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Laboratoire d'**E**conomie **F**orestière



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Anne STENGER

*Octobre 2008*

**Document de travail  
n° 2008-05**

# Insurance Demand for Disaster-type Risks and the Separation of Attitudes toward Risk and Ambiguity: an Experimental Study\*

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## Abstract

This article presents the results of an experiment designed to test theoretical predictions about the impact of public compensation schemes and ambiguity on insurance and self-insurance decisions. Consistent with theory, we find that government assistance significantly reduces willingness to pay (WTP) for insurance and self-insurance (compared with a free insurance market).

As expected, we also find significant differences between WTPs for insurance under different types of government compensation programs. For example, results from our experiment confirm the prediction that the WTP for insurance is smaller under a “Fixed Help” program than under a “Contingent Fixed Help” program where the government assistance is conditioned to the purchase of an insurance policy. Thirdly, we find that ambiguity, i.e., uncertainty about probability, significantly increases WTPs for insurance. This result, which indicates that decision-makers are ambiguity averse, is in line with previous results on the impact of ambiguity on insurance demand for low probability risks. Lastly, our experiment provides a clear support for the hypothesis that attitude to risk and attitude to ambiguity are two independent phenomena. In fact in this experiment, decision-makers are both risk-seekers (i.e., the mean WTP for insurance is on average smaller than the expected value of the loss) and ambiguity averse (i.e., the mean WTP for insurance is on average higher for an ambiguous risk than for a ‘risky’ risk).

**Key words:** Experimental Economics, Insurance, Self-Insurance, Public Policy, Forest, Ambiguity, Risk.

## Résumé

*Demande d'assurance pour les risques catastrophiques et séparation de l'attitude face au risque et à l'ambiguïté: une étude expérimentale.*

Cet article présente les résultats d'une expérience mise en place pour tester des prédictions théoriques concernant l'impact de programmes publics de compensations financières et de l'ambiguïté sur les décisions d'assurance et d'auto-assurance. En conformité avec la théorie, nous montrons que l'aide du gouvernement réduit significativement le consentement à payer (CAP) pour l'assurance et l'auto-assurance (comparé à une situation de référence sans aide publique). Nous prouvons également que les CAP pour l'assurance sont différents en fonction des différents programmes publics testés. Par exemple, les résultats font apparaître que le CAP pour l'assurance est plus faible lorsqu'une aide forfaitaire est accordée que lorsqu'une aide forfaitaire contingente l'est, c'est-à-dire lorsque l'aide de l'Etat est contingente à l'achat d'assurance. Ensuite, nous montrons que l'ambiguïté, l'incertitude sur les probabilités, accroît de façon significative les CAP pour l'assurance. Ce résultat, qui indique que les décideurs présentent de l'aversion à l'ambiguïté, est en accord avec les résultats précédents concernant l'impact de l'ambiguïté sur la demande d'assurance pour des risques associés à de faibles probabilités d'occurrence. Finalement, notre expérience fournit un support évident pour l'hypothèse que l'attitude face au risque et face à l'ambiguïté sont deux phénomènes indépendants. En effet, dans cette expérience, les décideurs expriment à la fois une préférence pour le risque (le CAP moyen pour l'assurance est en moyenne plus faible que l'espérance de perte) et une aversion à l'ambiguïté (le CAP moyen pour l'assurance est en moyenne plus élevé pour les risques ambigus que pour les risques non-ambigus).

**Mots clés :** Economie expérimentale, Assurance, Auto-assurance, Instruments de politique publique, Forêt, Ambiguïté, Risque.

**Classification JEL :** C91, D81, Q23.

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# 1 Introduction

In most countries, natural catastrophes, such as severe windstorms, hurricane or earthquakes, give rise to governmental assistance. For instance, after the series of severe windstorms and natural catastrophes of 1999 in Europe, the German government decided on a program of public financial help of 15.3 millions Euros and the French government implemented the “National Plan for the French Forest” (91.5 millions Euros per year during ten years). In Denmark also forest’s owners victims of the 1999 natural catastrophes have benefited from government assistance, but the public help was conditioned to the purchase of an insurance policy.

