the information contained in the Florida Division of Forestry websites for all major fires over the last 30 years (see http://www.fl-dof.com/wildfire/stats_significant_fires.html). This gives us a crisp one page summary of all major fires in Florida from an authentic source, and subjects are able to verify the fire pattern if they so wish at the end of the experiment.

The location we chose is Station 16, Volusia County in Central Florida. Between the years 1982 and 2001 the only fire was in 1998, in the 17th year. Since a fire in the 17th year is rather late in the twenty year cycle, this treatment allows subjects longer to develop a sense of security and therefore possibly to pay less towards self protection. An alternate treatment looks at the same area between the years 1988 and 2007. Here the fire occurs more towards the middle of the time horizon in the 11th year allowing less time for people to develop a sense of complacency.

As seen in Table 9 the instrument used for this task is slightly different from the short run individual experiment. Instead of asking the subject to circle “Yes” or “No” for each amount, they are asked to just circle the maximum amount they are willing to pay. This change in procedure is employed to make the design more compatible with the public goods experiment described in the following chapter.

II. Betting Task

In addition to the 20 WTP tasks that he faces, each subject completes 4 betting tasks. Two of the betting tasks are completed at the beginning of the experiment: one for the high fuel load condition or when prescribed burning has not been implemented, and another for the low fuel load case when prescribed burning has been implemented. The other two betting tasks, with and without prescribed burning, are performed immediately after the fire occurs. As is clearly stated in the instructions, if any one of the betting tasks is chosen for payment a fire is always simulated. While the simulations that determine the outcome of the WTP task immediately follow the task itself, the simulations for the belief tasks only occur at the end if that task is picked for payment.

The first set of betting tasks, performed at the beginning of the experiment, allow us to estimate the belief of the house burning when a fire always occurs, before any experience of the fire. Repeating the tasks after a fire occurs allows us to estimate any difference in these beliefs in response to the experience of a fire.

Instructions and instrument design are otherwise identical to those described in the previous chapter. As part of the instructions, we inform subjects that one set of betting tasks will be performed at the beginning of the experiment and another set immediately after a fire occurs. The subject is told that if no fire occurs, the second set of betting tasks will be performed at the end of the 20 rounds.

III. Standard Lottery Task

The standard lottery task is identical to the lottery task in the gain domain described in chapter 2. Since all subjects are required to attend both an individual session and a group session, they perform the lottery task only in the group session.

IV. Social Risk Attitude Task

The design for the social risk attitude task is adopted from Harrison, Lau, Rutström and Tarazona-Gómez (2005) (HLRT). This task tests whether subjects systematically use a different risk attitude in a social setting rather than when they are the only ones to bear the consequences. One of the objectives of our long run experiments is to compare beliefs in the individual experiment with beliefs in the group setting, controlling for risk attitudes. If the risk attitudes used in the two settings are different, we need to recognize that and elicit them separately. For this reason we included the social risk attitude task in our experiment design.

Subjects are divided into anonymous groups of 3. Each subject faces a multiple price list of choices between safe and risky lotteries identical to the instrument they face in the standard lottery task (Table 3). In each row the subject "votes" for the lottery he prefers. For the row that is chosen for payment, the lottery that gets the majority of the votes is played out. The final outcome is determined by the rolling of a 10-sided die by a volunteer in that group. Therefore, the crucial difference with the standard individual social risk task is that the subjects choices not only affect their own payoffs but also the payoffs of others in the group.

The instructions for the individual risk attitude task and the social risk attitude tasks are presented to the subject at the same time. Once the instructions have been red and any questions answered, an experimenter goes around the room distributing cards with numbers on them. The number on a subject's card determines what group he belongs to. Depending on the number of subjects, we have 2 or 3 groups in any experimental session. Subjects do not know the other members in their group and group membership is only revealed if the task is chosen for payment and the lottery task is played out.

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B. Results

The total number of subjects is 83. All experiments are conducted in University of Central Florida in January and February of 2010. Roughly 44% of the subjects are female, 62% are White and 10% Hispanic. 79% of the subjects are 22 or younger and 64% earn less than $15,000 annually. A substantial number of subjects had previous experience with a forest fire: 89% reported that a fire had come within 20 miles of their residence, 87% knew someone who had lost property in a fire, 29% have smelled smoke in a forest fire season, 16% have experienced reduced visibility while driving due to smoke from forest fire, and 19% say that they adopt mitigation behavior for reducing risk of property loss from forest fire.

We initially analyze the raw data using tables and graphs. Then we turn to results from the formal estimation model.

I. Analysis of Raw Data

A summary of the raw data reveals that the average WTP is fairly high (Table 10). More than 76% of the subjects are willing to pay a positive amount for prescribed burning. A majority of choices, 56%, are for $10 or more since these averages do not correct for risk attitudes, they still imply a fairly high belief that the house will burn since the risk of the house burning in any year is only reduced from 3% to 1% by undertaking prescribed burning.

There is very little evidence of a decline in WTP in successive rounds. Table 11 shows how WTP stays constant across periods with 42% to 49% of choices involving prescribed burning. Looking separately at the data for a fire in the 17^{th} year and a fire in the 11^{th} year, we find no evidence of change in WTP after the experience of a fire (Table 12). The only effect, rather surprisingly, is a decline in WTP after the 17^{th} year, which is especially prominent in the treatments where fire occurs in the 17^{th} year. It is almost as if subjects are expecting a fire in the 20 year period, and once that fire occurs they are "relieved" and do not expect another fire in the 3 remaining years.

We find that subjects believe the risk of the house burning to be higher under the high fuel load condition (no prescribed burning) than under the low fuel load condition (prescribed burning) as indicated by the choices made in the betting tasks. Assuming risk neutrality, a majority of subjects believe that there is a 60% chance of the house burning when no prescribed burning is done compared to only a 20% chance when prescribed burning is done (Table 14).

These are close to the actual probabilities of 65% and 27%. We also find no change in beliefs, recovered from the betting tasks assuming risk neutrality, in response to the fire.

II. Estimation

Maximum likelihood estimates of the EUT model assuming the expo-power function are presented in Table 15. The demographic variables are defined as before and the variable "social" indicates whether (=1) or not the risk attitude task affect only the individual or his group as a whole. The hypothesis that social risk attitude is different from individual risk attitude can be easily rejected (*p*-value is 0.38 > 0.10). We find evidence of moderate risk aversion, 0.29 similar to that found in the earlier experiment. Risk neutrality cannot be ruled out with a confidence interval between -0.16 and 0.74. For our estimation purpose, however, we do not rule out risk neutrality instead jointly estimating beliefs and risk attitudes because we want the risk attitudes of different subjects to condition their inferred subjective beliefs. With a *p* – value of 0.56, increasing relative risk aversion (IRRA) can be ruled out. Therefore, for the rest of the analysis we use a CRRA specification.[24]

The estimates from the betting task are presented in Table 16. These are the estimates recovered only by using the betting tasks. The estimates of the subjective probabilities reported here as *pLO* and *pHI* refer to a standard non-linear, log-odds transformation[25] to ensure that the latent probabilities π_{safe} and π_{risky}, respectively, fall between 0 and 1 while the estimated

[24] Estimates are also made for the Rank Dependent Expected Utility Model. There is evidence of probability weighting when Quiggins "power" weighting function is used but no evidence when the Tversky and Kahneman (1992)

[25] If we estimate the parameter τ then the transformation to the probability π is $\pi = 1/(1+\exp(\tau))$. So π_{safe} = 1/(1+exp(pLO)) and π_{risky} = 1/(1+exp(pHI)).

parameters pLO and pHI are unbounded; hence a value of 0 reflects a probability of ½, and a positive (negative) coefficient reflects a probability below (above) ½.

There is no effect of beliefs elicited before and after the experience of fire. Table 16 demonstrates this since the variable belief_after controlling for whether the belief is elicited before or after the fire is not significant. Fig. 10 gives a graphical rendition of the beliefs before a fire. A graph for the beliefs after the experience of a fire is very similar. Adding demographics does not affect the results. The recovered probabilities are π_{safe} 0.24 and π_{risky} 0.68, which are very close to the real probabilities 0.27 and 0.65 (Table 17). Therefore, we can conclude that the beliefs are accurate.[26]

Next, we estimate beliefs from the twenty WTP tasks. The two variables of interest here are 'fire' or whether or not a fire occurs immediately before this round and 'burn' whether or not the house burns in the fire. Experience of a fire directly preceding a round is not found to be significant indicating that the mere experience of a fire does not affect beliefs. Burn is significant (Table 18), but the relation is negative. This is puzzling since we expect that if the house burns subjects are likely to raise their beliefs about the probability of the house burning. What we find is the opposite, if the house burns subjects lower their perception of risk. One possible explanation is that subjects do not believe the risk of fire burning the house in each round to be truly independent. Even though this clearly violates the experimental setup carefully explained to subjects, it is possible that subjects are depending on the old saying – lightning does not strike twice at the same place. In that case, when the house burns down in one round it is less likely to do so in successive rounds. Adding demographics does not alter the basic result.

[26] The instructions for the experiment do state the probabilities when a fire always occurs and this suggests that subjects are able to extract this information from the instructions.

The latent probabilities in this regression are π_{safe} 0.58 and π_{risky} 0.99 (Table 19). This is higher than the objective estimates of 1% and 3% and the probabilities 0.24 and 0.68. Therefore, WTP tasks result in subjects having more extreme beliefs especially about the risky scenarios.

C. Conclusion

We find evidence that beliefs are not affected by merely experiencing a fire but only when the fire burns the simulated house in the forest. This seems to support the hypothesis that the experience of a natural disaster conveys new information about the risk thus resulting in an upward adjustment of perceptions. It helps to strengthen the anecdotal evidence that insurance coverage increases after natural calamities even when risk is not affected (hurricanes) or even declines (earthquakes) after the event.

Our experimental design does not have a metric to measure a near miss when a fire narrowly misses the house. This would be an interesting extension to the current design that would allow us to test if a particularly bad experience, even when it does not burn the house, affects beliefs. Also our design does not allow for variations in the extent of loss caused by the fire. Realistically, the extent of damage varies with the severity of the event and it can be hypothesized that when damage is significant it is more likely to cause a shift in beliefs.

Table 8. Probability of the House Burning in Fire in Different Scenarios

	Scenarios	No. of times house burns	Probability house burns when fire always occurs	Probability house burns when fire may occur
No prescribed burning	480	312	0.65	0.65 x 0.05 = 0.03
Prescribed burning	480	130	0.27	0.27 x 0.05 = 0.01
Total	960	442	0.46	

Table 9. WTP Tasks in 20 Rounds of the Long Run Individual Experiment

Indicate the maximum amount you are willing to pay for prescribed burning

Row	**Amount**
1	$0
2	$5
3	$10
4	$15
5	$20
6	$25
7	$30
8	$35
9	$40

Table 10. Percentage of Choices Willing to Pay each Amount

Cost of Prescribed Burning	Percentage of Positive Choices
$0	99.82
$5	76.75
$10	56.08
$15	35.00
$20	21.93
$25	20.27
$30	14.73
$35	9.05
$40	7.97

Table 11.Percentage of Choices Willing to Pay a Positive Amount by Task

Tasks	Percentage of Choices with Positive WTP
1	47.42
2	46.71
3	47.07
4	47.78
5	46.00
6	46.00
7	47.07
8	45.65
9	45.65
10	46.18
11	46.54
12	46.18
13	45.65
14	47.07
15	45.29
16	46.89
17	49.20
18	42.27
19	44.40
20	43.16

Table 12. Percentage of Choices Willing to Pay a Positive Amount by Task Separated by the Year of the Fire

Choice made in the year the Fire occurred is marked in Bold

Tasks	Fire in 11th Round	Fire in 17th Round
1	43.73	51.49
2	41.69	52.24
3	42.37	52.24
4	42.37	53.73
5	40.34	52.24
6	42.03	50.37
7	41.36	53.36
8	41.02	50.75
9	42.37	49.25
10	43.05	49.63
11	**42.37**	51.12
12	42.03	50.75
13	40.68	51.12
14	43.73	50.75
15	40.34	50.75
16	42.03	52.24
17	42.71	**56.34**
18	40.68	44.03
19	43.05	45.90
20	42.37	44.03

Table 13. Beliefs implied by Betting Tasks assuming Risk Neutrality

Bet That House Burns where Probability is..	**High Fuel Load**	**Low Fuel Load**
0.1	95.78	72.89
0.2	96.39	68.07
0.3	95.78	48.19
0.4	90.96	30.72
0.5	81.33	17.47
0.6	60.24	3.01
0.7	39.16	3.01
0.8	23.49	3.61
0.9	18.07	3.01

Table 14. Beliefs implied by Betting Tasks Before and After the fire Assuming Risk Neutrality

Bet That House Burns where Probability is..	**Before Fire**	**After fire**
0.1	83.73	84.94
0.2	82.53	81.93
0.3	73.49	70.48
0.4	60.84	60.84
0.5	51.20	47.59
0.6	32.43	30.72
0.7	21.08	21.08
0.8	11.45	15.66
0.9	10.24	10.84

Table 15. Maximum Likelihood Estimate of Risk Attitudes

Parameter	**Variable**	**Point Estimate**	**Standard Error**	***p*-value**	**Lower 95% Confidence Interval**	**Upper 95% Confidence Interval**
r	Constant	0.29	0.23	0.21	-0.16	0.74
	Social	0.04	0.04	0.38	-0.04	0.12
	Age	-0.00	0.14	0.78	-0.03	0.02
	Female	-0.18	0.10	0.08	-0.38	0.02
	Hispanic	-0.14	0.12	0.24	-0.40	0.10
	Business	-0.10	0.08	0.21	-0.26	0.06
	GPA high	-0.12	0.13	0.38	-0.37	0.14
	Works	-0.00	0.07	0.97	-0.14	-0.14
α	Constant	-0.06	0.98	0.56	-0.25	0.13
	Social	-0.00	0.01	0.59	-0.03	0.01
	Age	0.00	0.00	0.49	-0.00	0.00
	Female	0.17	0.03	0.52	-0.03	0.07
	Hispanic	0.02	0.03	0.47	-0.03	0.07
	Business	0.00	0.01	0.69	-0.02	0.03
	GPA high	0.03	0.05	0.53	-0.07	0.14
	Works	-0.00	0.01	0.91	-0.02	0.02
μ	Constant	-1.81	0.14	0.00	-2.09	-1.54

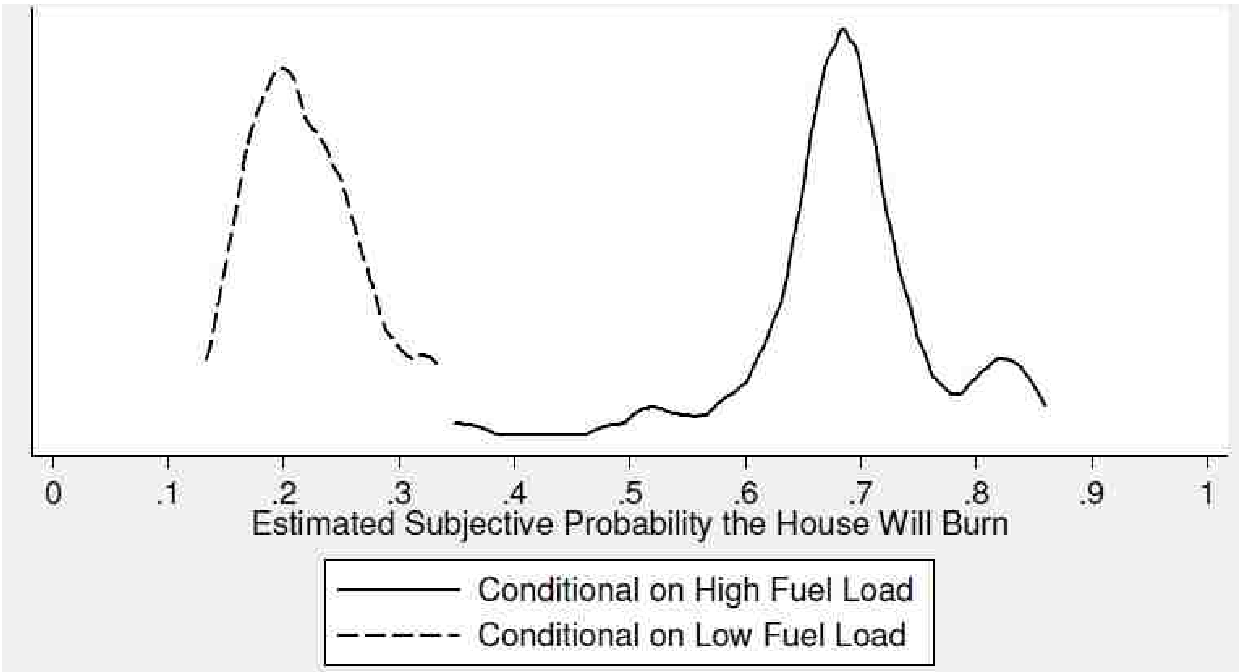


Figure 10. Estimated Subjective Probabilities from Belief Elicitation Tasks Prior to Experiencing Wildfire

Table 16.Maximum Likelihood Estimates of Beliefs from Betting Tasks

Parameter	**Variable**	**Point Estimate**	**Standard Error**	***p*-value**	**Lower 95% Confidence Interval**	**Upper 95% Confidence Interval**
r	Constant	-0.52	0.11	0.00	-0.74	-0.30
pHI	Constant	-0.75	0.13	0.00	-1.00	-0.50
	Belief after	-0.02	0.07	0.83	-0.16	0.13
pLO	Constant	1.14	0.18	0.00	0.79	1.49
	Belief after	0.04	0.13	0.77	-0.22	0.29
μ	Constant	-0.93	0.10	0.00	-1.12	-0.74
	ISrisk	-2.15	0.17	0.00	-2.48	-1.81

Table 17. Latent Probabilities from Belief Elicitation Task

Parameter	**Variable**	**Point Estimate**	**Standard Error**	***p*-value**	**Lower 95% Confidence Interval**	**Upper 95% Confidence Interval**
π_{safe}	Constant	0.24	0.03	0.00	0.18	0.30
π_{risky}	Constant	0.68	0.03	0.00	0.62	0.73
$\pi_{Difference}$	Constant	0.44	0.05	0.00	0.33	0.54

Table 18. Maximum Likelihood Estimates of Beliefs from the WTP Tasks

Parameter	Variable	Point Estimate	Standard Error	*p*-value	Lower 95% Confidence Interval	Upper 95% Confidence Interval
r	Constant	0.22	0.04	0.00	0.14	0.31
pHI	Constant	-12.49	13.91	0.37	-39.75	14.77
	Fire	11.65	13.76	0.40	-15.32	38.62
	Burn	-0.81	0.38	0.03	-1.56	-0.06
pLO	Constant	-0.25	0.12	0.04	-0.49	-0.00
	Fire	0.42	0.26	0.10	-0.09	0.93
	Burn	-0.56	0.19	0.00	-0.93	-0.18
μ	Constant	1.51	0.14	0.00	1.24	1.79

Table 19. Latent Probabilities from WTP Tasks

Parameter	Variable	Point Estimate	Standard Error	*p*-value	Lower 95% Confidence Interval	Upper 95% Confidence Interval
π_{safe}	Constant	0.58	0.02	0.00	0.53	0.63
π_{risky}	Constant	1.00	0.00	0.00	1.00	1.00
$\pi_{Difference}$	Constant	0.42	0.02	0.00	0.37	0.46

4: LONG RUN PUBLIC GOODS EXPERIMENT: EFFECT OF EXPERIENCE ON BELIEFS WHEN ACTING IN A GROUP.

In this experiment subjects' beliefs are informed not only by their experience, as in the long run individual experiment, but also by choices made by other members in the group. Several mitigation options are collective in nature and require group contributions for the self protection action. Consider for instance the risk of a fire in a park or forest spreading to an adjacent residential area. This is a risk faced by all individuals living in that area, to a greater or lesser degree, depending on the location of their house. The cost of prescribe burning this forest has to be borne by the group as a whole instead of by any particular individual. That is we have a public goods game with the added dimension of risk that can only be mitigated by the group and not by the individual. Here the perception of risk held my members of the group becomes an important determinant of behavior and is likely to cause a deviation from the behavior predicted in the standard public goods game. In addition, the design allows us to test if perceptions are affected by the experience of a forest fire or the experience of the house burning when the choice is made by the group not the individual.

