Ambiguity, Government Intervention and Insurance Decision: an Experimental Study*

Marielle Brunette† Laure Cabantous‡ Stéphane Couture§ and Anne Stenger¶

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Abstract

This article analyzes the effects of public intervention and ambiguity on insurance demand. It first defines some theoretical predictions about the impact of these two parameters on insurance decision. It then presents the results of an experiment, conducted with 78 participants, 42 real private forest owners and 36 students from a French Forest Engineer School, designed to test the theoretical predictions. The analysis of willingness to pay for insurance (WTP), which was made on the overall data base, leads to two results. First, we find that the presence of public compensation programme induces a reduced insurance demand, whatever the quality of the information about the risk (ambiguous or precise) and the revenue level (low or high). Second, the results show that insurance levels are significantly higher for risks when there is ambiguity regarding the probability of the loss so that, the subjects are ambiguity averse. We also conduct an analysis with separate samples concerning the frequency of contracts and WTP for self-insurance. For the WTP for self-insurance, no effect emerge whatever the populations and the tested effect (public policy instrument or ambiguity). Concerning the frequency of contracts, firsts, it allows to observe a risk aversion of forest owners and forest students. Second, we observe that the presence of ambiguity has no impact on the participants ’ decisions. Third, while no effect of public policy instrument was observed for the forest owners, a positive effect emerge for the forest students for two instruments: fixed public help and contingent fixed public help.

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†Corresponding Author: LEF UMR INRA/AgroParisTech-ENGREF and BETA-REGLES (Nancy University). Marielle.Brunette@univ-nancy2.fr. 13 place Carnot. 54 035 NANCY-FRANCE.
‡Nottingham University Business School. Laure.Cabantous@nottingham.ac.uk
§LEF UMR INRA/AgroParisTech-ENGREF. couture@nancy-engref.inra.fr
¶LEF UMR INRA/AgroParisTech-ENGREF. stenger@nancy-engref.inra.fr
1 Introduction

Forests, which often need several years before being a source of revenue for their owners (i.e., they are a long term growth process) are very sensitive to natural risks. A series of extreme natural disturbances - partly due to global warming - have recently severely damaged large areas of forest all over Europe. Hurricane Kyrill, of January 2007, for instance has damaged 54,000,000 cubic meters of forests (this correspond approximately to 12% of total European annual harvest). Previously, in 2005 a series of windstorm damaged 75,000,000 cubic meters of the Sweden forest. Before that, the 1999 European windstorm damaged 140,000,000 and 34,000,000 cubic meters of forest in France and Germany, respectively. Apart from the ecological loss and changes in the natural landscapes that they cause, these natural disasters also generate huge economic losses for forest owners. After the natural catastrophes of 1999, the German government for instance decided on a program of public financial help of 15.3 millions Euros. In France the "National Plan for the French Forest", implemented in 1999 to cope with Lothar and Martin storms, was allocated 91.5 millions Euros per year during ten years. More recently, after Hurricane Gudrun in 2005, the Swedish government allocated 2 millions Euros to facilitate the evaluation of damages and to inform owners and the public of the dangers of being and working in the storm felled forests. The Danish government has opted for another type of public help: it conditioned the compensation to the purchased of an insurance policy. Among the Danish forest owner’s victims of the catastrophe, only those who had previously purchased a forest insurance policy received a lump-sum grant to replant and clear the storm felled forest areas.

Given that insurance policies against fire and storm are available to private forest owners everywhere in Europe; it is quite surprising to observe that governments still need to implement such huge public help programmes to financially compensate the victims of natural catastrophes! Yet, in practice, the use of insurance is varying widely among European countries. In France and Germany for instance, less than 7% of the private forest area is insured against fire or fire and windstorm. In Denmark and Sweden, on the other hand, more than 60% and 90%, respectively, of the private forest area is insured either against fire or against fire and windstorm.

An economic analysis of the situation suggests that a moral hazard problem can be at play here (e.g., Birot and Gollier, 2001; Lewis and Nickerson, 1989; Kaplow, 1991; Arvan and Nickerson, 2000; Harrington, 2000; Smetters, 2004; Kunreuther and Pauly, 2006; Brunette and Couture, 2007). These theoretical works indeed show that when private forest owners can anticipate that the government
will implement a public financial help programme after a natural catastrophe, they are less likely to undertake either self-insurance and self-protection actions\(^1\) (i.e., actions aiming at reducing the loss in case of catastrophe, or to decrease the probability of occurrence of a disaster); or to subscribe an insurance policy against fire and windstorm. In other words, the limited liability for financial losses created by the public compensation removes the individuals’ incentives to insure or self-insure.