This article examines the impact of governmental assistance on insurance demand for natural catastrophe risks. This is an important issue because many research on insurance demand for natural disaster risks have reported under-assurance (e.g., Camerer and Kunreuther, 1989; Kunreuther, 1978). One reason why people fail to buy insurance against natural catastrophes is that such risks are not well understood. When it comes to low probability/high consequence risk, individuals indeed tend to consider only one dimension of the risk, i.e., the probability or the loss, and fail to compute the expected loss (Ganderton et al., 2003). If they focus on the probability of the event, they will probably not purchase insurance coverage because the probability is very likely to fall below their sensitivity threshold. In fact, empirical research have reported that willingness to pay for low-probability/high consequences risks can take very low value, i.e., below the expected loss (e.g., McClelland et al., 1993). Another reason for these observed under-assurance behaviors comes from economic research on the impact of public compensation on insurance demand. Economists, who has been studying the topic for a long time (see e.g., Kaplow, 1991; Lewis and Nickerson, 1989 for early works), have shown that the limited liability for financial losses created by the public compensation removes the individuals’ incentives to insure (e.g., Arvan and Nickerson, 2000; Birot and Gollier, 2001; Harrington, 2000; Smetters, 2004; Kunreuther and Pauly, 2006 among others). When potential victims of natural catastrophes can anticipate that an ex-post public disaster relief program will be implemented, they may simply behave “as if the likelihood of a disaster causing damage to their property is zero” (e.g., Kunreuther and Pauly, 2006, p. 103). As a result they do not purchase insurance.

Although economic research on the impact of governmental assistance for risks have proven rich with insights and have contributed to clarify the effects of different types of governmental programs on insurance behaviors, some crucial points have been neglected. First, most papers have reduced

their focus on insurance behaviors and have neglected self-insurance activities (see Lewis and Nickerson, 1989 for an exception). Second, in all the researches, attention has been reduced to one type of governmental assistance. A general view of the respective impacts of different compensation programs on insurance demand is therefore still lacking. Third, past research has focused on “risky risks”, i.e., risks with well-known probabilities. For most potential victims of natural catastrophes however, the probability of the natural disaster is rather ambiguous and integrating ambiguity in the analysis of insurance demand for natural hazard could make a difference. Yet, there is now evidence that ambiguity, i.e., uncertainty of probability, has a net impact on insurance behaviors (e.g., Camerer and Weber, 1992; Kunreuther et al. 1995). Specifically, because ambiguity tends to increase WTP for insurance (i.e., decision-makers are ambiguity averse for low probability risks), the negative impact of public intervention programs on insurance demand that past research has found might actually have been over-estimated. Lastly, there has been almost no attempt to test experimentally the predictions of the economic literature on governmental assistance for risks (see Kunreuther, 1976 for a noticeable exception). An experimental setting however, offers a unique opportunity to gather some data on insurance behaviors under the various public compensation schemes that the economic literature has studied theoretically. Collecting data in the field would not allow such an empirical test as real life governmental assistance programs often differ from the stylized programs used in the theoretical literature. In addition, there is a practical issue with field study on insurance demand against natural catastrophes: because such risks occur relatively infrequently (i.e., low probability risks), there are thus not so many opportunities to collect data from the field.

In this article, we present a general model of the effect of different types of public intervention program on insurance and self-insurance behaviors. We then test experimentally the predictions of this model, and we have designed the experiment to take into account the impact of ambiguity on insurance and self-insurance behaviors. In addition, because one potential limitation of experimental research is that participants (usually students) have little, if any, knowledge of the situation, we have run the experiment with two types of knowledgeable participants: French non-industrial forest owners who have a prior experience with insurance against natural disaster; and French graduate students in Forest engineering, who might not have a prior experience with insurance against natural disaster because they have not yet managed a forest, but are likely to be familiar with the forest scenarios we have developed for the purpose of this experiment.

The article is structured as follows. Section 2 presents the theoretical predictions. Section 3 describes the experimental method. Section 4 presents the results of experiments and Section 5 discusses the results and concludes.

## 2 Theoretical framework and predictions

We designed our experiment to test two sets of hypotheses about insurance demand against natural risks. The first set of hypotheses deals with the potential effects of public compensation schemes on insurance demand. The second set of hypotheses concerns the impact of ambiguity on insurance behaviors. The next two sections presents our predictions and the rationales behind them.