The unique component of this experiment is the 20 rounds of public goods game where prescribed burning is provided if and only if total contributions made by the group exceed the cost of prescribed burning. There are two alternate treatments – with and without risk. These are discussed in the experimental design section. In order to avoid repetition we do not include a description of the other tasks – 4 betting tasks, a standard risk attitude task and a social risk attitude task, which have already been described in the earlier chapter. Similarly, we do not include a description of the estimation methods developed in details in the earlier chapters. We end this chapter with a description of the results and concluding remarks about possible extensions of this experiment.

A. Experimental Design

In this section, we first describe the standard public choice task without risk that forms our baseline treatment to compare with existing literature on public goods. Next, we turn to the public goods game with risk that introduces the idea of making self protection expenditure to reduce shared risk.

Similar to the long run individual experiment, each subject faces 20 WTP tasks and 4 betting tasks. The cost of prescribed burning is common knowledge and given to subjects as part of their initial instructions.[27] Each member of the group privately indicates his WTP to undertake prescribed burning. If the total contribution made by all members in the group exceeds cost, prescribed burning is provided and the maximum each member is willing to pay is deducted from his initial credit. Conversely, if total contributions made do not exceed the cost, prescribed burning is not provided and nothing is deducted from the initial credit.

Just like in the long run individual experiment, we check to see if a fire occurred in a particular year (depending on whether the card in that year is red or white). In the event that a fire occurs, the final payoff is determined by whether the house burns in the fire. Background conditions for the fire are selected at random by rolling a die. If there is no fire the game moves to the next round. Subjects lose any payment made towards prescribed burning in that round, provided prescribed burning was provided, even though no fire actually occurs in that round.

[27] Instructions are in Appendix D and decision sheets in Appendix F.

We hypothesize that the belief about the probability of a fire declines in successive rounds. There are three possible reasons for this decline. First, with each successive round of there being no fire, subjects update their beliefs and their perception about the probability of there being a fire declines. Conversely, the actual occurrence of a fire is seen as evidence of greater frequency of fire, and beliefs are adjusted upwards. Note that this process is identical to the long run individual experiment, and we use data from that earlier experiment to identify this "individual belief updating" effect.

In order for prescribed burning to be provided, contributions made by all members of the group must exceed the total cost of prescribed burning. Given the public goods nature of this problem, free riding behavior may be expected since some subjects may be able to get the benefits of prescribe burning without contributing anything or by contributing less than the fair share. To control for this incentive to free ride we conduct a standard public goods game where no risk is involved. If total contribution exceeds cost and prescribed burning is provided, the house does not burn in that round, and if total contribution does not cover costs and prescribed burning is not provided, the house burns. This experiment involves no risk and the final outcome depends wholly on whether or not sufficient contributions are made.[28]

The third factor that could alter beliefs is response to the beliefs held by other members of the group. Whether or not prescribed burning is undertaken in any round implicitly conveys information about the aggregate WTP of other members in the group. A subject may revise his belief and consequently his WTP in response to this information. For instance, in one session fire occurs. In response to this fire an individual's WTP increases. However, at the end of the round

[28] Instructions for this task are similar to the instructions for the public goods task with risk. The instructions and decision sheets are in Appendices E and F respectively.

he finds out that prescribed burning is not provided, since the contribution made by others in the group was not sufficient. From this he might infer that his belief is too high and he may adjust downward his belief, and as a result reduce his WTP. Therefore, introducing risk in the public goods game affects behavior through change in risk perception reflected by a change in WTP in successive rounds.

As in chapter 3, we have the four betting tasks to identify beliefs about the risk of the house burning when a fire *always* occurs, the standard lottery task to identify individual risk attitude, and the social risk attitude task.

I. Standard Public Choice Task

The classic problem that plagues public goods games is the problem of free riding where all members of a group have the incentive to under contribute, in the most extreme case not contribute at all, with the expectation that other members will contribute enough to provide for the good. With everyone under contributing the equilibrium ends up with the good not being provided and everyone in the group being worse off than if they had provided their fair share.

Our public goods game is slightly different in nature, since it has a natural threshold, the cost of prescribed burning. The existence of a threshold changes the nature of the problem and also some of the predictions. John Ledyard (1995, p. 144) observes an important distinction between the two:

> Without a threshold the voluntary contributions mechanism is usually a prisoners' dilemma game; with a threshold it becomes a game of chicken… In the former it is a dominant strategy not to cooperate, and there is (usually) a unique noncooperative equilibrium which is not Pareto-Optimal. In the game of chicken there are generally many noncooperative equilibria, each of which may be optimal and none of which is dominant, and the task of the players is to coordinate their actions to select one.

Therefore, in our game it is possible to achieve the cooperative equilibrium where all members contribute their fair share and the good is provided. Our objective is to design a game where the subject has the incentive to contribute his fair share and to compare how these contributions are affected when risk is introduced into the mix. We studied several public goods experiments with thresholds to come up with a design most suitable for our purpose. The design choices made by these studies are summarized in Table 20.

All the studies given in Table 20 have a fixed threshold. This threshold may be defined in two alternate ways: (i) as a minimum contribution which has to be reached for the public good to be provided or (ii) as a production function with a jump discontinuity at a provision point, at which the returns from the public project overtakes the returns from the private project. The latter is employed by Isaac, Walker & Thomas (1984). Isaac, Schimtz & Walker (1989), and Marwell & Ames (1980) and better represents a public project which needs a certain level of investment before it yields a higher return than a private alternative. Notice that in this case the yield is positive even when total contributions do not exceed the threshold. This, however, does not fit our experiment where there is no return if the total contributions fall short of the cost of prescribed burning. We do not have any cheaper alternative like cutting down trees in the neighborhood that reduces the risk but not as much as prescribed burning. Our design is more similar to Bagnoli & Mckee (1991) where the good is provided if the sum of contributions meets or exceeds the cost. All contributions in excess of the cost are retained by the experimenter, and if contributions fall short of the cost, and the good is not provided, all contributions are returned.[29]

Note that Bagnoli & McKee (1991) use a money back option. The money back option simply states that if total contributions fall short of the threshold and the good is not provided then all contributions are returned. This eliminates the risk that subjects end up losing the money made as contribution while not actually getting the good they paid for. Isaac, Schimtz & Walker (1989) show that the money-back feature behaviorally increases contributions for the public good.

The other feature that behaviorally increases contribution is homogeneity of the initial endowment and value of the private good among members of a group (see Rappoport & Suleiman (1992) and Rappoport & Suleiman (1993)). We deviate from the Bagnoli & McKee design by adopting homogeneity in endowment and value of the good to all members in the group. This is done to encourage contributions and can easily be relaxed in later designs.

It is not obvious that repetition increases contributions: in public good games without thresholds contributions decline with time while in the presence of threshold they usually decline but remain above the threshold level. In our design, we had to use a repeated game framework. The 20 rounds of decision making in our design, mirrors 20 years or 20 fire seasons in the Central Florida area and the lightning pattern used is taken from the real pattern in the area in the last 30 years.

In a simple set up we create groups who jointly own the house in the forest. Initial credit, share of the house, and the cost of damage to the house are homogenous and common

[29] Bagnoli and Lipman (1989) prove that excess contributions may be returned as long as it is done in such a manner that the subjects cannot increase their refund by their choice of contribution.

knowledge. All subjects in a room, during the experiment, are part of the same group. Therefore, subjects know who the other members in the group are even though they are not allowed to communicate with each other during the experiment.

Table 21 summarizes the various treatments. As before, we have the high prize and the low prize treatments and group size varies between 6 and 9. Let us describe the treatment in the upper left hand corner of the table. Group size is 6. Each subject has an initial credit of $40 and a share of $40 in the house, valued at $240.,Prescribed burning is only provided if total contributions exceed cost of prescribed burning, $120. Therefore, the decision to prescribe burn depends on all members of the group rather than an individual. It is not feasible for any one member to pay the entire amount for prescribed burning since individual endowments are lower than the cost of prescribed burning.

If prescribed burning is provided the house does not burn and subjects get their share of the house. If no prescribed burning is provided the house burns and subjects lose their share of the house. That is if all 6 members in the group pay $20 towards prescribed burning, then the cost of prescribed burning, $120, is covered and each member gets a payoff of $60 (initial credit – contribution + share of house = $40 - $20 + $40). This is higher than the payoff of $40 each member gets when prescribed burning is not provided (initial credit – contribution = $40 - $0). Conversely, if an individual volunteers to pay for prescribed burning and total contribution falls short of cost, the money back feature ensures that he still earns the $40. That is he is guaranteed an income of at least $40.[30] This incentive to contribute, however, is eroded by the incentive to

[30] If an individual pays $30 for prescribed burning, payoff, $50 (initial credit – contribution + share of house = $40 - $30 + $40) is greater than when no prescribed burning is provided and a minimum of $40 is guaranteed. The subject is indifferent when he makes a contribution of $40, in all cases he gets a payoff of $40.

free ride. For instance, if a subject contributes only $10 and prescribed burning is still provided (some other member has to pay $30 for this to work), then his individual payoff goes up to $70.

II. Public Choice Task Reducing Risk

Now we add risk to the public goods game. The basic set up is identical to the one described in the standard public choice game and the treatments are the same as before. Prescribed burning is provided only if total contribution exceeds cost. Providing for prescribed burning, however, does not guarantee the safety of the house. In the event of a fire, there is some risk that the house will burn; though the risk is lower than when no prescribed burning is provided. Prescribed burning thus reduces but does not eliminate the risk of burning.

.Borrowing from the individual experiment a fire does not occur in every round. In rounds where there are no fires the house does not burn even when prescribed burning is not provided. So while paying for prescribed burning does not guarantee the safety of the house, not paying for it does not guarantee that it burns. In either case the outcome cannot be predetermined with certainty.

We have 20 rounds of decision making and in each round the subject is asked the maximum amount he is WTP for prescribed burning. Prescribed burning is provided in any round, if total contributions in that round exceeds cost. In every round there is a non zero probability of a fire. The fire may or may not burn the property. This allows us to test whether the experience of a fire or the experience of the house burning in a fire affects perception where each member contributes according to his perception and members have to contribute together to provide for prescribed burning.

B. Results

I. Analysis of Raw Data

The most striking result in the public goods experiment with risk is the decline in WTP in successive rounds. While the WTP remains more or less constant in the experiment without risk, it declines sharply in the experiment with risk. This result is evident from Table 22. More than 50% of the time subjects are willing to pay for prescribed burning in the experiment without risk. Compare this to the results from the experiment with risk. In the first round a positive amount is paid 51.36% of the time. By the second round it is 47.08% which is below 50%. Note that the number of choices in the public goods experiment without risk never falls below 50%. In the third round WTP as a percentage has fallen to 45.91 and then to 41.63%. By the fifth round it is below 40% (37.35% to be precise). It never crosses the 40% mark again.

Consistent with the findings from the individual experiment, there is no evidence of an effect of experience of fire on WTP (Fig 11). Table 23 shows that the experience of a fire in the 17^{th} round is not followed by an increase or decrease in WTP; the decline in the first few rounds is also apparent from Table 23. However, a different set of results arise when fire occurs in the 11^{th} round. In this case, WTP remains unchanged and falls slightly in the first three rounds, and then starts rising. By round 17 it is 73.33%, and it stays at that level until the end of the 20 rounds. It is not appropriate to read too much into this result, since it represents one group consisting of 6 members, which incidentally is the only group that succeeded in cooperating. It may be the exception rather than the rule and more data is necessary before drawing firm conclusions.

II. Estimation

Detailed estimations are presented in Tables 24 and 25. Table 24 reports the beliefs recovered from the betting tasks. The variable group controls for data collected from the public goods experiments. We find no evidence of a group effect on beliefs about either higher (*p* – value is 0.57) or lower (*p* – value is 0.26) fuel load conditions. Note that betting tasks elicit individual's perception about risk of the house burning when the house always burns. These are individual decision tasks even in the group experiments and should not be affected by beliefs of others in the group. Moreover, these probabilities are given to the subjects as part of the instructions so that in some sense this is merely a test of whether the subjects followed instructions. Table 25 reports Maximum Likelihood estimates of beliefs recovered from the 20 WTP tasks in the public goods game with risk. The group effect is not significant for either the high fuel load or low fuel load conditions..

We also jointly estimate risk attitudes and beliefs allowing the demographic characteristics of subjects to explain choices. Table 26 and 27 are the estimates from the Betting tasks and WTP tasks, respectively. We find no significant difference in beliefs elicited in the individual and public experiments when only the betting tasks are considered. However, group effect is statistically significant in the estimates of beliefs recovered from the WTP tasks. Under the low fuel load condition, the effect of the variable burn is significant, implying that the experience of fire increases the subjective perception of risk.

The marginal effects for covariates are reported in Table 28 and Table 29. None of the covariates are significant in either the Betting or the WTP tasks. We find that the marginal effects for the WTP tasks are miniscule, implying that we should be cautious when drawing any conclusions from these data. Predicted values for the beliefs are presented in Table 30 and 31. Beliefs recovered from the betting tasks are fairly accurate, in the sense that they match the objective probabilities relatively closely, and there is no significant difference between beliefs recovered before and after the fire. In line with the estimated probabilities and marginal effects, the predictions for the WTP tasks are also very small.

C. Conclusion

The objective of this thesis is to test the behavioral implication of introducing endogneity in the controlled environment of the laboratory. We find that beliefs elicited when risk is exogenous are significantly different from those elicited when risk is endogenous. In the long run model, where fire only occurs in certain years, the actual experience of the fire does not affect beliefs. However, if the house burns in the fire beliefs are negatively affected. Introducing a risk faced by a community rather than an individual does not alter these results.

In this thesis, our estimation is based on the static EUT model of decision making under risk and the comparative static relations implied by such a model. Our results, however, suggest the role of a dynamic model in explaining the results. While there is no group effect of the experience of fire on beliefs, there is a clear downward trend of WTP in the public experiment with risk. This suggests that with each successive round there is new information conveyed to the subject, namely about the beliefs of others in the group, that affects individual's beliefs. The first step in rigorously studying this trend will be to develop a dynamic model that considers the information updates acquired between successive rounds of decision making in this public goods game.

In our experiment, the same group faced each other for all 20 rounds. Money back was given and no communication permitted. Variations of this are easy to design and may have implications for the results. First, results may vary for random strangers when groups are anonymous and change in every round. The laboratory allows us to conduct this controlled experiment. The only requirement for this experiment is to provide individual monitors for each participant. For the current set of experiments we only had one computer in every room and when a fire was simulated all the subjects watched the fire together on one common screen. Second, group building exercises may be performed at the beginning of the experiment to encourage people to behave more altruistically. This is the opposite of the earlier case where group members are anonymous. A third variation will be to allow communication among members to encourage coordination. Communication usually improves contribution. If some members of the group believe the risk to be low and manage to convince others about their beliefs we might actually pick up the opposite effect in this experiment. Finally, removing the assumption of homogeneity is likely to affect the results substantially. If subjects have houses in different parts of the forest facing different risk profile contributions are likely to vary. Similarly, if initial incomes are different contributions may be very different depending on initial credit level.

Table 20. Design Choices for several Public Goods studies with Threshold

	Bagnoli & McKee (1991)	Isac, Walker & Thomas (1984)	Isac, Schimtz & Walker (1989)	Marwell & Ames (1980)	Rappoport & Suleiman (1992)	Rappoport & Suleiman (1993)
1. Threshold	√	√	√	√	√	√
2. Homogenous	×	√	√	√	×	√
3. Minimum Contribution	√	×	×	×	√	√
4. Money back	√	×	√	–	×	×
5. Repeated	√	√	√	×	×	×

Table 21. Treatments of the Public Goods Game

	Group of 6		Group of 9	
	Value of the House	Cost of Prescribed Burn	Value of the House	Cost of Prescribed Burn
$40 credit + $40 value	$240	$120	$360	$180
$80 credit + $80 value	$480	$240	$720	$360

Table 22. WTP by Task for Public Goods Experiment

Tasks	**Without Risk**		**With Risk**	
	Frequency	Percent	Frequency	Percent
1	158	53.20	132	51.36
2	158	53.02	121	47.08
3	160	53.69	118	45.91
4	165	55.37	107	41.63
5	161	54.03	96	37.35
6	162	54.36	96	37.35
7	159	53.36	87	33.85
8	159	53.36	88	34.24
9	158	53.02	84	32.68
10	164	55.03	88	34.24
11	157	52.68	95	36.96
12	162	54.36	99	38.52
13	157	52.68	100	38.91
14	157	52.68	88	34.24
15	157	52.68	82	31.91
16	155	52.01	79	30.74
17	158	53.02	76	29.57
18	161	54.03	82	31.91
19	156	52.35	74	28.79
20	158	53.02	84	32.68

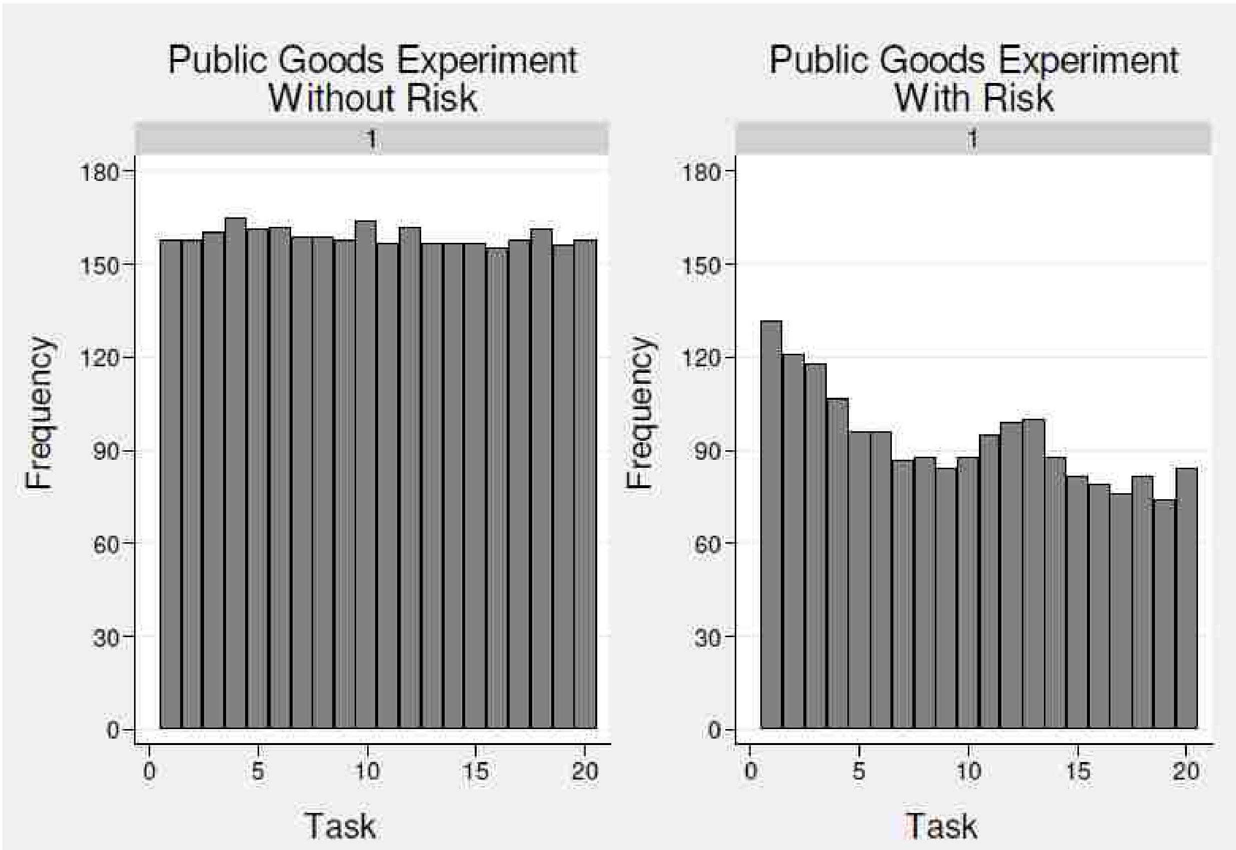


Figure 11. Trend in WTP in Public Goods Experiment With and Without Risk

Table 23. Effect of Fire on Percentage of Positive WTP choices

Choice made in the year the Fire occurred is marked in Bold

Tasks	Fire in 11th Round	Fire in 17th Round
1	60.00	52.86
2	60.00	48.02
3	46.67	44.93
4	66.67	42.73
5	60.00	37.00
6	60.00	37.00
7	60.00	33.04
8	70.00	34.80
9	66.67	32.60
10	66.67	34.36
11	**63.33**	37.00
12	63.33	38.77
13	60.00	38.77
14	63.33	33.92
15	66.67	31.72
16	73.33	31.28
17	73.33	**29.96**
18	73.33	32.60
19	73.33	29.07
20	73.33	33.48