Economic analysis also suggests that the ambiguity surrounding natural risk might play a key role in private forest owners’ insurance behaviors. Experimental research on decision-making under ambiguity (i.e., uncertainty about the probability), has indeed shown that ambiguity has a strong impact on decision-makers’ behaviors (e.g., Camerer and Weber 1992). In the loss domain several papers have documented that decision-makers tend to prefer "risky risks" (with well defined probabilities) to ambiguous risks especially for low levels of probability (e.g., Viscusi and Chesson 1999). Focusing specifically on insurance decisions, Hogarth and Kunreuther (1989) have reported that insurees are willing to pay higher insurance premiums for ambiguous risks. Similarly, Hogarth and Kunreuther (1995) have found that people are more likely to buy warranties for consumer durables when they do not know the chance that the durable fails. These experimental studies therefore suggest that forest owners - who perceive the natural risk as a rather ambiguous - could be willing to pay more for being insured against an ambiguous risk of natural disaster; and/or increase the likelihood that they will subscribe an insurance policy. Yet, from the perspective of forest owners, the annual probability that a natural event will destroy their property is rather vague and uncertain. Even for insurers, having a precise valuation of the probability of a natural risk (such as a fire resulting from storm for instance) can be difficult. Although scientific evidence for climate change is now impressive, there is indeed still a current debate in the scientific community on the relationship between some natural hazards and climate change. As a consequence, even insurers might not be able to have precise estimations of the likelihood of natural hazard in some specific areas. The effect of ambiguity could therefore counterbalance the effect of the moral hazard problem.

Although theoretical economic research on insurance behavior has generated quite a lot of experimental studies, experimental research about the effects of public intervention on insurance demand has been rather limited. Most experimental research on insurance demand has indeed focused on the impact of attitude toward risk on insurance demand (Eisner and Strotz, 1961) or have dealt

\(^{1}\)For example, in forestry, self-insurance activities against climatic risks are artificial firebreaks, actions that facilitate the access of forests, smoke detectors and auxiliary generators for use in blackouts, and installation of fire retardants. Self-protection actions against natural risk generally take the form of clearing or raking.
with insurance demand for low-probability risk, a main feature of natural hazards (e.g., McCleland, Schultze and Coursey, 1993; Ganderton, Brookshire, Mc Kee, Stuart and Thurston, 2000; Schoemaker and Kunreuther, 1979). Surprisingly, then, there is only one published experimental study (Kunreuther, 1976) that deals with the impact of subsidy on insurance decisions. However, we are not aware of any research looking at both the effect of public intervention and ambiguity on insurance demand.

The objective of the article is to fill this gap; and tests in the lab the impacts of several types of public help programme and ambiguity on insurance demand. The paper also informs on the difference between the responses of the people directly affected by this experience, the forest owners and the answers provided by forest students, whom interests are close to the ones of owners. The article presents the results of an experiment, conducted with 78 agents, 42 real forest owners and 36 students from a French Forest Engineer School (ENGREF), designed to a series of theoretical predictions about i) the effects of the type of public intervention on insurance demand and; ii) the effects of ambiguity on insurance demand, under different types of private intervention. Results of experiment are divided in two part. The first part deals with WTP for insurance on the overall data base. We find that the presence of public compensation programme induces a reduced insurance demand, whatever the quality of the information about the risk (ambiguous or precise) and the revenue level (low or high). We also show that insurance levels are significantly higher for risks when there is ambiguity regarding the probability of the loss so that the participants are ambiguity averse. The second part analyzes the frequency of contracts and WTP for self-insurance for the two samples separately: forest owners and forest students. For the WTP for self-insurance, no effect emerge whatever the populations and the tested effect (public policy instrument or ambiguity). Concerning the frequency of contracts, first, it allows to observe a risk aversion of forest owners and forest students. Second, we observe that the presence of ambiguity has no impact on the participants’ decisions. Third, while no effect of public policy instrument was observed for the forest owners, a positive effect emerge for the forest students for two instruments: fixed public help and contingent fixed public help.

This paper is structured as follows. We start in Section 2 with some theoretical predictions. In Section 3 we describe the experimental design by focusing on the questionnaire, sample and implementation. In Section 4 we present the results of experiments testing the predictions of the model. Some concluding comments will be made in Section 5.
2 Theoretical predictions

To derive some predictions about the effect of public intervention on insurance demand, we first rely on Brunette and Couture (2007) - a theoretical model of insurance demand under different types of public help instruments. Second, building on Klibanoff et al. (2005) we develop an original model of insurance demand under ambiguity, when there is no public intervention.

2.1 Theoretical model of insurance demand under risk

Brunette and Couture (2007) develop an expected utility model of insurance behavior under various types of public instruments (see Appendix A.1 for a formal presentation of the model). They consider a risk-averse private forest owner endowed with an even-aged forest. This private forest owner, although it is a non-industrial one, extracts annual revenues from his/her forest. This revenue is subject to a possible risk of windstorm or fire and then to a possible loss. The private forest owner can purchase a coinsurance policy against the risk. The forest owner may face a public assistance programme that guarantees some minimum wealth levels. Private financial loss due to a natural disaster may be limited by compensation from the programme of public disaster relief. Insurance decisions are made contingent on the knowledge of this programme and prior to an observation of the severity of an impending disaster. The public programme can be either conditioned to insurance or not.

The model predicts the optimal private expenditures on insurance. They focus on the influence of the level of insurance price on these decisions and next examine the effects of public financial help programmes on the forest owner’s optimal coverage decisions. We show that public post-disaster compensation programme removes incentives of the private forest owners’ choices to protect their forest.