### 2.1 Insurance demand and government compensation programs

In this section we rely on a simple but general model of insurance behavior under different types of public interventions developed by two of the authors of this manuscript elsewhere (Brunette and Couture, 2008). The interest of this model are twofolds. First, this model is more general than other models because it considers three different types of public compensation schemes and a perfect insurance market situation (with no governmental assistance). Second, the model makes predictions for both insurance and self-insurance behaviors. In this subsection, we briefly present the model main characteristics and its main predictions. Readers interested in the detailed presentation of the model can refer to Brunette and Couture (2008).

Generally speaking, the model considers a risk-averse-expected-utility-maximizing decision-maker managing a property that generates some revenue (e.g., a forest). The property is exposed to a loss due to a natural catastrophe (e.g. a severe windstorm or forest fire destroying the entire forest and reducing its economic value to zero); and the owner has to make insurance and self-insurance decisions. The model then derives predictions about the decision-maker's insurance and self-insurance decisions under four different cases, a 'free insurance market' (subscripted NH in Table 1 for 'No Help') where the decision-makers bears 100% of the financial losses if the loss occurs; and three types of public compensation schemes. The first program is a 'Fixed Help' (subscripted FH in Table 1) compensation scheme. Under that program, should the natural catastrophe destroy the property, the owner will receive a fixed financial help from the government. The second program is called 'Contingent Fixed Help' (subscripted CFH in Table 1) scheme because the owner will perceive the fixed financial help only if the following two conditions are met: her/his property has been destroyed by a natural catastrophe and the owner had insured (or self-insured) the property against

the damage. The third program is an ‘Insurance Subsidy’ (subscripted IS in Table 1) scheme where the government pays direct subsidies as percentages of insurance premiums.

Comparing the optimal insurance and self-insurance decisions under the four different cases leads to important behavioral results (see Brunette and Couture, 2008 for the detailed development of the predictions). First, the model predicts that both a ‘Fixed Help’ and ‘Contingent Fixed Help’ reduce the willing to pay (WTP) for a full coverage insurance contract, compared to the WTP under the ‘free insurance market’ - or ‘No Help’- case. The same result applies for self-insurance. Second, the authors show that the reduction the ‘Contingent Fixed Help’ program generates is smaller than the one the ‘Fixed Help’ program generates. Put differently, the model predicts that risk-averse individuals are willing to pay less for a full coverage insurance under a ‘Contingent Fixed Help’ program than under a ‘Fixed Help’ program, and than under a ‘No Help’ program. Note that the same result applies to self-insurance. Thirdly, the authors show that the ‘Subsidy insurance’ program generates mixed behaviors, depending on the decision-maker’s type of risk aversion. Specifically, the model predicts that if the individual is characterized by an Increasing Absolute Risk Aversion coefficient or a Constant Absolute Risk Aversion coefficient, her/his WTP for insurance is higher when the government implement an ‘Insurance Subsidy’ scheme than when it does not implement any assistance program; otherwise (Decreasing Risk Aversion coefficient), results are ambiguous. Interestingly, the authors also show that the type of risk aversion has no impact on self-insurance behaviors undertaken under the ‘Insurance Subsidy’ scheme. Under that scheme, though, predictions are again mixed: with subsidized insurance, the individual reduces WTP for insurance if the marginal benefit of the wealth increases when self-insurance activities rise. This hypothesis means that self-insurance is more profitable for higher production revenue since, larger forest implies higher potential losses.

## **2.2 Insurance demand, self-insurance activities and ambiguity**

Experimental research on decision-making under ambiguity, i.e., uncertainty about the probability, has 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): they are ambiguity averse. Several experimental studies have reported the same type of results for insurance and self-insurance behavior (e.g., Cabantous, 2007; Di Mauro and Maffioletti, 1996; Kunreuther et al., 1995; Ozdemir 2007). Focusing on insurance de-

mand, Hogarth and Kunreuther (1989) for instance have found that insurees are willing to pay higher insurance premiums for ambiguous risks. Similarly, Hogarth and Kunreuther (1995) have reported that people are more likely to buy warranties for consumer durables when they do not know the chance that the durable fails. Taken as a whole, this literature suggests that decision-makers' WTP for insurance and self-insurance will be higher for ambiguous risks (subscripted A in Table 1) than for risky risk (subscripted R in Table 1) suggesting ambiguity averse behavior. From this research we can also predict that attitude to risk and attitude to ambiguity are two independent phenomena.