Table 24. Maximum Likelihood Estimates of Directly Elicited Beliefs Controlling for Group

Parameter	**Variable**	**Point Estimate**	**Standard Error**	***p*-value**	**Lower 95% Confidence Interval**	**Upper 95% Confidence Interval**
r	Constant	-0.60	0.14	0.00	-0.87	-0.33
pHI	Constant	-0.70	0.19	0.00	-1.08	-0.32
	Belief after	-0.02	0.08	-0.83	-0.17	0.13
	Group	-0.11	0.18	0.57	-0.47	0.26
pLO	Constant	1.28	0.21	0.00	0.86	1.69
	Belief after	0.07	0.14	0.62	-0.20	0.34
	Group	-0.18	0.16	0.26	-0.49	0.13
μ	Constant	-0.91	0.10	0.00	-1.10	-0.72
	ISrisk	-2.24	0.18	0.00	-2.60	-1.88

Table 25. Maximum Likelihood Estimates of Beliefs from the WTP Tasks Controlling for Group

Parameter	Variable	Point Estimate	Standard Error	p-value	Lower 95% Confidence Interval	Upper 95% Confidence Interval
r	Constant	0.22	0.05	0.00	0.13	0.31
pHI	Constant	-12.41	1.80	0.00	--15.94	-8.90
	Fire	11.72	1.97	0.00	-0.54	-0.14
	Burn	-0.61	0.20	0.02	-1.56	-0.09
	Group	-0.17	0.30	0.57	-0.75	0.41
pLO	Constant	-0.34	0.10	0.00	-0.54	-0.14
	Fire	0.35	0.24	0.14	-0.12	0.82
	Burn	-0.61	0.20	0.00	-1.01	-0.21
	Group	0.24	0.17	0.17	-0.10	0.58
μ	Constant	1.51	0.14	0.00	1.23	1.79

Table 26. Maximum Likelihood Estimates of Directly Elicited Beliefs with Demographics

Parameter	Variable	Point Estimate	Standard Error	p-value	Lower 95% Confidence Interval	Upper 95% Confidence Interval
r	Constant	-0.43	0.17	0.01	-1.58	-0.13
	Age	-0.00	0.15	0.91	-0.03	0.03
	Female	-0.34	0.16	0.04	-0.66	-0.02
	Hispanic	-0.23	0.15	0.12	-0.53	0.61
	Business	-0.24	0.13	0.05	-0.49	0.08
	GPA high	-0.18	0.13	0.17	-0.45	0.08
	Works	0.10	0.11	0.35	-0.11	0.31
pHI	Constant	-0.85	0.37	0.02	-1.58	-0.13
	Beliefs_after	-0.19	0.87	0.83	-0.19	0.15
	Group	-0.11	0.21	0.60	-0.52	0.30
	Age	0.07	0.02	0.01	0.18	0.11
	Female	-0.15	0.24	0.53	-0.61	0.32
	Hispanic	-0.83	0.56	0.15	-1.98	0.31
	Business	0.07	0.28	0.80	-0.48	0.63
	GPA high	0.01	0.25	0.96	-0.48	0.50
	Works	-0.02	0.37	0.02	-1.58	-0.13
pLO	Constant	1.04	0.27	0.00	0.51	1.57
	Beliefs_after	0.63	0.15	0.68	-0.24	0.36
	Group	-0.29	0.19	0.13	-0.67	0.09
	Age	0.00	0.02	0.80	-0.03	0.43
	Female	0.39	0.20	0.06	-0.13	0.79
	Hispanic	0.33	0.22	0.12	-0.09	0.76
	Business	0.27	0.17	0.12	-0.07	0.61
	GPA high	0.33	0.18	0.06	-0.02	0.69
	Works	-0.14	0.16	0.37	-0.46	0.17
μ	Constant	-0.88	0.12	0.00	-1.12	-0.65
	ISRisk	-2.53	0.31	0.00	-3.14	-1.91

Table 27. Maximum Likelihood Estimates of Beliefs from the WTP Tasks with Demographics

Parameter	Variable	Point Estimate	Standard Error	p-value	Lower 95% Confidence Interval	Upper 95% Confidence Interval
r	Constant	0.15	0.18	0.39	-0.20	0.51
	Age	-0.00	0.15	0.86	-0.03	0.03
	Female	0.01	0.12	0.91	-0.21	0.24
	Hispanic	0.03	0.23	0.88	-0.41	0.48
	Business	-0.06	0.04	0.19	-0.15	0.03
	GPA high	0.15	0.17	0.38	-0.18	0.47
	Works	0.01	0.15	0.39	-0.20	0.51
pHI	Constant	-13.18	0.51	0.00	12.18	14.19
	Fire	0.13	0.09	0.14	-0.04	0.29
	Group	0.35	0.09	0.00	0.17	0.54
	Age	0.00	0.05	0.92	-0.09	0.10
	Female	0.11	0.35	0.75	-0.57	0.79
	Hispanic	-0.08	0.65	0.90	-1.37	1.20
	GPA high	-0.32	0.49	0.51	-0.28	0.64
	Works	0.02	0.43	0.96	-0.83	0.87
pLO	Constant	13.85	0.61	0.00	12.65	15.05
	Fire	-0.00	0.10	0.99	-0.20	0.20
	Burn	-0.22	0.08	0.00	-0.37	-0.07
	Group	0.46	0.13	0.00	-0.20	0.72
	Age	-0.01	0.05	0.87	-0.12	0.10
	Female	0.19	0.43	0.65	-0.64	1.03
	Hispanic	-0.12	0.74	0.87	-1.58	1.34
	GPA high	-0.42	0.57	0.47	-1.54	0.70
	Works	-0.07	0.52	-1.08	-0.46	0.95
μ	Constant	-11.78				

Table 28. Marginal Effect of Covariates in the Betting Tasks

Covariates	**Point Estimate**	**Standard Error**	**p-value**	**Lower 95% Confidence Interval**	**Upper 95% Confidence Interval**
*pHI*_Belief	0.00	0.02	0.82	-0.03	0.04
*pLO*_Belief	-0.01	0.03	0.67	-0.07	0.04
pHI _Group_	0.02	0.04	0.61	-0.06	0.11
*pLO*__Group	0.06	0.04	0.12	-0.01	0.13
*pHI*_Age	-0.01	0.00	0.01	-0.25	-0.00
*pLO*_Age	-0.00	0.00	0.80	-0.01	0.01
pHI _Female	0.03	0.05	0.52	-0.06	0.12
pLO _Female	-0.07	0.03	0.02	-0.12	-0.01
pHI _Hispanic	0.14	0.09	0.14	-0.04	0.33
pLO _Hispanic	-0.06	0.04	0.14	-0.14	0.02
pHI _Business	-0.01	0.06	0.80	-0.13	0.10
*pLO*_Business	-0.05	0.03	0.10	-0.11	0.01
pHI _GPA high	-0.00	0.05	0.96	-0.10	0.10
pLO _GPA high	-0.06	0.03	0.06	-0.12	0.00
pHI _Works	0.00	0.05	0.93	-0.09	0.10
pLO _Works	0.03	0.03	0.38	-0.03	0.09

Table 29. Marginal Effect of Covariates in the WTP Tasks

Covariates	Point Estimate	Standard Error	p-value	Lower 95% Confidence Interval	Upper 95% Confidence Interval
*pHI*_Fire	-2.23e-07	6.04e-07	0.71	-1.41e-06	9.61e-07
*pLO*_Fire	1.48e-09				
pHI _Group	-5.56e-07	9.82e-07	0.57	-2.48e-06	1.37e-06
*pLO*__Group	-3.56e-07				
*pLO*_Burn	2.38e-07	9.95e-07	0.81	-1.71e-06	2.19e-06
*pHI*_Age	-9.56e-09	3.10e-07	0.97	-6.18e-07	5.99e-07
*pLO*_Age	8.75e-09				
pHI _Female	-1.96e-07	2.39e-06	0.93	-4.89e-06	4.50e-06
pLO _Female	-1.72e-07				
pHI _Hispanic	1.68e-07	3.69e-06	0.96	-7.07e-06	7.41e-06
pLO _Hispanic	1.22e-07	0.00	0.99	-0.00	0.00
pHI _GPA high	6.98e-07	2.48e-06	0.78	-4.17e-06	5.57e-06
pLO _GPA high	5.00e-07	4.87e-06	0.92	-9.04e-06	0.00
pHI _Works	-3.86e-08	2.67e-06	0.99	-5.28e-06	5.20e-06
pLO _Works	6.91e-08	0.00	0.99	-0.00	0.00

Table 30. Predicted Beliefs from Betting Tasks

Percentile	pHI_Before	pHI_After	pLO_Before	pLO_After	pHI_Diff.	pLO_Diff.
1%	0.33	0.33	0.11	0.10	1.18	0.19
5%	0.57	0.58	0.13	0.12	0.32	0.34
10%	0.62	0.63	0.14	0.14	0.33	0.35
25%	0.66	0.66	0.16	0.15	0.42	0.43
50%	0.69	0.69	0.20	0.19	0.49	0.50
75%	0.71	0.72	0.25	0.24	0.54	0.56
90%	0.80	0.81	0.28	0.27	0.61	0.62
95%	0.83	0.83	0.28	0.27	0.67	0.68
99%	0.86	0.86	0.35	0.33	0.75	0.76
Mean	0.69	0.69	0.21	0.20	0.48	0.50
Standard Deviation	0.08	0.08	0.05	0.05	0.10	0.10

Table 31. Predicted Beliefs from WTP Tasks

Percentile	***pHI***	***pLO***	**pDiff**
1%	1.13e-06	5.36e-07	3.46e-07
5%	1.25e-06	6.74e-07	4.38e-07
10%	1.27e-06	7.59e-07	4.58e-07
25%	1.59e-06	8.44e-07	5.91e-07
50%	1.79e-06	1.04e-06	7.48e-07
75%	2.27e-06	1.35e-06	8.75e-07
90%	2.51e-06	1.63e-06	1.03e-06
95%	2.55e-06	1.69e-06	1.06e-06
99%	2.78e-06	2.22e-06	1.10e-06
Mean	1.87e-06	1.14e-06	7.34e-07
Standard Deviation	4.31e-06	3.54e-07	2.01e-07

APPENDIX A. INSTRUCTIONS FOR SHORT RUN INDIVIDUAL EXPERIMENT

Here are the instructions for the short run private experiment. Instructions were presented in the form of a booklet. The blank pages in between are to facilitate reading in the form of a booklet. Decision sheet for each task was presented to the subject along with the instructions for that task. Decision sheets are included in Appendix B.

Welcome to the experiment. Today you will perform several tasks. There are 11 tasks in total. For each task we will first describe the task to you and, after you have had a chance to ask questions, you will make your decision. At the end of the experiment you will be paid for one of these tasks.

Let me explain how we select the task to pay you. The box in front of you has 11 envelopes and 11 cards numbered 1 through 11. Please put one card into each envelope and close the envelopes. I will now shuffle these envelopes.

The envelopes have now been carefully shuffled, and would like you to pick one of them. The number on the card in the envelope you selected determines which task you will be paid for. You will not know what that number is until the end of the experiment, when you will be allowed to open the envelope.

Forest fires and possible solutions

In this part of the experiment you will make decisions about forest fires that pose a threat to homes, cars, boats, businesses, etc., and can cause millions of dollars of damage. For example, the total economic cost estimated for the 1998 wild fires in Florida was at least $448 million.

A build-up of wild fire fuel in the form of brush, dead branches, logs and pine needles on the forest floor has occurred over several decades. As a result, when wild fires are ignited they spread faster and burn longer than would otherwise be the case. During drought years the fuel moisture levels are low and compound the risks. In addition, when winds are strong the spread is faster and the damages more extensive.

Prescribed burning has been used to prevent wild fires from becoming intensive and spreading quickly. Prescribed burning involves having fire professionals periodically set fires to clear the forest floor of the excess brush, dead branches and pine needles. These prescribed fires are easier to manage than wild fires since prescribed fires do not burn as intensely and they can be directed away from housing structures. The effect of using prescribed burning is to lower the fuel load in the forest so if a fire starts it will be less intensive and spread more slowly.

Simulations

Several computerized simulation programs have been developed in order to predict the spread and severity of wild fires with high accuracy. They are used by fire fighters during actual wild fires to predict the spread of fire and the best actions to contain the fire and minimize damage. These simulations are based on the landscape and urban settlements in specific regions of the US and therefore provide good examples of potential fire risks. We are going to use one such simulation program in this section, developed by the United States Forest Service.

The forest area that we are simulating is based on the topography and vegetation of Ashley National Forest in Utah. We are going to let you run through several simulations so you can experience the effect of wild fires *with and without a prescribed burn program*. The difference between the simulations with and without a prescribed burn is entirely due to differences in the fuel load of the forests. *The fuel load with the prescribed burn is much lower.* We also vary other factors that affect the severity of the fires, such as fuel moisture, winds, rain and temperatures. These background factors will vary in the same way across the simulations with and without the prescribed burn program. The purpose of these initial simulations is to familiarize you with how the fire reacts to changing conditions.

Some of the tasks today will involve the use of these simulations. Please note that there is one house in this simulation of Ashley National Forest. The choices you will be asked to make refer to this house. You can see where it is placed in the forest in the top picture, and the bottom picture is a close-up.


Forest Fire Demo
Load
N
W
E
S
Flying Mode "PAUSED"
P - play
Page Up - elevate
Page Down - descend
W, Up - move forward
S, Down - move backward
A, Left - strafe left
D, Right - strafe right
H - toggle interface
M - change to path designer mode
[0d:00h:00m:00s]
[0d:05h:14m:56s]
[0d:00h:00m:00s]


Forest Fire Demo
Load
N
W
E
S
Flying Mode "PAUSED"
P - play
Page Up - elevate
Page Down - descend
W, Up - move forward
S, Down - move backward
A, Left - strafe left
D, Right - strafe right
H - toggle interface
M - change to path designer mode
[0d:00h:00m:00s]
[0d:05h:14m:56s]
[0d:00h:00m:00s]

Tasks 1 and 2

The first two tasks involve betting on the outcomes of uncertain events. Usually we bet on events like sports or elections. Today you will be betting on events related to forest fires in our simulations.

You will be making bets with several betting houses or "bookies." This is similar to betting on a football game or a horse race.

To familiarize you with betting, we will first illustrate how it works with the example of a horse race.

Imagine a two-horse race between Blue Bird and White Heat. Several bookies offer different odds for the horses. The table below shows the odds offered by three bookies (A, B and C) along with the amounts they would pay if you bet $10 on the *winning* horse. At this point you should take some time to study the table.

		If you bet on Blue Bird and...		If you bet on White Heat and…	
Bookie	**Stake**	**Blue Bird wins you get**	**White Heat wins you get**	**Blue Bird wins you get**	**White Heat wins you get**
A	$10	$50.00	0	0	$12.50
B	$10	$33.33	0	0	$14.30
C	$10	$20.00	0	0	$20.00

For each bookie, whether you would choose to bet on Blue Bird or White Heat will depend on three things: your judgment about how likely it is that each horse will win, the odds offered by the bookie, and how much you like to gamble or take risks.

Betting on forest fires

Now that you are familiar with odds and betting, let us explain the forest fire betting task. You will be betting on two events. Recall the house that is located in the Ashley National Forest. You will be asked to bet on whether or not the house will burn in a simulated forest fire.

The first event is a forest fire that takes place in a year when the forest has not been managed through prescribed burns. In this case a lot of fuel is left in the forest, increasing the intensity and spread of fires. You will be asked to place a bet on whether or not the house will burn in the simulated fire. This will be Task 1.

The second event is a forest fire that takes place in a year when the forest has been managed through prescribed burns. A reduced fuel level reduces the intensity and spread of fires. Again, you will be asked to bet on whether or not the house will burn in the simulated fire. This will be Task 2.

For each event there will be 9 bookies offering odds. **You will make bets with all 9 bookies. For each event you are given a $5 stake to bet with**. If the number on the card in the envelope you picked at the beginning is either a 1 or a 2, you will be paid for the corresponding betting task. If so, we will also have to roll a die to choose one of these 9 betting houses. Thus, each of your bets is equally likely to be chosen to determine your earnings.

Before you place your bets you will get the chance to experience some fire simulations. In these simulations there will be variations in fire management and other background factors, such as weather. This will make it possible for you to assess how likely you think it is that the house will burn in the two events you are betting on.

After placing your bets we will run an additional simulation, which will be used to determine your earnings. Thus, depending on your bets and on whether the house burns or not in this final simulation, your earnings will be calculated.

What determines the risk of the house burning?

We have generated a number of fire simulations by varying several background factors that determine how severe a wild fire is.

The first background factor is the temperature and humidity. In one case we have a *high temperature and low humidity*, which makes for a more severe fire. In this case the morning low temperature is 60 degrees and the afternoon high is 99 degrees, with morning high humidity of 70% and afternoon low of 10%. And in another case we have a relatively *low temperature and high humidity*, which makes for a less severe fire. This time the morning low temperature is 40 and the afternoon high is 85, with morning high humidity of 90% and afternoon low of 60%.

The second background factor is the wind speed. This will be either *high or low*, corresponding to 5 miles per hour or 1 mile per hour. Wild fire spreads more rapidly when winds are high.

The third background factor is the fuel moisture in the vegetation. This will either be *high or low*, with expected effects on the severity of the wild fire. When fuel moisture is high the moisture content of all dead vegetation is set to 20%, and when it is low it is set to 3-5%. Further, when the dead fuel moisture is high the proportion of dead vegetation is low (0-10%), and when the dead fuel moisture is low the proportion of dead vegetation is higher (25-50%).

The fourth background factor is the duration of the fire, which will either be 1 day or 2 days. You can think of this as reflecting rainfall or fire-fighting activities. The longer a fire lasts, the more it will spread across the landscape.

The final background factor is the location of the initial lightning strike that ignites the fire. This could be in the center of Ashley National Forest, in the north (in the mountains), or in the south. Each is equally likely when we select a scenario to actually pay you. The house is in the center of Ashley, slightly to the east and close to the foothills.

In the initial series of simulations you will have a chance to understand the nature of the fires and how it depends on these background factors. You will experience forest fires under both benign and severe conditions.

For the final simulation which determines your earnings, the background factors will be determined using dice. We will roll the dice for each of the 5 background conditions: temperature/humidity (2 possibilities), wind (2 possibilities), fuel moisture/proportion of dead vegetation (2 possibilities), duration (2 possibilities), and, the location of the lightning strike that starts the fire (3 possibilities).

This table shows you how a roll of a standard 6-sided die will determine the background factor that we will use in the final simulation that determines our payments:

Die roll	1-3	4-6
Temperature	Low	High
Air humidity	High	Low

Die roll	1-3	4-6
Wind speed	Low	High

Die roll	1-3	4-6
Fuel Moisture	High	Low
Proportion Dead Fuel	Low	High

Die roll	1-3	4-6
Duration	1 day	2 days

Die roll	1-2	3-4	5-6
Lightning	North	South	Central

In addition, the simulation will be determined by whether the fuel load is high or low, depending on whether your betting task is number 1 (high fuel load) or 2 (low fuel load).