2.2 Theoretical model of insurance demand under ambiguity

To analyze the impact of ambiguity and ambiguity aversion on optimal insurance decision, we use the Klibanoff et al. (2005) framework (see Appendix A.2 for a formal presentation of the model). We assume that there is ambiguity about the probabilities of a fire risk occurring, and that the forest owner may be ambiguity averse.

Applying Klibanoff et al. (2005) model to the context of insurance allows us to derive a prediction about the impact of ambiguity on insurance demand. Specifically, we predict that, under ambiguity, the optimal insurance demand will be higher if the forest owner is ambiguity averse. This prediction is in line with previous empirical researches about the effect of ambiguity on behavior in the loss
domain (e.g., Camerer and Weber, 1992; Hogarth and Kunreuther, 1989, 1995).

We have not been able yet to derive, a set of formal predictions about the effects on insurance demand of public intervention when the probability of the risk is ambiguous, from this model.

Table 1 summarizes the predictions regarding insurance behaviors.

<table>
<thead>
<tr>
<th>Prediction</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1. Insurance under Risk (Benchmark case)</td>
<td>In the absence of public compensation and if the price of insurance is fair, then full coverage is optimal if the forest owner is risk averse.</td>
</tr>
</tbody>
</table>
| P2. Intervention and Insurance | P21. The presence of public assistance program induces a reduced insurance demand.  
P22. The existence of public compensation for disaster contingent to coverage has the effect of increasing the optimal level of insurance.  
P23. It is necessarily not true that a subsidy for insurance increases the optimal insurance demand. |
| P3. Ambiguity and Insurance | Ambiguous averse forest owners will select higher insurance premiums for a risk with ambiguous probability than for a risk with non-ambiguous probability. |

3 Experimental design

We designed an experiment to test the predictions of the theoretical model of insurance behavior introduced in the previous section.

3.1 Stimuli

We developed the insurance scenarios with the help of the members of Regional Center of Private Forest Property in Aquitaine. They provided helpful assistance, and in particular helped us to select meaningful values for the type of forest (we selected maritime pines because it is the most common type of forest in the region where we run the experiment with forest owners); the size of the forest (12 hectares corresponds to the mean size of the private forest property in Aquitaine); and the annual income that a forest can generate (High = 6000 Euros/year; Low = 3000 Euros/year). They also helped us to choose a realistic value for the annual probability of the risk of fire in the area (0.2%).


3.1.1 The context

Throughout the experiments, the participants were asked to assume the role of a forest owner having 12 hectares of maritime pines in Aquitaine and to react to a short scenario about a risk of fire destroying their entire forest. After reading an insurance scenario, they were asked to answer a series of three questions about their insurance behavior.

Each insurance situation included three pieces of information, corresponding to our three independent variables: the type of public policy intervention following the destruction of their forest by a fire (no public help, a fixed public help, a fixed public help contingent to the subscription of an insurance contract, and an insurance subsidy); the quality of the probabilistic information about the risk of fire in the area (precise and consensual called “Risk”, and imprecise called “Ambiguous”), and the annual revenue that the forest generates (High, Low).

3.1.2 Quality of the probabilistic information (Risk vs. Ambiguity)

Depending on their group, participants were exposed to either a “risk” context (i.e., a precise estimate of the probability of the risk) or an “ambiguous” (i.e., an imprecise estimate of the probability of the risk) one. Participants in the risky context were given a precise and well defined estimate of the annual probability of fire occurrence in the area (0.2%). They were told that several independent experts have assessed the probability of the risk, and that they all agree on this precise value. Specifically, they could read:

“For all the questions asked in the experiment, you are in a situation where you perfectly know the fire destruction probability of your forest in the current year. The probability that a fire destroys entirely your forest during the current year is scientifically assessed at 0.2%.”

Participants in the ambiguous context, on the other hand, were given imprecise information about the annual probability of the fire risk in the area. There are different ways to implement ambiguity. Some experimental papers implement ambiguity by giving the participants a point estimate of the probability of the event, and by telling them that experts are not sure of this figure (Einhorn and Hogarth, 1985). Other papers provide the participants with an interval of probabilities (Hogarth and Kunreuther, 1989). Eventually, some authors have implemented ambiguity by providing the participants with different expert opinions of the probability of a given loss within a given time period (Gardenfors and Sahlin, 1982; Kunreuther et al., 1995). In this experiment, we followed the third methodology because we think that it is closer to the real context. In the
ambiguous context then, the participants were told that four experts have been consulted. Because there is a discrepancy between them, four different probabilities emerge from their consultation. Specifically the participant could read:

“For all the questions asked in the experiment, you are in a situation where you do not know precisely the fire destruction probability of your forest in the current year. The different values given by the experts concerning the probability that a fire destroys entirely your forest in the current year are: (0.05%, 0.15%, 0.25%, 0.35%).”