The table below summarises the two set of predictions we can derive from the literature, the two third deal with impact of public compensation on insurance and self-insurance decisions and the last one with the effect of ambiguity.

Table 1: Theoretical predictions

	Insurance (A)*	Self-insurance (B)*
Prediction 1	$WTP_{\{NH\}} > WTP_{\{FH\}}$	$WTP_{\{NH\}} > WTP_{\{FH\}}$
Prediction 2	$WTP_{\{CFH\}} > WTP_{\{FH\}}$	$WTP_{\{CFH\}} > WTP_{\{FH\}}$
Prediction 3	CARA and IARA: $WTP_{\{IS\}} > WTP_{\{NH\}}$	$L_{\{Rq\}} > 0 : WTP_{\{IS\}} < WTP_{\{NH\}}$
	DARA: $WTP_{\{IS\}} > or < WTP_{\{NH\}}$	$L_{\{Rq\}} < 0 : WTP_{\{IS\}} > or < WTP_{\{NH\}}$
Prediction 4	$WTP_A > WTP_R$	$WTP_A > WTP_R$

\* When we will refer to predictions for insurance case, we will use the letter A such as prediction 1A, 2A... and B for self-insurance situation such as prediction 1B, 2B...

### 3 Experimental Method

In this section, we present the design (3.1), the stimuli and tasks that participants performed (3.2), we detailed the subjects (3.3) and the procedure and instructions (3.4).

#### 3.1 Experimental Design

The participants were asked to assume the role of a non-industrial private forest owner managing 12 hectares of maritime pines in Aquitaine, and to react to several scenarios describing a risk of fire. Each scenario included three pieces of information: i) the legal information about the forest insurance compensation scheme (i.e., the government forest insurance compensation program currently

in force); ii) the average gross annual income that the forest generates; and iii) the probability information about a risk of fire in the area where the forest is located, given as the annual probability (%) that a fire entirely destroying the forest. The first two variables were within-subject variables. The third variable was a between-subject variable because past research on the effect of ambiguity on behavior has shown that a within-subject design tends to increase the contrast between the two informational contexts and generates stronger ambiguity aversion (Fox and Tversky, 1995; Chow and Sarin, 2001).

After each scenario, participants were asked to answer three questions about their insurance behavior: a willingness to pay (WTP) for insurance question; a WTP for self-insurance question; and a choice task where they had to select their preferred insurance contract among a menu of five different contracts.

### 3.2 Stimuli and tasks

The scenarios were developed with the assistance from the Aquitaine Regional Center of Private Forest Property. Member of the Center gave us valuable advices regarding the size of the forest (in Aquitaine, private forest properties cover on average 12 hectares); the annual income (between 3000€ and 6000€/year); and the type of trees (maritime pine is the most common species in Aquitaine).

#### *The legal information about regulation of insurance and self-insurance in forest*

Three forest compensation programs and one ‘Perfect Insurance Market’ case were introduced. As explained above, under the ‘Perfect Insurance Market’ case (also called the ‘No Help’ case), the government is committed not to assist forest owners following a fire (*ex-post*) and not to intervene *ex-ante* either. In other words, in this case, fire insurance and forest management activities are voluntary, and forest owners who have not undertaken such measures bear 100% of the financial losses caused by the fire. Under the ‘Fixed Help’ compensation scheme, the government is committed to assist financially forest owners whose forest has been entirely destroyed by a fire. The amount of the financial compensation is fixed to 1500€. The ‘Contingent Fixed Help’ scheme is similar to the ‘Fixed Help’ scheme (1500€ indemnity in case of fire), but is restricted to forest owners who have purchased fire insurance or who have undertaken self-insurance actions. Lastly, under the ‘Insurance Subsidy’ program, the government pays 50% of fire insurance premium purchased by the forest owner or of the prevention activities that the owner implement.