Before placing your bets you will experience four of these scenarios. For each of the high and low fuel load cases you will experience the most benign and the most intense combination of background factors

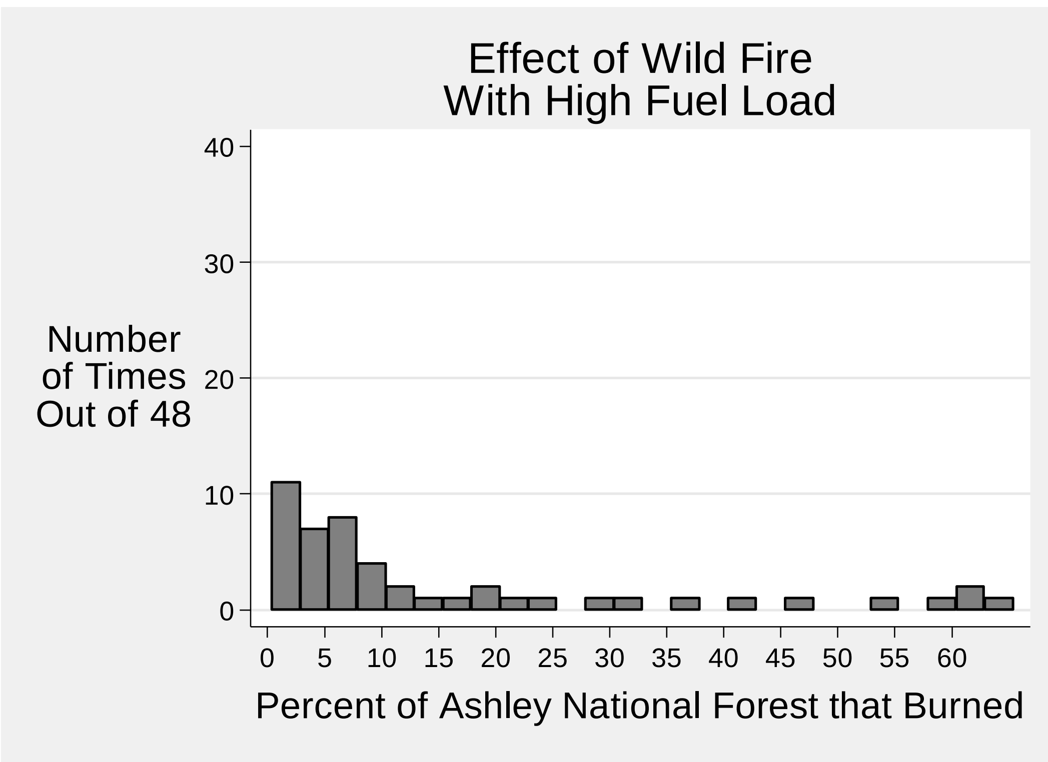
- Benign: Temperature low and air humidity high; wind speed low; fuel moisture high and proportion dead fuel low; duration 1 day; and lightning strike in the north.

- Intense: Temperature high and air humidity low; wind speed high; fuel moisture low and proportion dead fuel high; duration 2 days; and lighting strike in the central area.

Risks when fuel load is high

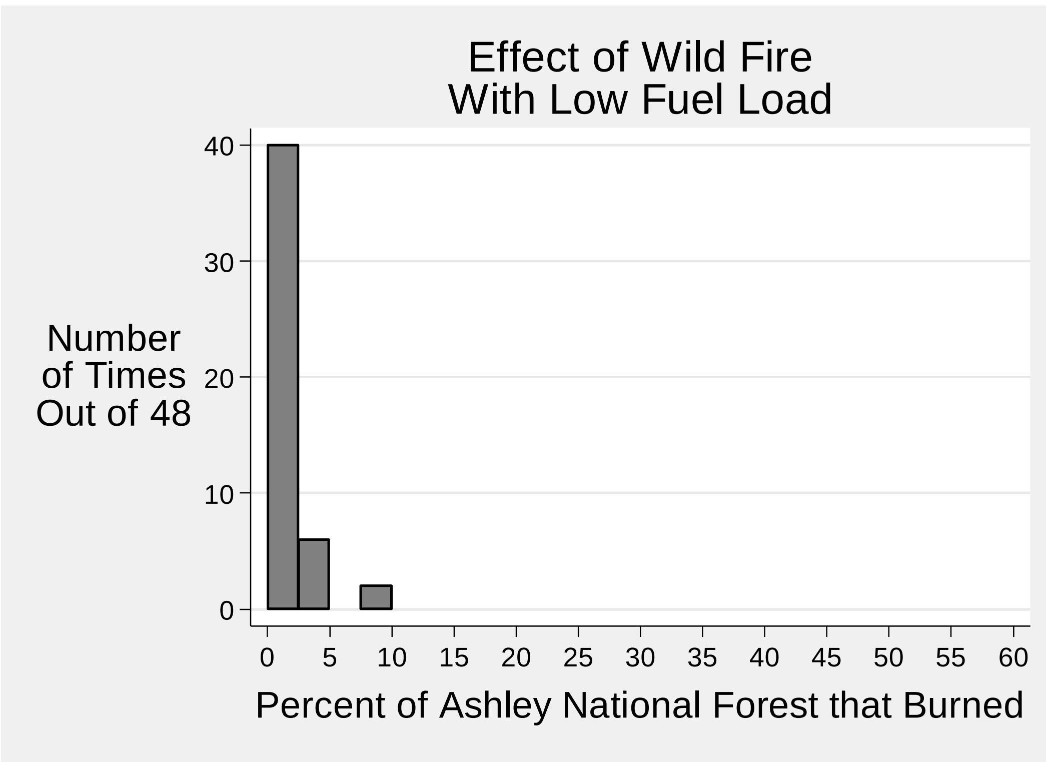
Here we will statistically describe the spread of wild fires generated by the simulation model and how it varies due to varying background factors. If we consider each of the possible background factors, not counting the variation in fuel load due to prescribed burning, there are 48 scenarios that are possible. Each scenario is a combination of temperature/humidity (high/low or low/high), wind (high or low), fuel moisture/proportion of dead vegetation (high/low or low/high), duration (short or long), and location of lightning striking (center, north, or south).

The graph below shows you what happens when the prescribed burn is *not* undertaken, that the fuel load is high. The horizontal or bottom axis shows the total acreage of Ashley National Forest that burns, in percentages. So the most severe fires burn slightly more than 60% of the whole area (in the bottom right hand side of the graph). But many of the fires burn less than 10% of the whole area (in the bottom left hand side of the graph). The vertical axis shows the number of times that the fire burns each percent of the whole area. So we see that the fire burned between 0% and 2½% of the whole area in 11 of the 48 scenarios (the first bar at the bottom left) and over 60% of the area in 3 of the 48 scenarios (the last two bars).



Risks when fuel load is low

We can generate a similar graph, assuming the same background risk factors, in the event that the prescribed burn policy is implemented and the fuel load is low.



The results are clear: lowering the fuel load by using the prescribed burn lowers the risk of having more severe wild fires. It does not eliminate those risks, but now almost every wild fire burns less than 5% of the whole area of Ashley National Forest. There are some wild fires that are more severe, even with prescribed burn policy in place.

You should also keep in mind that these displays refer to the percent of the whole area of Ashley National Forest that is burned. Even if it is only 1%, if that 1% happens to be the house, the house will burn. Of course, you can judge the risk of that for yourself.

Experiencing the risks

You will now be given a chance to experience the risks we have been describing before you place your bets. For each of the high and low fuel load cases you will experience the most benign and the most intense combination of background factors. So you will experience a total of four fire simulations.

- Benign conditions with no prescribed burn policy in place.
- Intense conditions with no prescribed burn policy in place.
- Benign conditions with a prescribed burn policy in place.
- Intense conditions with a prescribed burn policy in place.

	Simulation 1 No prescribed burn	**Simulation 2** No prescribed burn	**Simulation 3** Prescribed burn	**Simulation 4** Prescribed burn
Temperature/ Humidity	Low/High	High/Low	Low/High	High/Low
Wind Speed	Low	High	Low	High
Fuel moisture/ Proportion of dead vegetation	High/Low	Low/High	High/Low	Low/High
Duration	1 day	2 days	1 day	2 days
Lightning	North	South	North	South

Your bets for the first two tasks

Now you are ready to place your bets in the first two tasks as described earlier. You will be placing bets on two events:

1. For a simulation when the fuel load is high, because prescribed burning has not been used, you will bet on whether or not the house will burn.

2. For a simulation when the fuel load is low, because prescribed burning has been used, you will bet on whether or not the house will burn.

For each bet you will face odds from 9 bookies. Please place a bet for each of the bookies for each of the two events.

Later you will roll the die several times to randomly select the background factors for the final simulation which will determine your earnings.

Your payoff is determined by four things:

- whether the number on the card in the envelope is a 1 or a 2
- which bookie is chosen to be played out using a 10-sided die;
- what your bet is for the chosen bookie; and
- the outcome of the final simulation

Please look at the first decision sheet. It is called "Place a bet with each bookie when fuel load is high because prescribed burning has not been used." The table has 5 columns. Columns 3 and 4, labeled "If you bet that the house will burn in a forest fire and it…" and "If you bet that the house will not burn in a forest fire and it…", show you the dollar earnings you get from each bookie depending on whether the house burns or not in the final simulation. Each row in the table represents a different bookie. Recall that we will later roll a die to select only one of these bookies for payment, and only if the number on the card in the envelope has a number "1" on it representing this first task.

When you have finished filling in this first decision sheet, please continue with the second one called "Place a bet with each bookie when fuel load is low because prescribed burning has been used."

Before we go on, do you have any questions?

Tasks 3 - 5: Pay for prescribed burn or not

Before we run the simulation you will be completing some more tasks. The next set of tasks also concern the question of whether the house burns or not in the simulated fire. The type of decision you make here is different from before, however. Again, if the numbered card in the envelope is a 3, or a 4, or a 5, then your earnings will be determined by the choice you make in one of these tasks.

You are asked to make a choice between paying for the prescribed burning of the forest or not. Before you make a choice you will be given an initial credit. This credit includes the value of "owning" the simulated house in the forest. In Task 3 the initial credit is $20 the house is valued at $8. In Task 4 the initial credit is $60 and the house is valued at $28. In Task 5 the initial credit is $80 and the house is valued at $38.

If you choose to pay for prescribed burn we will run a fire simulation that is based on the low fuel load. The background factors that determine the severity of the fire, such as weather conditions or the location of lightning strikes, will be determined by rolling dice. You will be asked to indicate how much you are willing to pay for the prescribed burn. This amount will be deducted from your initial credit. If the house does not burn in the simulation, you keep the remaining credit, but if it burns you lose the amount that the house is worth.

If you choose not to pay for prescribed burn we will instead run a fire simulation that is based on the high fuel load. If the house does not burn in the simulation, you therefore keep the entire credit, but if it burns you lose the amount that the house is worth.

In either case, recall that these choices will determine your earnings only if the card in the envelope has the number 3, 4 or 5 on it.

Please look at the decision sheet for this table. Each row shows you a different cost of implementing the prescribed burn. The amount of prescribed burn that results is the same, independent of the amount paid for prescribed burn. Look at decision 1 at the top of the table. It gives a choice between doing the prescribed burn and not doing the prescribed burn, when the cost of the prescribed burn is zero.

Now look at decision 2. In this row the cost of the prescribed burn in $2. Are you willing to pay $2 for prescribed burning? All the other decisions are similar, with the cost of prescribed burn increasing by $2 for each successive row. In the very last row the cost of the prescribed burn equals the value of the simulated house. In this sheet the cost of the prescribed burn in the last row is $8.

We ask you to indicate YES or NO for each of the amounts shown. If Task 3 is chosen, you will roll a 6-sided die to pick one of the rows for payment. If you get a 6 you roll again. If Task 4 or Task 5 is chosen, you will roll a 20-sided die to pick one of these rows for payment.

For each row please think about the following: if this row is selected using the dice, would you be willing to pay the amount indicated so as to run the simulation with the lower fuel load instead of the higher fuel load?

Therefore, your payoff is determined by four things:

- whether the number on the card in the envelope is a 3, 4 or 5;
- which row is chosen to be using the 20-sided die;
- whether you said "yes" or "no" on that row, and
- whether or not the house burns in the simulation (which will use a low fuel load if you said "yes" and a high fuel load if you said "no")

Please complete the decision sheets for tasks 3, 4 and 5 now, unless you have any questions.

Task 6: Lottery choices

In task 6 you will be making choices between pairs of lotteries. Please look at the decision sheet for this task. The table shows ten rows. Each row is a paired choice between "Option A" and "Option B." These options are both lotteries that will be played out. You will make a choice between these two options on each row and record these in the final column.

We will use two 10-sided dice to determine your payoffs. The numbers on the two dice are added to get a number between 0-99. We will use the number 0 to serve as 100. Look at decision 1 at the top of the table. It gives a choice between getting $24 for certain and getting $1 for certain. The die will not be needed for this option.

Now look at decision 2. Option A pays $26 if you get a number between 1 and 10, and it pays $24 if you get a number between11-100. Option B pays $50 if you get a number between 1-10, and it pays $1 if the number is between 11-100. The other decisions are similar, except that as you move down the table, the chances of the higher payoff for each option increase.

If the number 6 is inside the envelope you picked, you will roll a ten-sided die to select one of the ten rows. Your choice for that row, option A or B, will be played out with two ten-sided dies and the outcome will determine your earning.

Therefore, your payoff is determined by three things:

- which lottery pair is chosen to be played out using the 10-sided die;
- which lottery you selected, A or B, for the chosen lottery pair; and
- the outcome of that lottery when you roll the two 10-sided dice.

Task 7: Lottery choices

This task is similar to the task you just completed, except in this task there is a chance you will lose money. Before you make your choices you will be given a credit of $50 and any loss will be deducted from this money to determine your payment. You cannot lose more than $50.

Please look at the decision sheet for Task 7. In this decision sheet you have a credit of $50. Option A in the first row gives -$26 for numbers 1-100. Since you have a credit of $50, playing this lottery will give you a final payoff of $50 - $26 = $24. Similarly, Option B in the first row will give you a payoff of $50 – $49 = $1.

Each lottery in Option A of Task 7 has the payoffs -$26 and -$24 except the first lottery, which gives -$26 for certain. Each lottery in Option B has the payoffs -$49 and -$0 except the first lottery, which gives -$49 for certain. The chances of getting these payoffs are different in each row. As you move down the table, the chances of losing the higher amounts decrease.

Task 8-11: More lottery choices

These are the last set of tasks. Consider the decision sheet for Task 8. All lotteries in Option B of this table are the same. You have an initial credit of $20. If you get a number between 1-29 you lose $8, that is, your payoff is $20 - $8 = $12. For any other number you lose zero and your payoff is $20.

Option A in the first row pays -$8 if you get a number between 1-6 and zero otherwise. In the second row Option A pays -$10 for a number between 1-6 and -$2 for any other number. That is, your payoff is $20-$10 = $10 if you get a number 1-6 and $20 - $2 = $18 otherwise. As you move down the table the amount you lose increases, although the chance of losing each remains same.

Notice that both lotteries in the top row pay -$8 and -$0, although getting -$0 (or a payoff of $20) is more likely for Option A.

Please make a choice for each pair of lottery in the decision sheets 8-11. If either number 8 or 9 is inside the envelope you picked, you will roll a 6-sided die to select one of the 6 rows. If you roll the number 6 you will simply roll again. Your choice for that row, option A or B, will be played out with two ten-sided dice and the outcome will determine your earning.

If either number 10 or 11 is inside the envelope you picked, you will roll a 20-sided die to select one of the 20 rows. Your choice for that row, option A or B, will be played out with two ten-sided dice and the outcome will determine your earning.

Therefore, your payoff is determined by four things:

- whether the number on the card is between 8-11;
- which lottery pair is chosen to be played out using the 6-sided or 20-sided die;
- which lottery you selected, A or B, for the chosen lottery pair; and
- the outcome of that lottery when you roll the two 10-sided die.

After you have finished making your choices all the tasks you can open your envelope. The number in your envelope is the task for which you will be paid. If your envelope contains a number between 1 and 5 then we will run a final simulation to determine your payment. You will roll a 6-sided dice several times to choose the background factors for this final simulation.

If your envelope contains a number between 6 and 11 you will be paid for one of the lottery choices. You will roll a 10-sided lottery to pick the lottery choice you will be paid for. The outcome of this lottery will determine your earnings.

APPENDIX B. DECISION SHEETS FOR SHORT RUN EXPERIMENT

This appendix contains the 11 decision sheets faced by subjects in the short run individual experiment.

1. Place a bet with each bookie when
Fuel Load is High because prescribed burning has not been used.

Bookie	Your Stake	A. If you bet that the house will burn in a forest fire and it…	B. If you bet that the house will not burn in a forest fire and it…	Do you bet your stake on A or B? (Circle A or B)
1	$5	does you get $50 does not you get $0	does you get $0 does not you get $5.55	A B
2	$5	does you get $25 does not you get $0	does you get $0 does not you get $6.25	A B
3	$5	does you get $16.66 does not you get $0	does you get $0 does not you get $7.19	A B
4	$5	does you get $12.50 does not you get $0	does you get $0 does not you get $8.33	A B
5	$5	does you get $10 does not you get $0	does you get $0 does not you get $10	A B
6	$5	does you get $8.33 does not you get $0	does you get $0 does not you get $12.50	A B
7	$5	does you get $7.19 does not you get $0	does you get $0 does not you get $16.66	A B
8	$5	does you get $6.25 does not you get $0	does you get $0 does not you get $25	A B
9	$5	does you get $5.55 does not you get $0	does you get $0 does not you get $50	A B

2. Place a bet with each bookie when
Fuel Load is Low because prescribed burning has been used.

Bookie	Your Stake	A. If you bet that the house will burn in a forest fire and it…	B. If you bet that the house will not burn in a forest fire and it…	Do you bet your stake on A or B? (Circle A or B)
1	$5	does you get $50 does not you get $0	does you get $0 does not you get $5.55	A B
2	$5	does you get $25 does not you get $0	does you get $0 does not you get $6.25	A B
3	$5	does you get $16.66 does not you get $0	does you get $0 does not you get $7.19	A B
4	$5	does you get $12.50 does not you get $0	does you get $0 does not you get $8.33	A B
5	$5	does you get $10 does not you get $0	does you get $0 does not you get $10	A B
6	$5	does you get $8.33 does not you get $0	does you get $0 does not you get $12.50	A B
7	$5	does you get $7.19 does not you get $0	does you get $0 does not you get $16.66	A B
8	$5	does you get $6.25 does not you get $0	does you get $0 does not you get $25	A B
9	$5	does you get $5.55 does not you get $0	does you get $0 does not you get $50	A B

3. Choose Prescribed Burn or Not for each possible cost.
You have $20. Your house is valued at $8.

Cost	Yes, I choose prescribed burn.	No, I do not choose prescribed burn.
$0	Yes	No
$2	Yes	No
$4	Yes	No
$6	Yes	No
$8	Yes	No

4. Choose Prescribed Burn or Not for each possible cost.
You have $60. Your house is valued at $28.

Cost	Yes, I choose prescribed burn.	No, I do not choose prescribed burn.
$0	Yes	No
$2	Yes	No
$4	Yes	No
$6	Yes	No
$8	Yes	No
$10	Yes	No
$12	Yes	No
$14	Yes	No
$16	Yes	No
$18	Yes	No
$20	Yes	No
$22	Yes	No
$24	Yes	No
$26	Yes	No
$28	Yes	No