3.1.3 Type of public instrument

Then, the participants were given information about the type of public intervention. In the “No Help” case, they learnt that in the event of a fire destroying their property, the government is committed not to intervene. As a result of that commitment, the forest owners bear the wholeness of the losses. In the “Fixed Public Help” situation, they learnt that in the event of a fire destroying their property, the government is committed to give them a 1500 Euros fixed indemnity. In the “Contingent Fixed Public Help” context, they learnt that if a fire occurs and destroy their property, they would received the 1500 Euros fixed indemnity from the government only if they had taken out an insurance policy against the risk of fire. Last, in the fourth type of intervention, called “Subsidized Insurance”, they learnt that the public authority will pay half of the fire risk insurance premium of their chosen insurance policy. We selected these three types of public instruments because of their ecological validity. The “Fixed public Help” for instance is the most common type of indemnity in France, with help for reforestation. The “Contingent Fixed Public Help” is currently in use in Denmark, where the government financially helps forest owners’ victim of an extreme event, only if they had previously taken out an insurance policy. Lastly, German Länders have chosen the “Subsidized Insurance” instrument and pay 50% of the forest owner’s fire risk insurance premium. We can observe that the last public policy instrument acts ex-ante while the two previous ones act ex-post, when the fire has occurred.

3.1.4 Dependent variables

After reading the scenario, the participants had to answer three questions about their insurance behavior, corresponding to our three dependent variables. First, they were asked their maximum willingness to pay (WTP) to be fully covered against potential losses due to a fire destroying their forest. Second, they had to select a private insurance contract in a menu of five different contracts, varying in their premiums and degrees of coverage. Then, assuming that they are indeed covered by
the insurance contract they had chosen in the previous question, they had to give their willingness to pay for self-insurance actions. For example, in the scenario “Fixed Public Help” they could read:

‘If a fire occurs; your forest is fully destroyed. In this case, the public authority gives you a fixed public help of 1500 Euros in order to compensate a part of your financial losses. You can also choose to take out an insurance policy. Thus, you can cumulate the public help and the insurance indemnity. We propose several contracts. You can only choose one of them. Each of these contracts has different costs and decreases differently the risk of loss. If you decide to take out an insurance policy, the insurance price will be directly deducted from your revenue.

1). What is the maximal amount of annual premium that you are willing to pay in order to be fully covered against potential losses due to fire?

2) What is the insurance contract that you will choose?

Contract A: indemnity = 500 Euros/ha and premium net of tax = 1 Euro/ha.
Contract B: indemnity = 375 Euros/ha and premium net of tax = 0,75 Euros/ha.
Contract C: indemnity = 250 Euros/ha and premium net of tax = 0,5 Euros/ha.
Contract D: indemnity = 125 Euros/ha and premium net of tax = 0,25 Euros/ha.
Contract E: indemnity = 0 euros/ha and premium net of tax = 0 Euros/ha.

3) You have chosen a contract among the fifth proposed. Additionally to the insurance premium, what is the amount of money you are willing to pay in order to implement actions (clearing, pruning...) which will reduce the magnitude of the losses in fire case?’

For each participant we therefore collected 8 willingness to pay to be fully covered against a risk of fire; 8 insurance contract choices; and 8 willingness to pay for self-insurance actions.

The forest owners’ experiment ended with a series of socio-demographic questions (sex, age, educational level, income, marital status and size of household). We also included a series of questions about the forest owners’ own forest (size of the forest, acquisition mean) and past insurance behavior (past experience in terms of insurance and fire risk). The students’ experiment contains questions on sex, age, status (civil or state employee) but also on the potential forest owned by their parents.

3.2 The design

The design was a 4x2x2x2 full factorial design composed with 4 public policy instruments, 2 revenue levels, 2 populations and 2 levels of information about the risk. The last two variables were
between-subject ones, so each participant was exposed to 8 different insurance situations (see Figure 1 for a graphical representation of the experimental design in the Risky context).

Two variables, the type of public intervention and the revenue, were within-subject variables. For the latter variable, we controlled for order effects, and randomly assigned the participants to one of the two possible orders (High revenue first; Low revenue first). Regarding the public intervention variable, all participants were therefore presented with the same following sequence of public policy instruments: no public help; a fixed public help; a fixed public help conditioned to the subscription of an insurance policy; and then the subsidized insurance instrument.

The quality of the probabilistic information about the fire risk was a between-subject variable. This is because several experimental studies on attitude to ambiguity have found that ambiguity aversion is more prevalent when the participants are exposed to both the ambiguous and the non-ambiguous contexts. Fox and Tversky (1995) for instance have showed that such a within-subject design artificially generates aversion to ambiguity, because it puts the participants in a comparative context, and makes the ambiguity of the context more salient. These authors have even argued, that in non-comparative context (i.e., between-subject design), ambiguity aversion might disappear (see Chow and Sarin, 2001 for a discussion of Fox and Tversky 1995).

### 3.3 Participants

Because experimental work is often criticized for relying on students only, we decided to run our experiment with a population of 42 real forest owners and 36 students from a French Forest Engineer School (ENGREF). We organized three experimental sessions (with different participants). In the first session (April 2007), 24 forest owners were exposed to the risky scenarios; in the second session
(November 2007) 18 other forest owners were exposed to the ambiguous scenarios and in the last session (December 2007), 36 students were randomly assigned to risky or ambiguous scenarios.

In April 2007, we invited a population of 24 forest owners (21 mens, 3 womens, a mean age of 56.8 years) from Aquitaine (a region located in the South-Western part of France) to take part to the experiment (risky scenarios). The participants were directly contacted by a local forest trade-association, and invited to attend a one-day session (including a free-meal) on forest insurance scheme. The experiment took place during the morning and the participants needed approximately 45 min to complete. After the experiment, one of the experimenter explained the motivations of the experiment with a presentation about forest insurance in other countries, so that the participants understood the choice of public policy instruments tested in the experiment.