5. Choose Prescribed Burn or Not for each possible cost.
You have $80. Your house is valued at $38.

Cost	Yes, I choose prescribed burn.	No, I do not choose prescribed burn.
$0	Yes	No
$2	Yes	No
$4	Yes	No
$6	Yes	No
$8	Yes	No
$10	Yes	No
$12	Yes	No
$14	Yes	No
$16	Yes	No
$18	Yes	No
$20	Yes	No
$22	Yes	No
$24	Yes	No
$26	Yes	No
$28	Yes	No
$30	Yes	No
$32	Yes	No
$34	Yes	No
$36	Yes	No
$38	Yes	No

6. Choose between Option A and Option B

Decision	Option A	Option B	Your Choice (Circle A or B)
1	$24 if throw of die is 1-100	$1 if throw of die is 1-100	A B
2	$26 if throw of die is 1-10 $24 if throw of die is 11-100	$50 if throw of die is 1-10 $1 if throw of die is 11-100	A B
3	$26 if throw of die is 1-20 $24 if throw of die is 21-100	$50 if throw of die is 1-20 $1 if throw of die is 21-100	A B
4	$26 if throw of die is 1-30 $24 if throw of die is 31-100	$50 if throw of die is 1-30 $1 if throw of die is 31-100	A B
5	$26 if throw of die is 1-40 $24 if throw of die is 41-100	$50 if throw of die is 1-40 $1 if throw of die is 41-100	A B
6	$26 if throw of die is 1-50 $24 if throw of die is 51-100	$50 if throw of die is 1-50 $1 if throw of die is 51-100	A B
7	$26 if throw of die is 1-60 $24 if throw of die is 61-100	$50 if throw of die is 1-60 $1 if throw of die is 61-100	A B
8	$26 if throw of die is 1-70 $24 if throw of die is 71-100	$50 if throw of die is 1-70 $1 if throw of die is 71-100	A B
9	$26 if throw of die is 1-80$24 if throw of die is 81-100	$50 if throw of die is 1-80 $1 if throw of die is 81-100	A B
10	$26 if throw of die is 1-90 $24 if throw of die is 91-100	$50 if throw of die is 1-90 $1 if throw of die is 91-100	A B

7. Choose between Option A and Option B (You have a $50 credit)

Decision	Option A	Option B	Your Choice (Circle A or B)
1	-$26 if throw of die is 1-100	-$49 if throw of die is 1-100	**A B**
2	-$24 if throw of die is 1-10 -$26 if throw of die is 11-100	-$0 if throw of die is 1-10 -$49 if throw of die is 11-100	**A B**
3	-$24 if throw of die is 1-20 -$26 if throw of die is 21-100	-$0 if throw of die is 1-20 -$49 if throw of die is 21-100	**A B**
4	-$24 if throw of die is 1-30 -$26 if throw of die is 31-100	-$0 if throw of die is 1-30 -$49 if throw of die is 31-100	**A B**
5	-$24 if throw of die is 1-40 -$26 if throw of die is 41-100	-$0 if throw of die is 1-40 -$49 if throw of die is 41-100	**A B**
6	-$24 if throw of die is 1-50 -$26 if throw of die is 51-100	-$0 if throw of die is 1-50 -$49 if throw of die is 51-100	**A B**
7	-$24 if throw of die is 1-60 -$26 if throw of die is 61-100	-$0 if throw of die is 1-60 -$49 if throw of die is 61-100	**A B**
8	-$24 if throw of die is 1-70 -$26 if throw of die is 71-100	-$0 if throw of die is 1-70 -$49 if throw of die is 71-100	**A B**
9	-$24 if throw of die is 1-80 -$26 if throw of die is 81-100	-$0 if throw of die is 1-80 -$49 if throw of die is 81-100	**A B**
10	-$24 if throw of die is 1-90 -$26 if throw of die is 91-100	-$0 if throw of die is 1-90 -$49 if throw of die is91-100	**A B**

8. Choose between Option A and Option B (You have a $20 credit)

Decision	Option A	Option B	Your Choice (Circle A or B)
1	-$8 if throw of die is 1-6 -$0 if throw of die is 7-100	-$8 if throw of die is 1-29 -$0 if throw of die is 30-100	**A B**
2	-$10 if throw of die is 1-6 -$2 if throw of die is 7-100	-$8 if throw of die is 1-29 -$0 if throw of die is 30-100	**A B**
3	-$12 if throw of die is 1-6 -$4 if throw of die is 7-100	-$8 if throw of die is 1-29 -$0 if throw of die is 30-100	**A B**
4	-$14 if throw of die is 1-6 -$6 if throw of die is 7-100	-$8 if throw of die is 1-29 -$0 if throw of die is 30-100	**A B**
5	-$16 if throw of die is 1-6 -$8 if throw of die is 7-100	-$8 if throw of die is 1-29 -$0 if throw of die is 30-100	**A B**

9. Choose between Option A and Option B (You have a $20 credit)

Decision	Option A	Option B	Your Choice (Circle A or B)
1	-$8 if throw of die is 1-6 -$0 if throw of die is 7-100	-$8 if throw of die is 1-59 -$0 if throw of die is 60-100	**A B**
2	-$10 if throw of die is 1-6 -$2 if throw of die is 7-100	-$8 if throw of die is 1-59 -$0 if throw of die is 60-100	**A B**
3	-$12 if throw of die is 1-6 -$4 if throw of die is 7-100	-$8 if throw of die is 1-59 -$0 if throw of die is 60-100	**A B**
4	-$14 if throw of die is 1-6 -$6 if throw of die is 7-100	-$8 if throw of die is 1-59 -$0 if throw of die is 60-100	**A B**
5	-$16 if throw of die is 1-6 -$8 if throw of die is 7-100	-$8 if throw of die is 1-59 -$0 if throw of die is 60-100	**A B**

10. Choose between Option A and Option B (You have a $80 credit)

Decision	Option A	Option B	Your Choice (Circle A or B)
1	-$38 if throw of die is 1-6 -$0 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
2	-$40 if throw of die is 1-6 -$2 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
3	-$42 if throw of die is 1-6 -$4 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
4	-$44 if throw of die is 1-6 -$6 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
5	-$46 if throw of die is 1-6 -$8 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
6	-$48 if throw of die is 1-6 -$10 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
7	-$50 if throw of die is 1-6 -$12 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
8	-$52 if throw of die is 1-6 -$14 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
9	-$54 if throw of die is 1-6 -$16 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
10	-$56 if throw of die is 1-6 -$18 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
11	-$58 if throw of die is 1-6 -$20 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
12	-$60 if throw of die is 1-6 -$22 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
13	-$62 if throw of die is 1-6 -$24 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
14	-$64 if throw of die is 1-6 -$26 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B
15	-$66 if throw of die is 1-6 -$28 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	A B

16	-$68 if throw of die is 1-6 -$30 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	**A B**
17	-$70 if throw of die is 1-6 -$32 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	**A B**
18	-$72 if throw of die is 1-6 -$34 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	**A B**
19	-$74 if throw of die is 1-6 -$36 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	**A B**
20	-$76 if throw of die is 1-6 -$38 if throw of die is 7-100	-$38 if throw of die is 1-29 -$0 if throw of die is 30-100	**A B**

11. Choose between Option A and Option B (You have a $80 credit)

Decision	Option A	Option B	Your Choice (Circle A or B)
1	-$38 if throw of die is 1-6 -$0 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
2	-$40 if throw of die is 1-6 -$2 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
3	-$42 if throw of die is 1-6 -$4 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
4	-$44 if throw of die is 1-6 -$6 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
5	-$46 if throw of die is 1-6 -$8 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
6	-$48 if throw of die is 1-6 -$10 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
7	-$50 if throw of die is 1-6 -$12 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
8	-$52 if throw of die is 1-6 -$14 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
9	-$54 if throw of die is 1-6 -$16 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
10	-$56 if throw of die is 1-6 -$18 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
11	-$58 if throw of die is 1-6 -$20 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
12	-$60 if throw of die is 1-6 -$22 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
13	-$62 if throw of die is 1-6 -$24 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
14	-$64 if throw of die is 1-6 -$26 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B
15	-$66 if throw of die is 1-6 -$28 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	A B

16	-$68 if throw of die is 1-6 -$30 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	**A** **B**
17	-$70 if throw of die is 1-6 -$32 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	**A** **B**
18	-$72 if throw of die is 1-6 -$34 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	**A** **B**
19	-$74 if throw of die is 1-6 -$36 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	**A** **B**
20	-$76 if throw of die is 1-6 -$38 if throw of die is 7-100	-$38 if throw of die is 1-59 -$0 if throw of die is 60-100	**A** **B**

APPENDIX C. INSTRUCTIONS FOR THE LONG RUN INDIVIDUAL EXPERIMENT

Here are the instructions for the long run private experiment. Decision sheet for each task was presented to the subject along with the instructions for that task. Decision sheets are included in Appendix F.

Welcome to our experiment. This is one part of a two part experiment, and it is essential that you participate in both parts. For some of you this is your first part and for others it is the second part. You will be paid for both parts at the end of the second one. Thus, for those of you for whom this is the second part you will be paid at the end of today's session. For those of you who are here for the first part, you will receive the $5 show up fee at the end of today's session. All other earnings will be paid after your second part is completed.

If this is your first session, you can sign up for the second session at the end of today's session.

Today you will complete 24 tasks that have to do with simulated forest fires. In each of these tasks you will make some choices that have monetary consequences, but you will only be paid for one of these tasks. We will now proceed to determine which task you will be paid for.

We have here 24 envelopes and 24 cards with the numbers 1 through 24. These cards represent the tasks, which are also numbered 1 – 24. We will put these cards into the envelopes, seal the envelopes and shuffle them. Then you will select ONE of the envelopes without knowing which one contains which card. We will not open the selected envelope until you have finished all 24 tasks. The number on the card in the selected envelope is the task you will be paid for.

About Florida wild fires

Florida typically has about 5000 wild fires each year, with the most active period between March and June. For example, during the fire season of 2006 the Division of Forestry of Florida Department of Agriculture and Consumer Services reported over 4,000 wild fires covering more than 200,000 acres by the end of July.

Managing and preventing these wild fires is important. Significant economic costs, in terms of damage to property, as well as serious health and safety concerns from fire and smoke, make this an issue of interest to everyone in the state. On the other hand, there are many other important uses for your taxes than fire management. Some examples include the education system, health care, crime prevention, other environmental activities, or tax relief.

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Possible solutions to the wild fire problem

A build-up of wild fire fuel in the form of brush, dead branches, logs and pine needles on the forest floor has occurred over several decades. As a result, when wild fires are ignited they spread faster and burn longer than would otherwise be the case. During drought years the vegetation moisture levels are low and further increase the risks. In addition, when winds are strong the spread is faster and the damages more extensive.

Prescribed burning has been used to prevent wild fires from spreading quickly and getting out of hand. Prescribed burning involves having fire professionals periodically set fires to clear the forest floor of the excess brush, dead branches and pine needles.

Prescribed burns cost roughly $25 per acre. An average of half a million acres in Florida are already treated with prescribed burn each year. This corresponds to about 4% of the total forest area, and costs approximately $12.5 million statewide. To put the cost in perspective: The Florida state budget during 2005-2006 was $64.7 billion. For the 2006-7 budget year $80 million was allocated to beach restoration after increased hurricane damages.

Your Tasks

Today you will be asked to make decisions about prescribed burning in a simulated Central Florida forest where lightning may strike and start a wild fire. Your decisions and the outcome of the fire simulations will determine the earnings you get in addition to the fixed compensation of $5. There is one house in the simulated forest and your earnings will depend on whether this house burns or not in a fire.

You will be asked to make a decision about whether or not to prescribe burn in a sequence of 20 rounds. Each round represents a fire seasons in the simulated area. In every round there is some chance that lightning will strike and start a fire. To make the determination of lightning strike natural we are using the historic lightning strike pattern from different parts of Volusia County in the last 30 years to determine when and if lightning strikes. At the beginning of each round you will make your decision and after that we will reveal whether or not lightning strikes in that round.

If a fire occurs, its severity and spread depends on whether prescribed burning has been implemented in that round. If prescribed burning has been implemented the fuel load is lower and the fire burns out faster and spreads less rapidly. Conversely, if no prescribed burning has been implemented the fuel load is higher and the fire burns longer and more intensively and spreads more rapidly.

In addition to these 20 decisions over prescribed burning you will also be asked to place four bets on whether or not the house will burn in a series of separate simulations where the weather and burn conditions will differ, but where you know for sure that a fire will start.

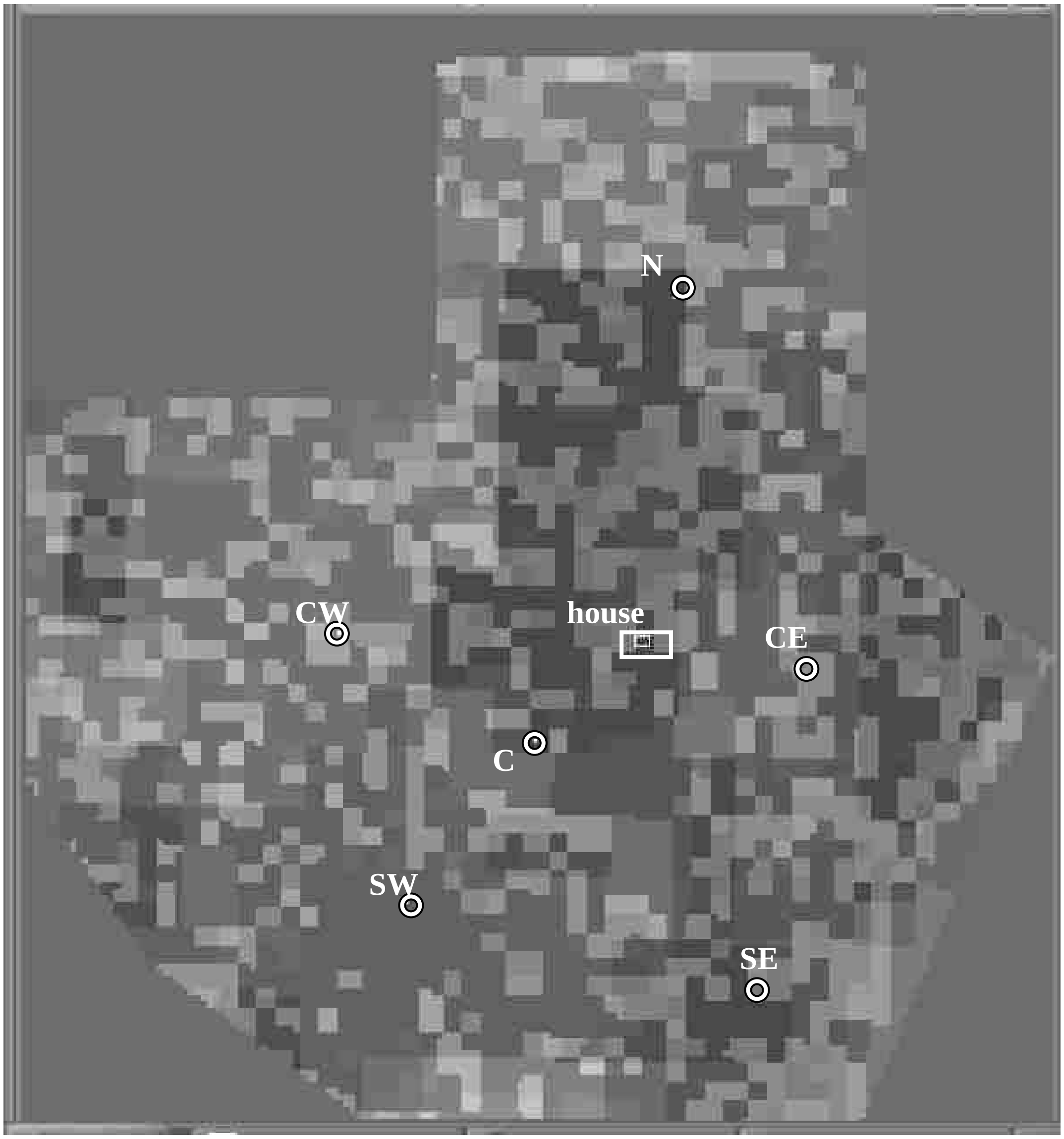
What determines the risk of the house burning?

The simulation of forest fires that we will use here is one that is employed by the US Forest Service when predicting spreads of wild fires. The forest area that we are simulating in this model is the Lake Diaz area, Volusia County in Central Florida.

A number of background factors affect the intensity of the fires and the way that the fires spread. Florida goes through cycles of drought and wet years, and in drought years fires are significantly more intensive due to the general dryness of the fuels. In addition, short term weather variations affect fires as well: higher temperatures, lower air moistures, and stronger winds. Our simulation software is built around two historic fire seasons in Central Florida: March – June 1999 and March – June 2003. According to Volusia County Fire Services 1999 was classified as a drought period, while 2003 was a normal year in terms of rain fall. For each of these periods we have collected data on rain fall, air humidity, temperatures and wind speeds and directions. We have randomly sampled 10 dates from each of March – June 1999 and March – June 2003 for which fires may start in our simulations. For each of these dates we use the historic weather data on

- Rain fall
- Air humidity
- Temperatures
- Wind direction
- Wind speed

In addition to these weather conditions the intensity and spread of a fire depends on a number of other factors that we realistically impose on the simulations. We can simulate time periods with more or less fire fighting resources by varying the duration of the fire from one to two days. We can simulate drought and normal years by changing vegetation moisture levels and the amount of dead vegetation. Drought years would have high or extremely high levels of dry and dead vegetation and normal years would have low or moderate levels. These background factors are determined by rolling several dice. This mimics the randomness of actual weather and drought conditions.



Above is a map of the simulated Lake Diaz area. The circles in the North, Central, Central East, Central West, South East or South West parts of the map show 6 selected sites where the lightning may strike and start a fire. The map also shows you where the house is located in relation to these sites. The house is the rectangular shape on the map. Thus, even though the determination of whether a lightning strike happens or not is given by historic data, the location of the lightning strike is restricted to these six locations and is randomly generated.

How will you learn if a fire occurs in a particular round? Here are twenty envelopes numbered 1-20 and kept in ascending order. After you have completed making your decision about prescribed burning you will open the envelope that has the number corresponding to the round you are in. For those years when a lightning strike did in fact occur we have placed a red card in the envelope. For all other years the card is white.

In years when a fire occurs, the background factors of the fire to be simulated are determined by repeatedly rolling the dies. The following tables show you how you will roll a standard 6-sided die to determine the background factors including duration, drought, vegetation moisture and location of lightning strike:

Die roll	**1-3**	**4-6**
Duration	One day	Two days

Another die roll	**1-3**	**4-6**
Drought or Normal year	Drought (1999)	Normal (2003)

Another die roll	**1-3**	**4-6**
Vegetation Moisture	Low	High

Die roll	**1**	**2**	**3**	**4**	**5**	**6**
Location of lightning strike	Central	Central East	Central West	North	South East	South West

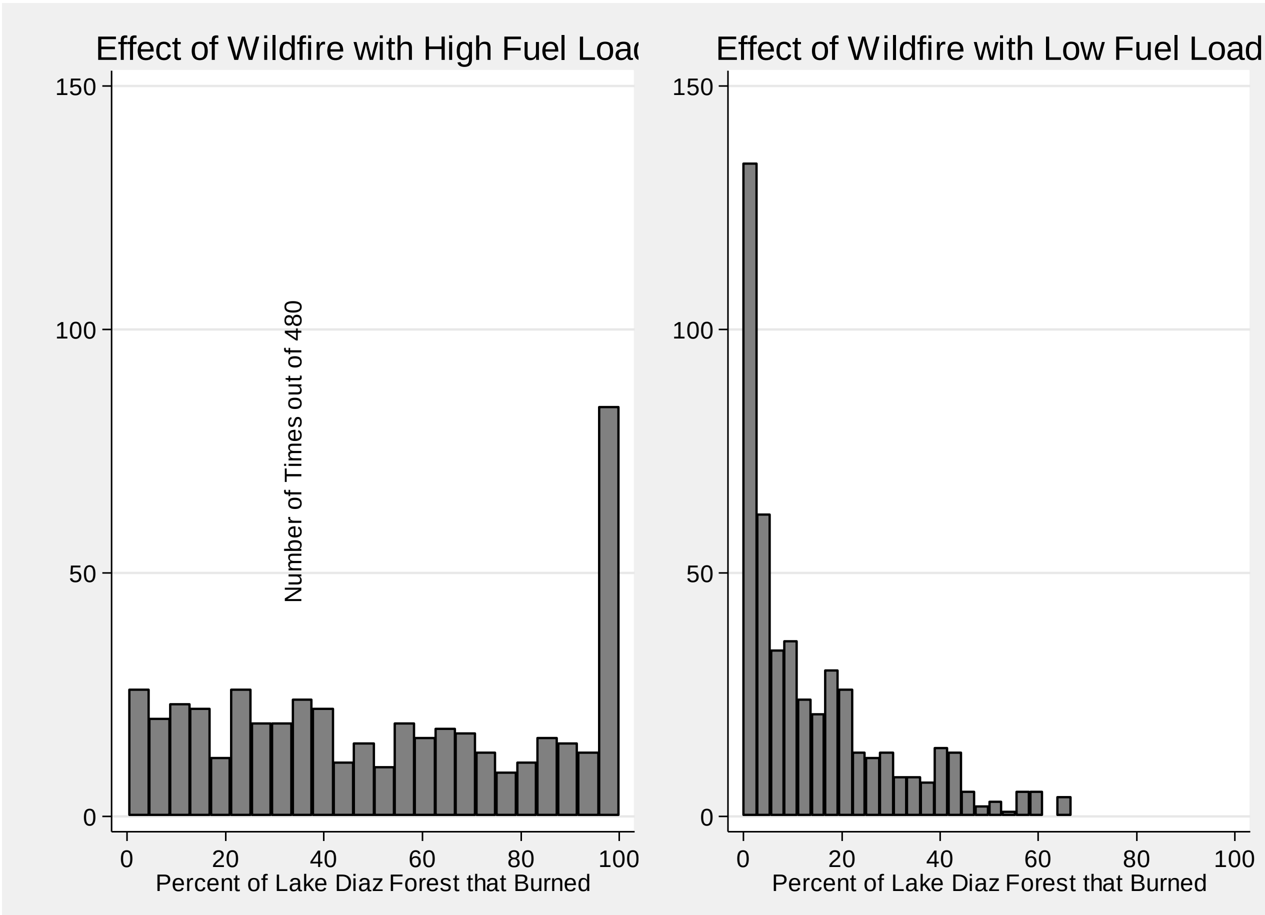
To select the day of the historic weather pattern that will be used you will roll a 10 sided die. This is how the date will be picked:

1999									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
03-05	**03-28**	**04-02**	**05-18**	**05-23**	**05-30**	**06-03**	**06-08**	**06-12**	**06-17**

2003									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
03-06	**03-26**	**04-04**	**04-12**	**05-26**	**05-27**	**06-18**	**06-20**	**06-22**	**06-25**

Comparing simulated fire risks with and without prescribed burns

In this section we will statistically describe the spread of wild fires generated by the simulation model. If we consider each of the possible background factors, not counting the variation in fuel load due to prescribed burning, there are 480 scenarios that are possible. Each scenario is a combination of vegetation moisture (drought or normal), fuel moisture (high or low), duration (short or long), ignition location (north, central, central east, central west, south east or south west) and historic weather pattern (10 different dates).



The graphs above compare the percentage of area burned under the high fuel load and low fuel load conditions. On the left we show what happens when prescribed burn is *not* undertaken, that is the fuel load is high and on the right we show what happens when prescribed burn is undertaken and the fuel load is low. The horizontal axis shows the total acreage of Lake Diaz forest that burns, in percentages and the vertical axis shows the number of times that the fire burns that percent of the whole area.

So in the high fuel case the entire forest area burns more than 80 times out of the total 480 scenarios. Compare this to the low fuel case where the entire forest area never burns. In fact, the maximum area that burns under the low fuel condition is only slightly more than 60%. Conversely, we see that the fire burns between 0% and 2½% of the whole area in 30 of the 480 scenarios in the high fuel case; Compare this to the 140 of the 480 scenarios in the low fuel case that the fire burns 0% and 2½% of the whole area.

The results are clear: Lowering the fuel load by using the prescribed burn lowers the risk of having more severe wild fires. It does not eliminate those risks, but now almost every wild fire burns less than 60% of the forest area. There are some wild fires that are more severe, even with the enhanced prescribe burn policy in place.

You should also keep in mind that these displays refer to the percent of the whole forest area that is burned. Even if it is only 1%, if that 1% happens to be the house, the house will burn. Out of the 480 scenarios for high fuel load the house burned 312 times and for the low fuel load it burned 130 times. In percentage terms this means the house burns 65% of the time in high fuel load condition and 27% of the time in low fuel load condition.

Tasks 1 – 20: Payment Tasks

There are 20 rounds in this experiment representing 20 fire seasons. At the beginning of each round, you complete one of these tasks starting with task 1 at the beginning of round 1.

In each round, you are given an initial credit of $40 and the "ownership" of the house in the forest. <u>There is a possibility that a fire may occur in any round.</u> If the house does not burn, you will sell the house to us for $40 at the end of the round. If the house burns this is what you stand to lose since you cannot sell it to us then.

In each round, you are asked to make a choice between paying for the prescribed burning of the forest or not. You may use the initial credit of $40 towards that, but you do not have to do it at all, and if you do you can choose how much of the $40 to pay. Whatever you do not pay you get to keep.

If you choose to pay for prescribed burn and if the lightning strikes in that round we will simulate a fire that is based on the low fuel load. If you choose not to pay for prescribed burn and if the lightning strikes we will instead simulate a fire based on the high fuel load. If the lightning does not strike there will be no fire.

Therefore, choosing to pay for prescribed burning reduces your $40 credit but lowers the risk of your house burning in the fire. If there is no lightning strike or if there is one but the house does not burn, you will earn an additional $40 by selling the house to us.

Here we show you how you make your choice of whether to pay for prescribed burn or not. Please look at the table below. Each row shows you a different cost for implementing the prescribed burn. The amount of prescribed burn is not affected by how much you pay. What we ask you to think about is what the maximum amount is that you would pay for the prescribed burn.

As you can see in the last row, the most you can choose to pay is $40. In the first row it shows you that the smallest amount you can choose is $0, i.e. to pay nothing. Why would you ever choose any amount higher than $0? The reason is that we are going to randomly select what the actual cost of doing the burn is by rolling a 10-sided die, and if the die picks a row with a cost that is more than the highest you stated you would pay, then no prescribed burn will be undertaken (and you would keep all of your $40 credit).

Please circle the row number that corresponds to the maximum dollar amount that you would be willing to pay

Table 1. Please circle the maximum amount you are willing to pay:

1	$0
2	$5
3	$10
4	$15
5	$20
6	$25
7	$30
8	$35
9	$40

Remember that only one of the 20 rounds will be selected to determine your actual earnings. Your payoffs therefore depend on:

- whether the round is selected for payment using the envelopes with cards you prepared earlier;
- which burn cost from Table 1 is selected using the 10-sided die;
- whether you were willing to pay that much for prescribed burning, ;
- whether there is a lightning strike and therefore a fire (red card) or no fire (white card) in this period
- which background factors (weather, moisture, drought, etc.) are chosen by rolling the dies
- whether or not the house burns in the fire simulation (when there is a lightning strike)

Tasks 21-24: Betting Tasks

You will also undertake four betting tasks in addition to making decisions about paying for prescribed burn. These tasks are numbered 21 – 24. In fact, you will do tasks 21 and 22 before you do tasks 1-20. The remaining two betting tasks, 23 and 24, will be done immediately after a fire has occurred. If no fire occurs at all during rounds 1-20 they will be undertaken after round 20.

All the betting tasks concern whether or not the house will burn in a simulated forest fire under randomly selected conditions. This simulation is not one of those that may occur during rounds 1-20 but is a completely independent one. In fact, it will be one in which you know for sure that there will be lightning strike and a fire, although you will not know the exact background factors that influence the fire.

The first event is a forest fire that takes place in a year when the forest has not been managed through prescribed burns. In this case a lot of fuel is left in the forest, increasing the intensity and spread of fires. You will be asked to place a bet on whether or not the house will burn in the simulated fire. This will be Task 21 and 23.

The second event is a forest fire that takes place in a year when the forest has been managed through prescribed burns. A reduced fuel level reduces the intensity and spread of fires. Again, you will be asked to bet on whether or not the house will burn in the simulated fire. This will be Tasks 22 and 24.

For each event there will be 9 bookies offering odds. You will make bets with all 9 bookies. For each event you are given a $5 stake to bet with. If the number on the card in the envelope you picked at the beginning is 21, 22, 23 or 24, you will be paid for the corresponding betting task. If so, we will also have to roll a die to choose one of these 9 betting houses. Thus, each of your bets is equally likely to be chosen to determine your earnings.

Please look at the table below. It is called “Place a bet with each bookie when fuel load is high because prescribed burning has not been used.” The table has 5 columns. Columns 3 and 4, labeled “If you bet that the house will burn in a forest fire and it…” and “If you bet that the house will not burn in a forest fire and it…”, show you the dollar earnings you get from each bookie depending on whether the house burns or not in the final simulation.

Each row in the table represents a different bookie. This table is similar to the decision sheet you will face for betting tasks 21 and 23 except that it has only 3 bookies while the final version has 9.

Table 2. Place a bet with each bookie when
Fuel Load is High because prescribed burning has not been used.

Bookie	Your Stake	A. If you bet that the house will burn in a forest fire and it…	B. If you bet that the house will not burn in a forest fire and it…	Do you bet your stake on A or B? (Circle A or B)
1	$5	does you get $50 does not you get $0	does you get $0 does not you get $5.55	A B
2	$5	does you get $25 does not you get $0	does you get $0 does not you get $6.25	A B
3	$5	does you get $16.66 does not you get $0	does you get $0 does not you get $7.19	A B

The decision sheet for betting task 22 and 24 are similar except they are labeled “Place a bet with each bookie when fuel load is low because prescribed burning has been used.”

Thus, your payoff for the betting tasks is determined by four things:

- whether the number on the card in the envelope is 21, 22, 23 or 24
- which bookie is chosen to be played out using a 10-sided die;
- what your bet is for the chosen bookie; and
- the outcome of the final simulation

Summary

To sum up, you will face 24 tasks in all: 20 payment tasks and 4 betting tasks. There are 20 rounds in this experiment corresponding to 20 fire seasons in different parts of Volusia county. Each round starts with a payment task in which you are asked to choose whether or not to pay for prescribed burning. Next you open an envelope to check if a fire occurs in that round. If the card inside is red there is a fire in that round and we will simulate a fire. If the card is white there is no fire. Depending on whether you chose to pay for prescribed burn or not, the simulated fire will use the low fuel load or the high fuel load. In the event of a fire, your payment for this task is determined by whether or not the house burns.

The 4 betting tasks require you to bet on whether or not the house will burn in a simulated forest fire. You are asked to place bets in 2 different events: with low fuel load or when the forest is prescribed burned and with high fuel load. You face tasks 21 and 22 are at the beginning of round one and tasks 23 and 24 after a round in which a fire occurs. Note that if any of the betting tasks are chosen for payment a fire will always be simulated.

APPENDIX D. INSTRUCTIONS FOR LONG RUN PUBLIC GOODS EXPERIMENT WITHOUT RISK

Here are the instructions for the long run public goods experiment with no risk. Decision sheet 1 to 20 in Appendix F accompanied these tasks. In addition subjects also completed the 2 risk aversion tasks or decision sheets 25 and 26 in Appendix F.

Welcome to our experiment. This is one part of a two part experiment, and it is essential that you participate in both parts. For some of you this is your first part and for others it is the second part. You will be paid for both parts at the end of the second one. Thus, for those of you for whom this is the second part you will be paid at the end of today's session. For those of you who are here for the first part, you will receive the $5 show up fee at the end of today's session. All other earnings will be paid after your second part is completed.

If this is your first session, you can sign up for the second session at the end of today's session.

Today you will complete 22 tasks. In each of these tasks you will make some choices that have monetary consequences, but you will only be paid for one of these tasks. We will now proceed to determine which task you will be paid for.

We have here 22 envelopes and 22 cards with the numbers 1 through 22. These cards represent the tasks, which are also numbered 1 – 22. We will put these cards into the envelopes, seal the envelopes and shuffle them. Then a volunteer from among you will select ONE of the envelopes without knowing which one contains which card. We will not open the selected envelope until you have finished all 22 tasks. The number on the card in the selected envelope is the task you will be paid for.

Tasks 1 through 20 have to do with forest fires.

About Florida wild fires

Florida typically has about 5000 wild fires each year, with the most active period between March and June. For example, during the fire season of 2006 the Division of Forestry of Florida Department of Agriculture and Consumer Services reported over 4,000 wild fires covering more than 200,000 acres by the end of July.

Managing and preventing these wild fires is important. Significant economic costs, in terms of damage to property, as well as serious health and safety concerns from fire and smoke, make this an issue of interest to everyone in the state. On the other hand, there are many other important uses for your taxes than fire management. Some examples include the education system, health care, crime prevention, other environmental activities, or tax relief.

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Possible solutions to the wild fire problem

A build-up of wild fire fuel in the form of brush, dead branches, logs and pine needles on the forest floor has occurred over several decades. As a result, when wild fires are ignited they spread faster and burn longer than would otherwise be the case. During drought years the vegetation moisture levels are low and further increase the risks. In addition, when winds are strong the spread is faster and the damages more extensive.

Prescribed burning has been used to prevent wild fires from spreading quickly and getting out of hand. Prescribed burning involves having fire professionals periodically set fires to clear the forest floor of the excess brush, dead branches and pine needles.

Prescribed burns cost roughly $25 per acre. An average of half a million acres in Florida are already treated with prescribed burn each year. This corresponds to about 4% of the total forest area, and costs approximately $12.5 million statewide. To put the cost in perspective: The Florida state budget during 2005-2006 was $64.7 billion. For the 2006-7 budget year $80 million was allocated to beach restoration after increased hurricane damages.

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Tasks 1 – 20: Payment Tasks

Today you will be asked to make decisions about prescribed burning in a forest. Your decisions and the decision of others in this room will determine the earnings you get in addition to the fixed compensation of $5. There is one house in the forest and your earnings will depend on whether this house burns or not in a fire.

You will be asked to make a decision about whether or not to prescribe burn in a sequence of 20 rounds. Each round represents a fire season. At the beginning of each round, you complete one of these tasks starting with task 1 at the beginning of round 1.

In each round, you are given an initial credit of $40 and the "joint ownership" of the house in the forest along with the other participants in this room. A fire occurs in every round. If the house does not burn, you will sell the house to us at the end of the round. And you will get your share of $40. If the house burns this is what you stand to lose since you cannot sell it to us then.

The cost of prescribed burning is $120. In each round, you are asked to make a choice between paying for the prescribed burning of the forest or not. You may use the initial credit of $40 towards that, but you do not have to do it at all, and if you do you can choose how much of the $40 to pay. Whatever you do not pay you get to keep.

Here is how your payoff is determined:

- If the total amount paid by all participants in the room exceeds $120, we will deduct the amount you chose to pa from your initial credit of $40. You will also get the additional $40 as your share of the house, since prescribed burning is provided your house does not burn.
- If the total amount paid by all participants in the room does NOT exceed $120, we will NOT deduct anything from your initial credit of $40. However, you will lose the additional $40, your share of the house, since prescribed burning is NOT provided and your house does burn.

Here we show you how you make your choice of whether to pay for prescribed burn or not. Please look at the table below. Each row shows you a different amount paid for prescribed burn. What we ask you to think about is what the maximum amount is that you would pay for the prescribed burn.

As you can see in the last row, the most you can choose to pay is $40. In the first row it shows you that the smallest amount you can choose is $0, i.e. to pay nothing.

Please circle the row number that corresponds to the maximum dollar amount that you would be willing to pay. Keep in mind that the cost of prescribed burning is $120 and nothing is deducted from your initial credit if prescribed burning is not provided.

Table 1. Please circle the maximum amount you are willing to pay:

1	$0
2	$5
3	$10
4	$15
5	$20
6	$25
7	$30
8	$35
9	$40

Your payoffs therefore depend on:

- whether the card in the envelope has a number between 1-20;
- whether the total amount paid by all participants exceeded the cost of prescribed burning or $120 ;

Tasks 21 & 22

Now we turn to the remaining tasks for today. Please look at the decision sheet. Your decision sheet shows ten decisions listed on the left. Each decision is a paired choice between "Option A" and "Option B." You will make a choice on each row and record these in the final column.

Here is a ten-sided die that will be used to determine payoffs. Look at Decision 1 at the top. Option A pays $20.00 if the throw of the ten sided die is 1, and it pays $16.00 if the throw is 2-10. Option B yields $38.50 if the throw of the die is 1, and it pays $1.00 if the throw is 2-10.

The other Decisions are similar, except that as you move down the table, the chances of the higher payoff for each option increase. In fact, for Decision 10 in the bottom row, the die will not be needed since each option pays the highest payoff for sure, so your choice here is between $20.00 or $38.50.

For task 21, after you have finished making your choices, you will throw this die twice, once to select one of the ten decisions to be used, and a second time to determine what your payoff is for the option you chose, A or B, for the particular decision selected. Even though you will make ten decisions, only one of these will end up affecting your earnings, but you will not know in advance which decision will be used.

Please choose Option A or B

Decision	Option A	Option B	**Your Choice** (Circle A or B)
1	$20.00 if throw of die is 1 $16.00 if throw of die is 2-10	$38.50 if throw of die is 1 $1.00 if throw of die is 2-10	A B
2	$20.00 if throw of die is 1-2 $16.00 if throw of die is 3-10	$38.50 if throw of die is 1-2 $1.00 if throw of die is 3-10	A B
3	$20.00 if throw of die is 1-3 $16.00 if throw of die is 4-10	$38.50 if throw of die is 1-3 $1.00 if throw of die is 4-10	A B
4	$20.00 if throw of die is 1-4 $16.00 if throw of die is 5-10	$38.50 if throw of die is 1-4 $1.00 if throw of die is 5-10	A B
5	$20.00 if throw of die is 1-5 $16.00 if throw of die is 6-10	$38.50 if throw of die is 1-5 $1.00 if throw of die is 6-10	A B
6	$20.00 if throw of die is 1-6 $16.00 if throw of die is 7-10	$38.50 if throw of die is 1-6 $1.00 if throw of die is 7-10	A B
7	$20.00 if throw of die is 1-7 $16.00 if throw of die is 8-10	$38.50 if throw of die is 1-7 $1.00 if throw of die is 8-10	A B
8	$20.00 if throw of die is 1-8 $16.00 if throw of die is 9-10	$38.50 if throw of die is 1-8 $1.00 if throw of die is 9-10	A B
9	$20.00 if throw of die is 1-9 $16.00 if throw of die is 10	$38.50 if throw of die is 1-9 $1.00 if throw of die is 10	A B
10	$20.00 if throw of die is 1-10	$38.50 if throw of die is 1-10	A B

Task 22 is similar, but in this case your earnings depend on your own choice between A and B and the choice by two other people in this room. Each group consists of three randomly selected individuals, and you will not know the identity of the two other people in your group. The choice between A and B in each row is determined by majority in the group.

Therefore, if two people in your group choose A and one person chooses B for a given row, A will be implemented for all three of you. If, on the other hand, two choose B and one chooses A, then B will be implemented.

Before the experiment starts we will go around the room with this basket containing cards numbered 1 or 2. If the number on your card is 1 you belong to group1; if it is 2 you belong to group 2.

If this task gets picked for payment, you will get into your groups. Then one person in each group will throw a 10-sided die twice, once to select one of the ten decisions to be used, and a second time to determine what your payoff is for the option you chose, A or B, for the particular decision selected.

APPENDIX E. INSTRUCTIONS FOR LONG RUN PUBLIC GOODS EXPERIMENT WITH RISK

Here are the instructions for the long run public goods experiment with risk. The decision sheets for this experiment are in Appendix F.