A few months later (November 2007), we run exactly the same experiment (ambiguous scenarios) with 18 forest owners (16 mens, 2 womens, a mean age of 57.5 years) also from Aquitaine. The characteristics of the experiment were the same but two elements changed: the experiment was implemented at the end of the journey (instead of the morning) and there was no meal after the experience.

It is noteworthy that there was no financial incentive to attend the all-day training session and take part to the experiment. We deliberately choose not to give them any financial incentive because, from past experience, we knew that this population of participants would have a rather negative reaction to it. A few months before, we indeed conducted an experiment with forest owners on a similar topic. The participants did not claim for refunding their travel expenses although we told them they could do so; and they seemed to be rather irritated by the fact that we could give them some cash to take part in the experiment. They told us that they prefer to do it for free (with benefits in kind), because they thought they were interested in the experience, and the results of our study. In addition, implementing a truly incentive scheme for experiments in the loss domain is always tricky. For all these reasons, we therefore decided not to give any financial incentive to the participants; but when it was possible we gave them a free meal (1st session in April 2007).

The last experience (December 2007) was conducted during the morning, at the end of an introductory lesson on Risk Economy with application to forest sector. The population was 36 students (18 mens, 19 womens, a mean age of 21.44 years) from a French Forest Engineer School (ENGREF) located in North-Eastern part of France, in Nancy. The students were paid 10 Euros for their participation.
3.4 Procedure

We initially wanted to develop software to make the experiment more interactive. Several discussions with the members of the trade association however, convinced us that forest owners would be more comfortable with a “paper and pencil” experiment. Most forest owners indeed are not familiar with computers and could react negatively to a computerized experiment. We therefore decided to run a "paper and pencil" experiment. At the beginning of the session, then participants received a 13-page booklet, each booklet containing 8 insurance scenarios. We randomly assigned the booklets to the participants.

4 Results

One of the originality of this paper it to conduct the experience on two different populations, because we want to test a potential “population effect”, i.e. if the answers provided by forest owners are significantly different from the ones provided by forest students. We obtain a significant difference concerning WTP for self-insurance and frequency of contracts but not for WTP for insurance. This result means that the analysis of WTP for insurance will be done on the overall data base (section 4.1) while the study of WTP for self-insurance and frequency of contracts will be made separately for forest owners and forest students (section 4.2).

4.1 An analysis on the overall data base: WTP for insurance

Table 2 reports the mean premium participants were prepared to pay both in the risky and ambiguous cases and for the four public policy contexts: no help (NH), fixed public help (FPH), contingent fixed public help (CFPH) and insurance subsidy (IS).

Because we had two endowment levels (3000 and 6000 Euros) we controlled for potential order effect. A series of t-tests for independent samples revealed that the order of presentation did not have any significant impact on the participants’ choices. There is a large discussion on these order effects in contingent valuation literature (Clark and Friesen, 2006; Stewart et al, 2002). Order effects are some methodological aspects for which we observe the consequences of varying the order in questions on WTP. Furthermore, in contingent valuations, order effects are understood as embedding effects or scope effects or sequencing effects. The value that the respondents give to the good depends on the way it is presented: isolated or in nested sequence. In theory, valuation should be independent of order but in empirical tests of sequence effects seem to reveal scope sensitivity, sometimes with a difference between private and publics goods (Clark and Friesen, 2006).
Table 2: Mean WTP for insurance

<table>
<thead>
<tr>
<th>Public Policy Instrument</th>
<th>Low forest revenue</th>
<th>High forest revenue</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Risky (1)</td>
<td>Ambiguous (2)</td>
<td>Col. (2) / Col. (1)</td>
</tr>
<tr>
<td>NH</td>
<td>1.35 (2.16)</td>
<td>3.55 (6.50)</td>
<td>2.63</td>
</tr>
<tr>
<td></td>
<td>[0.5] [0.5]</td>
<td>[0.5] [0.5]</td>
<td></td>
</tr>
<tr>
<td>FPH</td>
<td>0.92 (1.81)</td>
<td>2.8 (5.36)</td>
<td>3.04</td>
</tr>
<tr>
<td></td>
<td>0.3375 [0.75]</td>
<td>0.5 [1]</td>
<td></td>
</tr>
<tr>
<td>CFPH</td>
<td>1.04 (1.78)</td>
<td>2.95 (5.34)</td>
<td>2.84</td>
</tr>
<tr>
<td></td>
<td>[0.5] [0.5]</td>
<td>[0.5] [0.5]</td>
<td></td>
</tr>
<tr>
<td>IS</td>
<td>1.29 (2.25)</td>
<td>3.74 (9.05)</td>
<td>2.90</td>
</tr>
<tr>
<td></td>
<td>[0.25] [0.5]</td>
<td>[0.5] [1]</td>
<td></td>
</tr>
</tbody>
</table>

* Standard deviation in (.) and Median in [ ]

We were also interested in testing revenue effect. Comparing the participants’ decisions according to the two levels of income, we demonstrated the presence of a revenue effect for WTP for insurance, both in risky and in ambiguous contexts. This result is reassuring and shows a sensitivity of the WTP to income: a change in WTP for the good when income increases. However, this income effect seems to be relatively low, when observed in the literature (Horowitz and McConnell, 2003).