Welcome to our experiment. This is one part of a two part experiment, and it is essential that you participate in both parts. For some of you this is your first part and for others it is the second part. You will be paid for both parts at the end of the second one. Thus, for those of you for whom this is the second part you will be paid at the end of today's session. For those of you who are here for the first part, you will receive the $5 show up fee at the end of today's session. All other earnings will be paid after your second part is completed.

If this is your first session, you can sign up for the second session at the end of today's session.

Today you will complete 26 tasks. In each of these tasks you will make some choices that have monetary consequences, but you will only be paid for one of these tasks. We will now proceed to determine which task you will be paid for.

We have here 26 envelopes and 26 cards with the numbers 1 through 26. These cards represent the tasks, which are also numbered 1 – 26. We will put these cards into the envelopes, seal the envelopes and shuffle them. Then a volunteer from among you will select ONE of the envelopes without knowing which one contains which card. We will not open the selected envelope until you have finished all 26 tasks. The number on the card in the selected envelope is the task you will be paid for.

Tasks 1 through 24 have to do with simulated forest fires.

About Florida wild fires

Florida typically has about 5000 wild fires each year, with the most active period between March and June. For example, during the fire season of 2006 the Division of Forestry of Florida Department of Agriculture and Consumer Services reported over 4,000 wild fires covering more than 200,000 acres by the end of July.

Managing and preventing these wild fires is important. Significant economic costs, in terms of damage to property, as well as serious health and safety concerns from fire and smoke, make this an issue of interest to everyone in the state. On the other hand, there are many other important uses for your taxes than fire management. Some examples include the education system, health care, crime prevention, other environmental activities, or tax relief.

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Possible solutions to the wild fire problem

A build-up of wild fire fuel in the form of brush, dead branches, logs and pine needles on the forest floor has occurred over several decades. As a result, when wild fires are ignited they spread faster and burn longer than would otherwise be the case. During drought years the vegetation moisture levels are low and further increase the risks. In addition, when winds are strong the spread is faster and the damages more extensive.

Prescribed burning has been used to prevent wild fires from spreading quickly and getting out of hand. Prescribed burning involves having fire professionals periodically set fires to clear the forest floor of the excess brush, dead branches and pine needles.

Prescribed burns cost roughly $25 per acre. An average of half a million acres in Florida are already treated with prescribed burn each year. This corresponds to about 4% of the total forest area, and costs approximately $12.5 million statewide. To put the cost in perspective: The Florida state budget during 2005-2006 was $64.7 billion. For the 2006-7 budget year $80 million was allocated to beach restoration after increased hurricane damages.

Your Tasks

Today you will be asked to make decisions about prescribed burning in a simulated Central Florida forest where lightning may strike and start a wild fire. Your decisions and the outcome of the fire simulations will determine the earnings you get in addition to the fixed compensation of $5. There is one house in the simulated forest and your earnings will depend on whether this house burns or not in a fire.

You will be asked to make a decision about whether or not to prescribe burn in a sequence of 20 rounds. Each round represents a fire seasons in the simulated area. In every round there is some chance that lightning will strike and start a fire. To make the determination of lightning strike natural we are using the historic lightning strike pattern from different parts of Volusia County in the last 30 years to determine when and if lightning strikes. At the beginning of each round you will make your decision and after that we will reveal whether or not lightning strikes in that round.

If a fire occurs, its severity and spread depends on whether prescribed burning has been implemented in that round. If prescribed burning has been implemented the fuel load is lower and the fire burns out faster and spreads less rapidly. Conversely, if no prescribed burning has been implemented the fuel load is higher and the fire burns longer and more intensively and spreads more rapidly.

In addition to these 20 decisions over prescribed burning you will also be asked to place four bets on whether or not the house will burn in a series of separate simulations where the weather and burn conditions will differ, but where you know for sure that a fire will start.

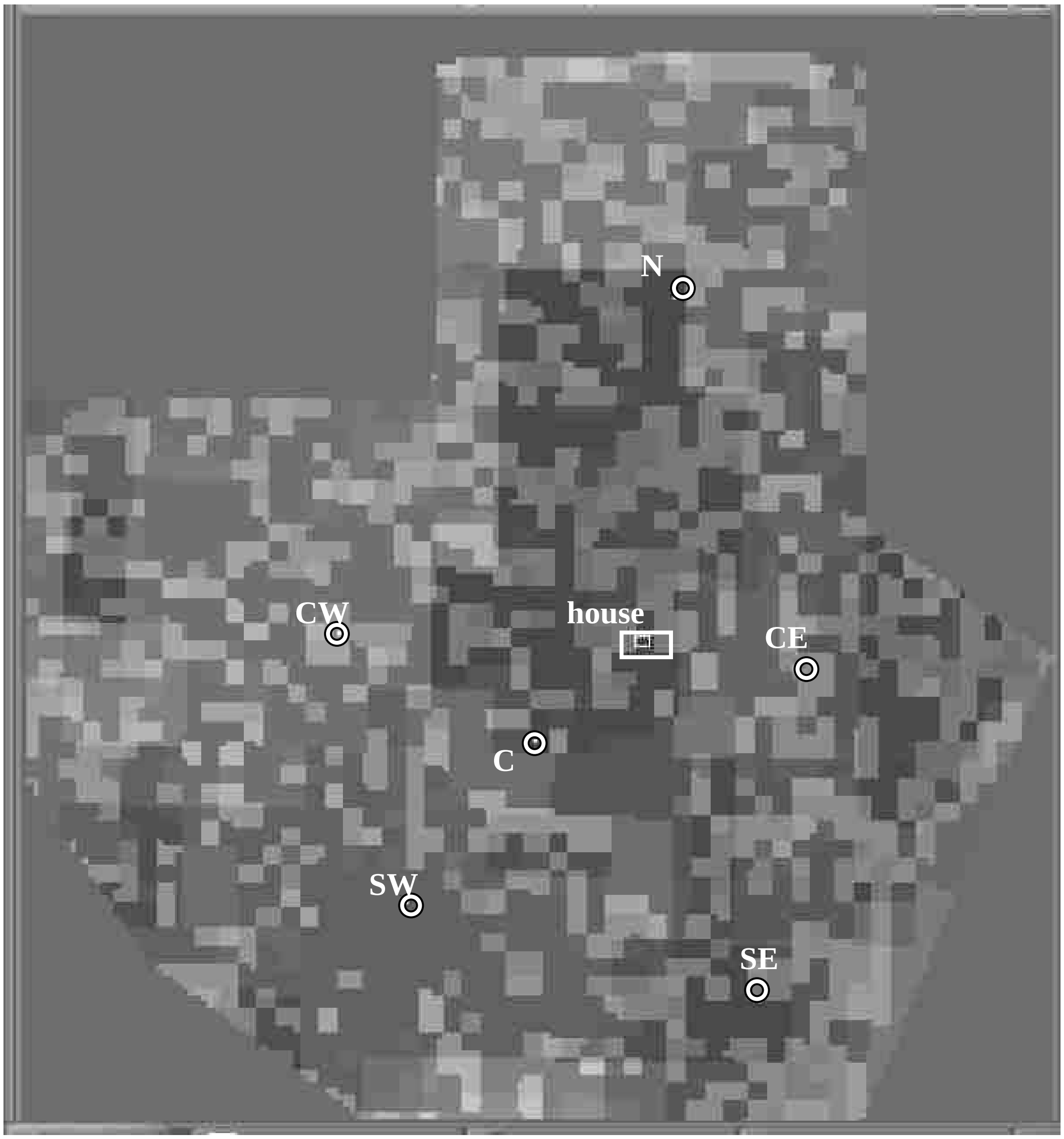
What determines the risk of the house burning?

The simulation of forest fires that we will use here is one that is employed by the US Forest Service when predicting spreads of wild fires. The forest area that we are simulating in this model is the Lake Diaz area, Volusia County in Central Florida.

A number of background factors affect the intensity of the fires and the way that the fires spread. Florida goes through cycles of drought and wet years, and in drought years fires are significantly more intensive due to the general dryness of the fuels. In addition, short term weather variations affect fires as well: higher temperatures, lower air moistures, and stronger winds. Our simulation software is built around two historic fire seasons in Central Florida: March – June 1999 and March – June 2003. According to Volusia County Fire Services 1999 was classified as a drought period, while 2003 was a normal year in terms of rain fall. For each of these periods we have collected data on rain fall, air humidity, temperatures and wind speeds and directions. We have randomly sampled 10 dates from each of March – June 1999 and March – June 2003 for which fires may start in our simulations. For each of these dates we use the historic weather data on

- Rain fall
- Air humidity
- Temperatures
- Wind direction
- Wind speed

In addition to these weather conditions the intensity and spread of a fire depends on a number of other factors that we realistically impose on the simulations. We can simulate time periods with more or less fire fighting resources by varying the duration of the fire from one to two days. We can simulate drought and normal years by changing vegetation moisture levels and the amount of dead vegetation. Drought years would have high or extremely high levels of dry and dead vegetation and normal years would have low or moderate levels. These background factors are determined by rolling several dice. This mimics the randomness of actual weather and drought conditions.



Above is a map of the simulated Lake Diaz area. The circles in the North, Central, Central East, Central West, South East or South West parts of the map show 6 selected sites where the lightning may strike and start a fire. The map also shows you where the house is located in relation to these sites. The house is the rectangular shape on the map. Thus, even though the determination of whether a lightning strike happens or not is given by historic data, the location of the lightning strike is restricted to these six locations and is randomly generated.

How will you learn if a fire occurs in a particular round? Here are twenty envelopes numbered 1-20 and kept in ascending order. After you have completed making your decision about prescribed burning a volunteer from among you will open the envelope that has the number corresponding to the round you are in. For those years when a lightning strike did in fact occur we have placed a red card in the envelope. For all other years the card is white.

In years when a fire occurs, the background factors of the fire to be simulated are determined by repeatedly rolling the dies. The following tables show you how you will roll a standard 6-sided die to determine the background factors including duration, drought, vegetation moisture and location of lightning strike:

Die roll	**1-3**	**4-6**
Duration	One day	Two days

Another die roll	**1-3**	**4-6**
Drought or Normal year	Drought (1999)	Normal (2003)

Another die roll	**1-3**	**4-6**
Vegetation Moisture	Low	High

Die roll	**1**	**2**	**3**	**4**	**5**	**6**
Location of lightning strike	Central	Central East	Central West	North	South East	South West

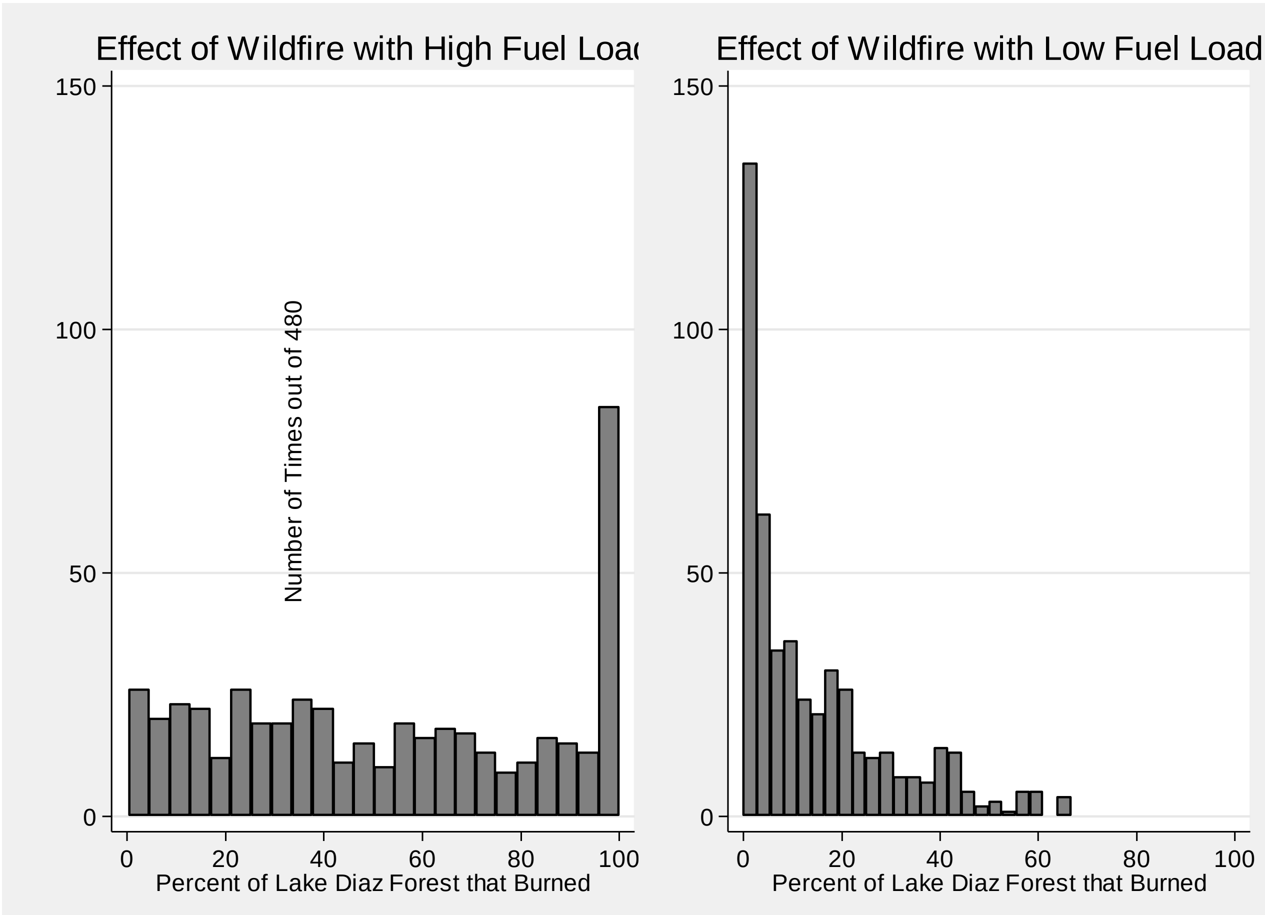
To select the day of the historic weather pattern that will be used you will roll a 10 sided die. This is how the date will be picked:

1999									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
03-05	**03-28**	**04-02**	**05-18**	**05-23**	**05-30**	**06-03**	**06-08**	**06-12**	**06-17**

2003									
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
03-06	**03-26**	**04-04**	**04-12**	**05-26**	**05-27**	**06-18**	**06-20**	**06-22**	**06-25**

Comparing simulated fire risks with and without prescribed burns

In this section we will statistically describe the spread of wild fires generated by the simulation model. If we consider each of the possible background factors, not counting the variation in fuel load due to prescribed burning, there are 480 scenarios that are possible. Each scenario is a combination of vegetation moisture (drought or normal), fuel moisture (high or low), duration (short or long), ignition location (north, central, central east, central west, south east or south west) and historic weather pattern (10 different dates).



The graphs above compare the percentage of area burned under the high fuel load and low fuel load conditions. On the left we show what happens when prescribed burn is *not* undertaken, that is the fuel load is high and on the right we show what happens when prescribed burn is undertaken and the fuel load is low. The horizontal axis shows the total acreage of Lake Diaz forest that burns, in percentages and the vertical axis shows the number of times that the fire burns that percent of the whole area.

So in the high fuel case the entire forest area burns more than 80 times out of the total 480 scenarios. Compare this to the low fuel case where the entire forest area never burns. In fact, the maximum area that burns under the low fuel condition is only slightly more than 60%. Conversely, we see that the fire burns between 0% and 2½% of the whole area in 30 of the 480 scenarios in the high fuel case; Compare this to the 140 of the 480 scenarios in the low fuel case that the fire burns 0% and 2½% of the whole area.

The results are clear: Lowering the fuel load by using the prescribed burn lowers the risk of having more severe wild fires. It does not eliminate those risks, but now almost every wild fire burns less than 60% of the forest area. There are some wild fires that are more severe, even with the enhanced prescribe burn policy in place.

You should also keep in mind that these displays refer to the percent of the whole forest area that is burned. Even if it is only 1%, if that 1% happens to be the house, the house will burn. Out of the 480 scenarios for high fuel load the house burned 312 times and for the low fuel load it burned 130 times. In percentage terms this means the house burns 65% of the time in high fuel load condition and 27% of the time in low fuel load condition.

Tasks 1 – 20: Payment Tasks

There are 20 rounds in this experiment representing 20 fire seasons. At the beginning of each round, you complete one of these tasks starting with task 1 at the beginning of round 1.

In each round, you are given an initial credit of $40 and the "joint ownership" of the house in the forest along with the other participants in this room. There is a possibility that a fire may occur in any round. If the house does not burn, you will sell the house to us at the end of the round. And you will get your share of $40. If the house burns this is what you stand to lose since you cannot sell it to us then.

The cost of prescribed burning is $120. In each round, you are asked to make a choice between paying for the prescribed burning of the forest or not. You may use the initial credit of $40 towards that, but you do not have to do it at all, and if you do you can choose how much of the $40 to pay. Whatever you do not pay you get to keep.

Here is how your payoff is determined:

- If the total amount paid by all participants in the room exceeds $120, we will deduct the amount you chose to pay for prescribed burning from your initial credit of $40. Also, if the lightning strikes in that round we will simulate a fire that is based on the **low fuel load,** since the total amount paid covers the cost of prescribed burning.

- If the total amount paid by all participants in the room does NOT exceed $120, we will NOT deduct anything from your initial credit of $40. However, if the lightning strikes in that round we will simulate a fire that is based on the **high fuel load,** since the total amount does NOT cover the cost of prescribed burning.

If there is no lightning strike or if there is one but the house does not burn, you will earn an additional $40 by selling the house to us.

Here we show you how you make your choice of whether to pay for prescribed burn or not. Please look at the table below. Each row shows you a different amount paid for prescribed burn. What we ask you to think about is what the maximum amount is that you would pay for the prescribed burn.

As you can see in the last row, the most you can choose to pay is $40. In the first row it shows you that the smallest amount you can choose is $0, i.e. to pay nothing.

In the decision sheet we will provide you, please circle the row number that corresponds to the maximum dollar amount that you would be willing to pay. Keep in mind that the cost of prescribed burning is $120 and nothing is deducted from your initial credit if prescribed burning is not provided.

Table 1. Please circle the maximum amount you are willing to pay:

1	$0
2	$5
3	$10
4	$15
5	$20
6	$25
7	$30
8	$35
9	$40

Remember that only one of the 20 rounds will be selected to determine your actual earnings. Your payoffs therefore depend on:

- whether the round is selected for payment using the envelopes with cards you prepared earlier;
- whether the total amount paid by all participants exceeded the cost of prescribed burning or $120, ;
- whether there is a lightning strike and therefore a fire (red card) or no fire (white card) in this period
- which background factors (weather, moisture, drought, etc.) are chosen by rolling the dies
- whether or not the house burns in the fire simulation (when there is a lightning strike)

Tasks 21-24: Betting Tasks

You will also undertake four betting tasks in addition to making decisions about paying for prescribed burn. These tasks are numbered 21 – 24. In fact, you will do tasks 21 and 22 before you do tasks 1-20. The remaining two betting tasks, 23 and 24, will be done immediately after a fire has occurred. If no fire occurs at all during rounds 1-20 they will be undertaken after round 20.

All the betting tasks concern whether or not the house will burn in a simulated forest fire under randomly selected conditions. This simulation is not one of those that may occur during rounds 1-20 but is a completely independent one. In fact, it will be one in which you know for sure that there will be lightning strike and a fire, although you will not know the exact background factors that influence the fire.

The first event is a forest fire that takes place in a year when the forest has not been managed through prescribed burns. In this case a lot of fuel is left in the forest, increasing the intensity and spread of fires. You will be asked to place a bet on whether or not the house will burn in the simulated fire. This will be Task 21 and 23.

The second event is a forest fire that takes place in a year when the forest has been managed through prescribed burns. A reduced fuel level reduces the intensity and spread of fires. Again, you will be asked to bet on whether or not the house will burn in the simulated fire. This will be Tasks 22 and 24.

For each event there will be 9 bookies offering odds. You will make bets with all 9 bookies. For each event you are given a $5 stake to bet with. If the number on the card in the envelope you picked at the beginning is 21, 22, 23 or 24, you will be paid for the corresponding betting task. If so, we will also have to roll a die to choose one of these 9 betting houses. Thus, each of your bets is equally likely to be chosen to determine your earnings.

Please look at the table below. It is called "Place a bet with each bookie when fuel load is high because prescribed burning has not been used." The table has 5 columns. Columns 3 and 4, labeled "If you bet that the house will burn in a forest fire and it…" and "If you bet that the house will not burn in a forest fire and it…", show you the dollar earnings you get from each bookie depending on whether the house burns or not in the final simulation.

Each row in the table represents a different bookie. This table is similar to the decision sheet you will face for betting tasks 21 and 23 except that it has only 3 bookies while the final version has 9.

Table 2. Place a bet with each bookie when
Fuel Load is High because prescribed burning has not been used.

Bookie	Your Stake	A. If you bet that the house will burn in a forest fire and it…	B. If you bet that the house will not burn in a forest fire and it…	Do you bet your stake on A or B? (Circle A or B)
1	$5	does you get $50 does not you get $0	does you get $0 does not you get $5.55	A B
2	$5	does you get $25 does not you get $0	does you get $0 does not you get $6.25	A B
3	$5	does you get $16.66 does not you get $0	does you get $0 does not you get $7.19	A B

The decision sheet for betting task 22 and 24 are similar except they are labeled "Place a bet with each bookie when fuel load is low because prescribed burning has been used."

Thus, your payoff for the betting tasks is determined by four things:

- whether the number on the card in the envelope is 21, 22, 23 or 24
- which bookie is chosen to be played out using a 10-sided die;
- what your bet is for the chosen bookie; and
- the outcome of the final simulation

Summary

To sum up, you will face 24 tasks in all: 20 payment tasks and 4 betting tasks. There are 20 rounds in this experiment corresponding to 20 fire seasons in different parts of Volusia county. Each round starts with a payment task in which you are asked to choose whether or not to pay for prescribed burning. Next we open an envelope to check <u>if a fire occurs in that round</u>. If the card inside is red there is a fire in that round and we will simulate a fire. If the card is white there is no fire. Depending on whether the total amount paid by all participants in the room covers the cost of prescribed burn or not, the simulated fire will use the low fuel load or the high fuel load. If prescribed burn is provided, we deduct the amount you chose to pay for prescribed burning from your initial credit. If it is NOT provided we will NOT deduct anything from your initial credit. In the event of a fire, your payment for this task is determined by whether or not the house burns.

The 4 betting tasks require you to bet on whether or not the house will burn in a simulated forest fire. You are asked to place bets in 2 different events: with low fuel load or when the forest is prescribed burned and with high fuel load. You face tasks 21 and 22 are at the beginning of round one and tasks 23 and 24 after a round in which a fire occurs. Note that if any of the betting tasks are chosen for payment <u>a fire will always be simulated</u>.

Tasks 25 & 26

Now we turn to the remaining tasks for today. Please look at the decision sheet. Your decision sheet shows ten decisions listed on the left. Each decision is a paired choice between "Option A" and "Option B." You will make a choice on each row and record these in the final column.

Here is a ten-sided die that will be used to determine payoffs. Look at Decision 1 at the top. Option A pays $20.00 if the throw of the ten sided die is 1, and it pays $16.00 if the throw is 2-10. Option B yields $38.50 if the throw of the die is 1, and it pays $1.00 if the throw is 2-10.

The other Decisions are similar, except that as you move down the table, the chances of the higher payoff for each option increase. In fact, for Decision 10 in the bottom row, the die will not be needed since each option pays the highest payoff for sure, so your choice here is between $20.00 or $38.50.

For task 25, after you have finished making your choices, you will throw this die twice, once to select one of the ten decisions to be used, and a second time to determine what your payoff is for the option you chose, A or B, for the particular decision selected. Even though you will make ten decisions, only one of these will end up affecting your earnings, but you will not know in advance which decision will be used.

Please choose Option A or B

Decision	Option A	Option B	Your Choice (Circle A or B)
1	$20.00 if throw of die is 1 $16.00 if throw of die is 2-10	$38.50 if throw of die is 1 $1.00 if throw of die is 2-10	A B
2	$20.00 if throw of die is 1-2 $16.00 if throw of die is 3-10	$38.50 if throw of die is 1-2 $1.00 if throw of die is 3-10	A B
3	$20.00 if throw of die is 1-3 $16.00 if throw of die is 4-10	$38.50 if throw of die is 1-3 $1.00 if throw of die is 4-10	A B
4	$20.00 if throw of die is 1-4 $16.00 if throw of die is 5-10	$38.50 if throw of die is 1-4 $1.00 if throw of die is 5-10	A B
5	$20.00 if throw of die is 1-5 $16.00 if throw of die is 6-10	$38.50 if throw of die is 1-5 $1.00 if throw of die is 6-10	A B
6	$20.00 if throw of die is 1-6 $16.00 if throw of die is 7-10	$38.50 if throw of die is 1-6 $1.00 if throw of die is 7-10	A B
7	$20.00 if throw of die is 1-7 $16.00 if throw of die is 8-10	$38.50 if throw of die is 1-7 $1.00 if throw of die is 8-10	A B
8	$20.00 if throw of die is 1-8 $16.00 if throw of die is 9-10	$38.50 if throw of die is 1-8 $1.00 if throw of die is 9-10	A B
9	$20.00 if throw of die is 1-9 $16.00 if throw of die is 10	$38.50 if throw of die is 1-9 $1.00 if throw of die is 10	A B
10	$20.00 if throw of die is 1-10	$38.50 if throw of die is 1-10	A B

Task 26 is similar, but in this case your earnings depend on your own choice between A and B and the choice by two other people in this room. Each group consists of three randomly selected individuals, and you will not know the identity of the two other people in your group. The choice between A and B in each row is determined by majority in the group.

Therefore, if two people in your group choose A and one person chooses B for a given row, A will be implemented for all three of you. If, on the other hand, two choose B and one chooses A, then B will be implemented.

Before the experiment starts we will go around the room with this basket containing cards numbered 1 or 2. If the number on your card is 1 you belong to group1; if it is 2 you belong to group 2.

If this task gets picked for payment, you will get into your groups. Then one person in each group will throw a 10-sided die twice, once to select one of the ten decisions to be used, and a second time to determine what your payoff is for the option you chose, A or B, for the particular decision selected.

APPENDIX F. DECISION SHEETS FOR LONG RUN EXPERIMENT

Here are the decision sheets used by all 3 long run experiments. First we present the decision sheets for the treatment where initial credit is $40. This is followed by the higher prize treatment where the initial credit is $80.

1. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

2. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

3. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

4. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

5. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

6. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

7. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

8. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

9. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

10. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

11. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

12. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

13. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

14. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

15. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

16. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

17. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

18. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

19. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

20. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**

21. Place a bet with each bookie when
Fuel Load is High because prescribed burning has not been used.

Bookie	Your Stake	A. If you bet that the house will burn in a forest fire and it…	B. If you bet that the house will not burn in a forest fire and it…	Do you bet your stake on A or B? (Circle A or B)
1	$5	does you get $50 does not you get $0	does you get $0 does not you get $5.55	A B
2	$5	does you get $25 does not you get $0	does you get $0 does not you get $6.25	A B
3	$5	does you get $16.66 does not you get $0	does you get $0 does not you get $7.19	A B
4	$5	does you get $12.50 does not you get $0	does you get $0 does not you get $8.33	A B
5	$5	does you get $10 does not you get $0	does you get $0 does not you get $10	A B
6	$5	does you get $8.33 does not you get $0	does you get $0 does not you get $12.50	A B
7	$5	does you get $7.19 does not you get $0	does you get $0 does not you get $16.66	A B
8	$5	does you get $6.25 does not you get $0	does you get $0 does not you get $25	A B
9	$5	does you get $5.55 does not you get $0	does you get $0 does not you get $50	A B

22. Place a bet with each bookie when
<u>Fuel Load is Low</u> because prescribed burning has been used.

Bookie	Your Stake	A. If you bet that the house will burn in a forest fire and it…	B. If you bet that the house will **not** burn in a forest fire and it…	Do you bet your stake on A or B? (Circle A or B)
1	$5	does you get $50 does **not** you get $0	does you get $0 does **not** you get $5.55	A B
2	$5	does you get $25 does **not** you get $0	does you get $0 does **not** you get $6.25	A B
3	$5	does you get $16.66 does **not** you get $0	does you get $0 does **not** you get $7.19	A B
4	$5	does you get $12.50 does **not** you get $0	does you get $0 does **not** you get $8.33	A B
5	$5	does you get $10 does **not** you get $0	does you get $0 does **not** you get $10	A B
6	$5	does you get $8.33 does **not** you get $0	does you get $0 does **not** you get $12.50	A B
7	$5	does you get $7.19 does **not** you get $0	does you get $0 does **not** you get $16.66	A B
8	$5	does you get $6.25 does **not** you get $0	does you get $0 does **not** you get $25	A B
9	$5	does you get $5.55 does **not** you get $0	does you get $0 does **not** you get $50	A B

23. Place a bet with each bookie when
Fuel Load is High because prescribed burning has not been used.

Bookie	Your Stake	A. If you bet that the house will burn in a forest fire and it…	B. If you bet that the house will not burn in a forest fire and it…	Do you bet your stake on A or B? (Circle A or B)
1	$5	does you get $50 does not you get $0	does you get $0 does not you get $5.55	A B
2	$5	does you get $25 does not you get $0	does you get $0 does not you get $6.25	A B
3	$5	does you get $16.66 does not you get $0	does you get $0 does not you get $7.19	A B
4	$5	does you get $12.50 does not you get $0	does you get $0 does not you get $8.33	A B
5	$5	does you get $10 does not you get $0	does you get $0 does not you get $10	A B
6	$5	does you get $8.33 does not you get $0	does you get $0 does not you get $12.50	A B
7	$5	does you get $7.19 does not you get $0	does you get $0 does not you get $16.66	A B
8	$5	does you get $6.25 does not you get $0	does you get $0 does not you get $25	A B
9	$5	does you get $5.55 does not you get $0	does you get $0 does not you get $50	A B

24. Place a bet with each bookie when
Fuel Load is Low because prescribed burning has been used.

Bookie	Your Stake	A. If you bet that the house will burn in a forest fire and it…	B. If you bet that the house will not burn in a forest fire and it…	Do you bet your stake on A or B? (Circle A or B)
1	$5	does you get $50 does not you get $0	does you get $0 does not you get $5.55	A B
2	$5	does you get $25 does not you get $0	does you get $0 does not you get $6.25	A B
3	$5	does you get $16.66 does not you get $0	does you get $0 does not you get $7.19	A B
4	$5	does you get $12.50 does not you get $0	does you get $0 does not you get $8.33	A B
5	$5	does you get $10 does not you get $0	does you get $0 does not you get $10	A B
6	$5	does you get $8.33 does not you get $0	does you get $0 does not you get $12.50	A B
7	$5	does you get $7.19 does not you get $0	does you get $0 does not you get $16.66	A B
8	$5	does you get $6.25 does not you get $0	does you get $0 does not you get $25	A B
9	$5	does you get $5.55 does not you get $0	does you get $0 does not you get $50	A B

25. Please choose A or B

Decision	Option A	Option B	**Your Choice** (Circle A or B)
1	**$20.00 if throw of die is 1** **$16.00 if throw of die is 2-10**	**$38.50 if throw of die is 1** **$1.00 if throw of die is 2-10**	**A B**
2	**$20.00 if throw of die is 1-2** **$16.00 if throw of die is 3-10**	**$38.50 if throw of die is 1-2** **$1.00 if throw of die is 3-10**	**A B**
3	**$20.00 if throw of die is 1-3** **$16.00 if throw of die is 4-10**	**$38.50 if throw of die is 1-3** **$1.00 if throw of die is 4-10**	**A B**
4	**$20.00 if throw of die is 1-4** **$16.00 if throw of die is 5-10**	**$38.50 if throw of die is 1-4** **$1.00 if throw of die is 5-10**	**A B**
5	**$20.00 if throw of die is 1-5** **$16.00 if throw of die is 6-10**	**$38.50 if throw of die is 1-5** **$1.00 if throw of die is 6-10**	**A B**
6	**$20.00 if throw of die is 1-6** **$16.00 if throw of die is 7-10**	**$38.50 if throw of die is 1-6** **$1.00 if throw of die is 7-10**	**A B**
7	**$20.00 if throw of die is 1-7** **$16.00 if throw of die is 8-10**	**$38.50 if throw of die is 1-7** **$1.00 if throw of die is 8-10**	**A B**
8	**$20.00 if throw of die is 1-8** **$16.00 if throw of die is 9-10**	**$38.50 if throw of die is 1-8** **$1.00 if throw of die is 9-10**	**A B**
9	**$20.00 if throw of die is 1-9** **$16.00 if throw of die is 10**	**$38.50 if throw of die is 1-9** **$1.00 if throw of die is 10**	**A B**
10	**$20.00 if throw of die is 1-10**	**$38.50 if throw of die is 1-10**	**A B**

26. Please choose A or B

Decision	Option A	Option B	**Your Choice** (Circle A or B)
1	$20.00 if throw of die is 1 $16.00 if throw of die is 2-10	$38.50 if throw of die is 1 $1.00 if throw of die is 2-10	A B
2	$20.00 if throw of die is 1-2 $16.00 if throw of die is 3-10	$38.50 if throw of die is 1-2 $1.00 if throw of die is 3-10	A B
3	$20.00 if throw of die is 1-3 $16.00 if throw of die is 4-10	$38.50 if throw of die is 1-3 $1.00 if throw of die is 4-10	A B
4	$20.00 if throw of die is 1-4 $16.00 if throw of die is 5-10	$38.50 if throw of die is 1-4 $1.00 if throw of die is 5-10	A B
5	$20.00 if throw of die is 1-5 $16.00 if throw of die is 6-10	$38.50 if throw of die is 1-5 $1.00 if throw of die is 6-10	A B
6	$20.00 if throw of die is 1-6 $16.00 if throw of die is 7-10	$38.50 if throw of die is 1-6 $1.00 if throw of die is 7-10	A B
7	$20.00 if throw of die is 1-7 $16.00 if throw of die is 8-10	$38.50 if throw of die is 1-7 $1.00 if throw of die is 8-10	A B
8	$20.00 if throw of die is 1-8 $16.00 if throw of die is 9-10	$38.50 if throw of die is 1-8 $1.00 if throw of die is 9-10	A B
9	$20.00 if throw of die is 1-9 $16.00 if throw of die is 10	$38.50 if throw of die is 1-9 $1.00 if throw of die is 10	A B
10	$20.00 if throw of die is 1-10	$38.50 if throw of die is 1-10	A B

1. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

2. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

3. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

4. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

5. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

6. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

7. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

8. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

9. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

10. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

11. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

12. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

13. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

14. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

15. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

16. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

17. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

18. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

19. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

20. Please circle the maximum amount you are willing to pay:

1	**$0**
2	**$5**
3	**$10**
4	**$15**
5	**$20**
6	**$25**
7	**$30**
8	**$35**
9	**$40**
10	**$45**
11	**$50**
12	**$55**
13	**$60**
14	**$65**
15	**$70**
16	**$75**
17	**$80**

21. Place a bet with each bookie when
<u>Fuel Load is High</u> because prescribed burning has not been used.

Bookie	Your Stake	A. If you bet that the house will burn in a forest fire and it…	B. If you bet that the house will <u>not</u> burn in a forest fire and it…	Do you bet your stake on A or B? (Circle A or B)
1	$10	does you get $100 does <u>not</u> you get $0	does you get $0 does <u>not</u> you get $11.10	A B
2	$10	does you get $50 does <u>not</u> you get $0	does you get $0 does <u>not</u> you get $12.50	A B
3	$10	does you get $33.32 does <u>not</u> you get $0	does you get $0 does <u>not</u> you get $14.38	A B
4	$10	does you get $25 does <u>not</u> you get $0	does you get $0 does <u>not</u> you get $16.66	A B
5	$10	does you get $20 does <u>not</u> you get $0	does you get $0 does <u>not</u> you get $20	A B
6	$10	does you get $16.66 does <u>not</u> you get $0	does you get $0 does <u>not</u> you get $25	A B
7	$10	does you get $14.38 does <u>not</u> you get $0	does you get $0 does <u>not</u> you get $33.32	A B
8	$10	does you get $12.50 does <u>not</u> you get $0	does you get $0 does <u>not</u> you get $50	A B
9	$10	does you get $11.10 does <u>not</u> you get $0	does you get $0 does <u>not</u> you get $100	A B

22. Place a bet with each bookie when
Fuel Load is Low because prescribed burning has been used.

Bookie	Your Stake	A. If you bet that the house will burn in a forest fire and it…	B. If you bet that the house will not burn in a forest fire and it…	Do you bet your stake on A or B? (Circle A or B)
1	$10	does you get $100 does not you get $0	does you get $0 does not you get $11.10	A B
2	$10	does you get $50 does not you get $0	does you get $0 does not you get $12.50	A B
3	$10	does you get $33.32 does not you get $0	does you get $0 does not you get $14.38	A B
4	$10	does you get $25 does not you get $0	does you get $0 does not you get $16.66	A B
5	$10	does you get $20 does not you get $0	does you get $0 does not you get $20	A B
6	$10	does you get $16.66 does not you get $0	does you get $0 does not you get $25	A B
7	$10	does you get $14.38 does not you get $0	does you get $0 does not you get $33.32	A B
8	$10	does you get $12.50 does not you get $0	does you get $0 does not you get $50	A B
9	$10	does you get $11.10 does not you get $0	does you get $0 does not you get $100	A B

23. Place a bet with each bookie when
Fuel Load is High because prescribed burning has not been used.

Bookie	Your Stake	A. If you bet that the house will burn in a forest fire and it…	B. If you bet that the house will not burn in a forest fire and it…	Do you bet your stake on A or B? (Circle A or B)
1	$10	does you get $100 does not you get $0	does you get $0 does not you get $11.10	A B
2	$10	does you get $50 does not you get $0	does you get $0 does not you get $12.50	A B
3	$10	does you get $33.32 does not you get $0	does you get $0 does not you get $14.38	A B
4	$10	does you get $25 does not you get $0	does you get $0 does not you get $16.66	A B
5	$10	does you get $20 does not you get $0	does you get $0 does not you get $20	A B
6	$10	does you get $16.66 does not you get $0	does you get $0 does not you get $25	A B
7	$10	does you get $14.38 does not you get $0	does you get $0 does not you get $33.32	A B
8	$10	does you get $12.50 does not you get $0	does you get $0 does not you get $50	A B
9	$10	does you get $11.10 does not you get $0	does you get $0 does not you get $100	A B

24. Place a bet with each bookie when
Fuel Load is Low because prescribed burning has been used.

Bookie	Your Stake	A. If you bet that the house will burn in a forest fire and it…	B. If you bet that the house will not burn in a forest fire and it…	Do you bet your stake on A or B? (Circle A or B)
1	$10	does you get $100 does not you get $0	does you get $0 does not you get $11.10	A B
2	$10	does you get $50 does not you get $0	does you get $0 does not you get $12.50	A B
3	$10	does you get $33.32 does not you get $0	does you get $0 does not you get $14.38	A B
4	$10	does you get $25 does not you get $0	does you get $0 does not you get $16.66	A B
5	$10	does you get $20 does not you get $0	does you get $0 does not you get $20	A B
6	$10	does you get $16.66 does not you get $0	does you get $0 does not you get $25	A B
7	$10	does you get $14.38 does not you get $0	does you get $0 does not you get $33.32	A B
8	$10	does you get $12.50 does not you get $0	does you get $0 does not you get $50	A B
9	$10	does you get $11.10 does not you get $0	does you get $0 does not you get $100	A B

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