4.1.1 Testing the public policy instrument effect

According to our predictions, public instruments could have an influence on insurance decisions: any public assistance programme reduces the WTP for insurance; any conditional help to insurance naturally increases the WTP for insurance; any subsidy for insurance has an uncertain effect. We compared the participants’ WTP for insurance in paired comparisons: the benchmark case against each public instrument case. In a no help context, the participants’ WTP for insurance is significantly different from the participants’ WTP for insurance in the other contexts: it was the null hypothesis. In addition, due to the similarity of the instrument except in its contingency, we also choose to test the influence of insurance incentives by comparing the responses of a fixed public help scenario and of a contingent fixed public help one.

The results of the tests showed that the public policy instruments play a role concerning the subjects’ WTP for insurance. As shown in Table 3, a series of student tests for paired samples
reveals that the difference between the WTP for insurance were significant, only for the comparison between WTP for insurance in no help case and fixed public help one, so that the predictions P21 is confirmed but not the predictions P22. and P23.

Table 3: Student coefficients for differences in WTP for insurance, according to the public policy instrument: the ambiguous context example

<table>
<thead>
<tr>
<th>High forest revenue</th>
<th>Low forest revenue</th>
<th>t-coef</th>
<th>t-coef</th>
</tr>
</thead>
<tbody>
<tr>
<td>NH</td>
<td>FPH</td>
<td>1.82</td>
<td>1.41</td>
</tr>
<tr>
<td>CFPH</td>
<td>1.41</td>
<td>2.27</td>
<td>0.92</td>
</tr>
<tr>
<td>IS</td>
<td>1.35</td>
<td>1.04</td>
<td>1.29</td>
</tr>
<tr>
<td>IS</td>
<td>1.35</td>
<td>1.04</td>
<td>1.60</td>
</tr>
<tr>
<td>NH</td>
<td>FPH</td>
<td>1.82</td>
<td>1.65</td>
</tr>
<tr>
<td>CFPH</td>
<td>1.41</td>
<td>1.81</td>
<td>0.86</td>
</tr>
<tr>
<td>IS</td>
<td>1.35</td>
<td>1.04</td>
<td>0.22</td>
</tr>
<tr>
<td>NH</td>
<td>FPH</td>
<td>1.82</td>
<td>1.65</td>
</tr>
<tr>
<td>CFPH</td>
<td>1.41</td>
<td>0.91</td>
<td>0.92</td>
</tr>
<tr>
<td>IS</td>
<td>1.35</td>
<td>1.04</td>
<td>1.60</td>
</tr>
</tbody>
</table>

Furthermore, contingent help for insurance do not induce larger WTP for insurance than fixed public help.

To conclude, in the two contexts, risky and ambiguous one, only one public policy instrument influences the WTP for insurance: the fixed public help. As it is the first instrument tested in the experiment, we can think that subjects are sensitive to the transition between absence of public help and presence of one.

4.1.2 Testing the risk information effect: risky context versus ambiguous one

We expect that forest owners had a higher WTP for insurance in ambiguous context than in risky one as stated by our predictions. So, by comparing the WTP for insurance in risky and in ambiguous context, we test the following null hypothesis: the subjects’ WTP for insurance is, on average, higher in ambiguous context than in risky one.

As shown in Table 3, a series of student tests for independent samples reveals that the difference between subjects’ WTP in ambiguous context is significantly different from the subjects’ WTP in risky framework, confirming the prediction P3.

Consequently, facing a risk with ambiguous probability, the subjects are prepared to pay more in order to be covered than for a risk with non-ambiguous probability so that, in accordance with prediction P3., the participants are ambiguity averse.
Our experimental tests confirm the prediction P3., so that the results support our ambiguity aversion hypothesis: insurance levels are indeed significantly higher for risks when there is ambiguity regarding the probability of the loss. Our results also support partly the predictions P2. Indeed, we find that the presence of public compensation programme induces a reduced insurance demand, whatever the quality of the information about the risk (ambiguous or precise) and whatever the revenue level (low or high), so as to confirm the prediction P23.

4.2 An analysis on separate samples: WTP for self-insurance and the frequency of contracts

As in the analysis of WTP for insurance, the presence of two revenue levels lead us to test for potential order effect. For WTP for self-insurance, a series of t-tests for independent samples revealed that the order of presentation did not have any significant effect on the participants’ decisions. In the same way, for frequency of contracts, a series of Chi-squared tests lets appeared the absence of order effect. Thus, we find no order effect neither for WTP for self-insurance nor for frequency of contracts. This result applied to forest owners and forest students.

We note the absence of revenue effect for the two populations concerning WTP for self-insurance and frequency of contracts.

4.2.1 Preferences towards risk

The objective is to know the preferences of the participants towards risk. The prediction P1. must be analyzed from the frequency of contracts choosen by the subjects. We took the benchmark case (i.e no help) to compare the frequency in the choice of the contracts: A contract against B, A against C. . . . If the frequency of the A contract is significantly different from the frequency of each other contract, then the subject is risk averse. We choose a Chi-squared test for paired comparisons.

For the forest owners sample the A contract was chosen by at least 50% of the forest owners so, the
difference in the frequencies was significant. For the students sample the A contract is not always chosen by the majority but we observe a significant difference between the frequency of A contracts and the frequency of each other ones. This result allow us to confirm the prediction P1. for the two samples: forest owners and forest students are risk averse. The same test done in the ambiguous context gives the same information on the preferences of the forest owners and forest students towards ambiguity.

4.2.2 Testing the public policy instrument effect

Concerning the WTP for self-insurance, none of the public policy instruments has an impact on the forest owners or forest students’ choices. Concerning the frequency of contracts, the public policy instruments have no effect on the forest owners’ decisions.

Inversely, for the students, we find a significant difference between benchmark case and fixed public help one but also between benchmark case and contingent fixed public help one, for the contracts A and B. This result hold whatever the level of revenue and the information about the risk. Consequently, while the public policy instruments have no impact on forest owners choices of insurance contracts, two of them: fixed public help and contingent one, seem to play a role in the decision making process of forest students.

4.2.3 Testing the risk information effect: risky versus ambiguous one

We find no connection between the WTP for self-insurance of forest owners and forest students and the presence of ambiguity. The same result applied to the frequency of contracts. In other words, the quality of the probabilistic information has no impact on the WTP for self-insurance and frequency of contracts for both subjects, forest owners and forest students.

5 Conclusion

 Experimental studies in the field of forestry are new and sparse (Stenger, 2007; Warziniack et al, 2007). They show a real interest in forest owners’ identity and decisions, especially concerning their management in some risky contexts. They are facing more natural risks and this tendency tends to be confirmed when looking at some environmental indicators. In order to fill some gap between theoretical part of the literature on insurance demand, forest owners’ management and public policies to be implemented, this paper presents the results of an experiment conducted on real forest owners and students from Forest Engineer School. The main objective was to analyze the effect of
public intervention and the effect of ambiguity on their insurance demand. Experiments revealed
that the participants were risk averse in the described scenarios. These results are conformed with
Stenger’ ones (2007) in which forest owners’ risk aversion was tested in lotteries and through insur-
ance purchase in storm context. In the same way, the participants were sensitive to some public
instrument like fixed public help. At least, these experiments showed that the context of ambiguity
raises the willingness to pay for insurance meaning that the subjects are ambiguity averse. This
paper also allows to observe if there is a difference between the responses of forest owners and forest
students. The results show that WTP for insurance for the two groups is quite similar, allowing us
to made the analysis of WTP for insurance on the overall data base, while WTP for self-insurance
and frequency of contracts are significantly different, leading to an analysis on two separate samples.

A Theoretical model of insurance decision

A.1 The model of insurance decision under risk

We consider a non-industrial private forest owner endowed with an even-aged forest with a net
revenue $R$. This revenue is subject to a possible risk of fire, defined by the probability $p$, and
then to a possible loss that is assumed to correspond to this revenue $R$. The private forest owner
can purchase a coinsurance policy with an indemnity function that is equal to $\alpha R$ and a premium
defined as $\alpha(1 + \lambda)pR$ with $\lambda$ the loading factor.

If the risk occurs then the final revenue of the forest owner is $W_1 = \alpha R - \alpha(1 + \lambda)pR$ whereas,
if the risk does not occur, then the final revenue is defined as $W_2 = R - \alpha(1 + \lambda)pR$. Note that
$W_2 > W_1$.

In presence of insurance market, the problem of the private forest owner is to choose $\alpha$ to
maximize expected utility:

$$Max_{\{\alpha\}} EU[\alpha] = pU[\alpha R - \alpha(1 + \lambda)pR] + (1 - p)U[R - \alpha(1 + \lambda)pR]$$

where $U[\cdot]$ is a strictly increasing and concave von Neumann-Morgenstern utility function.

The optimal insurance demand $\alpha^*$ is defined by the following condition:

$$pU'[W_1^*](R - (1 + \lambda)pR) - (1 - p)U'[W_2^*]((1 + \lambda)pR) = 0$$

If proportional insurance is available at a fair price ($\lambda = 0$), then full coverage is optimal, under
risk aversion. If the loading factor is positive, then full coverage is not optimal. There is a critical value of the loading factor the forest owner switches to zero coverage.

Now we focus on the impact of public intervention on optimal insurance decision. We analyze the effect of three different interventions: public compensation programme (the programme ensures a fixed indemnity $I$, unconditioned to insurance coverage, to the private forest owner, after the occurrence of a disaster), public financial help conditioned to insurance coverage (the public indemnity is function of insurance decision: $I\alpha$), and insurance subsidy. We assume that insurance decisions are made contingent on a knowledge of such programmes. All these analysis are found in a more general framework in Brunette and Couture (2007) and here we just report the results. The existence of public financial help programme induces a reduction of the optimal insurance demand. A public compensation for disasters subject to coverage has the effect of increasing the optimal level of insurance although the public programme reduces the forest owner’s loss of damage, leading to lower efficiency in private insurance. Finally, with a positive insurance loading factor, insurance cannot be a Giffen good under Constant Absolute Risk Aversion or Increasing Absolute Risk Aversion, but may be Giffen under Decreasing Absolute Risk Aversion.

A.2 The model under ambiguity

There is ambiguity about the probabilities of a fire risk occurring. There are reasons to believe that risk of fire is ambiguous. Even when fire hazards are properly anticipated, the elicitation of a probability distribution characterizing the fire risk is frequently very difficult. Large robust statistics and consistent scientific expert opinions are required to provide exact probability assessments. Scientific uncertainty is undoubtedly present in forest fire risks. In the same way, because of the fundamental uncertainties related to the climate change problem, there is not a single probability distribution. Insurers do not have access to large historical data; then estimating the probability of wildfires in a specific area is a difficult task.

We use the Klibanoff et al.’s (2005) framework that introduces a measure of ambiguity aversion. We assume that the forest owner is ambiguity averse (Klibanoff et al., 2005). Formally the forest owner’s utility is:

$$W = \mathbb{E}\phi\{EU(\alpha)\}$$

(3)

that is defined more detailed as follows:

$$W = \mathbb{E}\phi\{\hat{p}U(\alpha R - \alpha(1 + \lambda)Rp) + (1 - \hat{p})U(R - \alpha(1 + \lambda)pR)\}$$

(4)
with \( \tilde{p} = p + \tilde{\epsilon} \) is a random variable that represents ambiguity over the baseline risk, and \( E \) is the expectation operator over \( \tilde{\epsilon} \), with \( E\tilde{\epsilon} = 0 \).

An increasing function \( \phi(.) \) represents ambiguity averse (seeking) preferences if it is concave (convex). If people are neutral to ambiguity about probabilities, they are consistent with subjective expected utility theory (Ghirardato and Marinacci, 2002).

We assume differentiability of \( \phi \). The optimal insurance level under ambiguity, \( \alpha^*_a \), is obtained by the following first order condition:

\[
E\phi'(EU(\alpha^*_a))(\tilde{p}U'(\alpha^*_aR - \alpha^*_a(1 + \lambda)Rp)(R - R(1 + \lambda)p) - (1 - \tilde{p})(1 + \lambda)RpU'(R - \alpha^*_a(1 + \lambda)pR)) = 0 \tag{5}
\]

Notice that without ambiguity aversion (or under subjective expected utility), that is under \( \phi' \) constant, we would get:

\[
E(\tilde{p}U'(\alpha^*_nR - \alpha^*_n(1 + \lambda)Rp)(R - R(1 + \lambda)p) - (1 - \tilde{p})(1 + \lambda)RpU'(R - \alpha^*_n(1 + \lambda)pR)) = 0 \tag{6}
\]

with \( \alpha^*_n \) the optimal insurance level under neutral ambiguity.

The optimal insurance demand is higher with ambiguity aversion than without ambiguity aversion if and only if:

\[
E\phi'(EU(\alpha^*_a))E(U'(\alpha^*_a)) + cov(\phi'E(U(\alpha^*_a)), EU'(\alpha^*_a)) = 0 \tag{7}
\]

Using the covariance definition, then the condition [5] can be rewritten as:

\[
E\phi'(EU(\alpha^*_a))E(U'(\alpha^*_a)) + cov(\phi'E(U(\alpha^*_a)), EU'(\alpha^*_a)) = 0
\]

Then the insurance demand is higher if the covariance is positive, then if the term \( \phi'(EU(\alpha^*_a)) \) is increasing with \( \tilde{\epsilon} \) and if \( EU'(\alpha^*_a) \) is increasing with \( \tilde{\epsilon} \).

First, we study the variation of the term \( \phi'(EU(\alpha^*_a)) \) with \( \tilde{\epsilon} \). It is easy to show that the term \( \phi'(EU(\alpha^*_a)) \) is increasing (decreasing) with \( \tilde{\epsilon} \) if \( \phi'' < (>)0 \). Second, we analyze the variation of the term \( EU'(\alpha^*_a) \) with \( \tilde{\epsilon} \). The term \( EU'(\alpha^*_a) \) is defined as:

\[
EU'(\alpha^*_a) = \tilde{p}U'(\alpha^*_aR - \alpha^*_a(1 + \lambda)Rp)(R - R(1 + \lambda)p) - (1 - \tilde{p})(1 + \lambda)RpU'(R - \alpha^*_a(1 + \lambda)pR)
\]
Therefore, we have:

\[
\frac{dEU'(\alpha^*_a)}{d\tilde{\epsilon}} = s U'(W^*_1)R(1 - (1 + \lambda)p) + U'(W^*_2)Rp(1 + \lambda)
\]

Then, \(EU'(\alpha^*_a)\) is increasing with \(\tilde{\epsilon}\).

Finally, we obtain the following result: under ambiguity, the optimal insurance demand will be higher if the forest owner is ambiguity averse. In that case, ambiguity aversion is viewed as an extra risk aversion.

References


\(^2\)A sufficient condition for guaranteeing that \(\alpha^*_a > 0\) is \(1 - (1 + \lambda)p > 0\).


Stenger A. (2007), “Natural Hazard and insurance: an experimental study on non industrial
private forest owners - Test for a computer administered risk aversion survey”, 46p, revisited 2008.