### *The probability information about the risk of fire (risk vs. ambiguity)*

In all scenarios, the losses were precisely specified (3000€ in the low-incomes scenarios or 6000€ in the high-income scenarios), but we introduced two types of probability information about the risk of fire. Some participants received precise information about the risk of fire ('Risk'); other faced ambiguous information about the risk of fire ('Ambiguity'). In the *Risk* group, the annual probability of the fire was precisely specified and fixed to 0.2% in all scenarios. Participants in this group could read: *"Throughout the experiment, assume that there is no uncertainty about the annual probability of fire damage. The probability of a fire destroying your forest this year has been scientifically assessed at 0.2%"*. Participants in the *Ambiguity* group, on the other hand, could read: *"Throughout the experiment, assume that there is some uncertainty about the annual probability of a fire damage. Four experts have given you four different estimates of the probability of a fire destroying your forest this year: 0.05%, 0.15%, 0.25% and 0.30%"*. Note that even in the *Ambiguity* group, participants had some information about the annual probability of fire damage. The experiment indeed established ambiguity by providing different risk estimates of fire damage, from different sources of risk information. The lack of consensus between the experts suggests that the fire risk is more uncertain in the *Ambiguity* group than in the *Risk* group (see e.g., Cabantous 2007, Gardenfors and Sahlin 1982, Kunreuther et al. 1995, Viscusi and Chesson 1999). This manipulation of ambiguity is close to real life situations where forest owners can gather information about the annual risk of fire from different forest trade associations.

Figure 1 presents a sample of a scenario in the case of the 'No Help' programme. The first task for the participants was to give their maximum willingness to pay to be fully covered against the losses due to fire (full insurance coverage contract). Second, they had to select one insurance contract among five. Lastly, assuming that they had indeed purchased the contract they have selected in the previous question, participants were asked to state their maximum willingness to pay for investing in protection measures to reduce the magnitude of potential losses from a future fire (i.e., self-insurance measures).

### **3.3 Participants**

Seventy-eight volunteer's participants were recruited for this study. There were 42 forest owners (37 men, 5 women; mean age, 57 years) from Aquitaine (South-western part of France), and 36 post-graduate engineering students (18 men, 17 women; mean age, 21.4 years) from AgroParis-Tech/ENGREF (a French "Grande Ecole" dedicated to the training of future forest engineers).

Figure 1: Presentation of basic experiment scenario ('No Help' scheme)

General context	You are participating to an experience intended to study the decision making process for insurance. The objective is to analyze your insurance demand toward a fire risk run by your forest. You must answer to several questions. For each question, you own a forest of 12 hectares of maritime pines in Aquitaine region. This forest gets you an annual revenue with an amount depending on the situation described. Your forest is exposed to a fire risk.	
Information about probability	<i>Risk Group</i> Throughout the experiment, assume that there is no uncertainty about the annual probability of fire damage. The probability of a fire destroying your forest this year has been scientifically assessed at 0.2%.	<i>Ambiguity Group</i> Throughout the experiment, assume that there is some uncertainty about the annual probability of fire damage. Four experts have given you four different estimates of the probability of a fire destroying your forest this year: 0.05%, 0.15%, 0.25% and 0.30%.
Information about the programme	If a fire occurs, your forest is fully destroyed. In this case, the government is committed to give you a fixed public help of 1500 € 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 deduced from your income.	
WTP for Insurance	1. What is the maximal amount of annual premium that you are willing to pay to be fully covered against potential losses due to fire?	
Choice task	2. Which insurance contract do you purchase? Contract A: indemnity = 500 €/ha, premium net of tax = 1 €/ha. Contract B: indemnity = 375 €/ha, premium net of tax = 0,75 €/ha. Contract C: indemnity = 250 €/ha, premium net of tax = 0,5 €/ha. Contract D: indemnity = 125 €/ha, premium net of tax = 0,25 €/ha. Contract E: indemnity = 0 €/ha, premium net of tax = 0 €/ha.	
WTP for Self-Insurance	3. You have chosen a contract among the five contracts. 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?	

### 3.4 Procedure and instructions

Forest owners' subjects were run in two small groups ( $n_1 = 24$ ,  $n_2 = 18$ ), during two one-day training sessions on forest insurance (April and November 2007, respectively). Students were invited to participate in the experiment as part of an introductory lecture on Economics of Risk in December 2007. Students were paid 10€ for their participation but forest owners received no financial incentive. The reason for this is the following: in 2006 we conducted an experiment with forest owners during a training session on forest insurance (Stenger, 2007). We told the volunteers that they could claim for their travel expenses. Not only none of the forest owners filled the expense claim form, but they also told us that receiving money from us for taking part to the experiment would

suggest that they could not be interested in the experiment *per se*, but in the financial incentive. Following this experiment, we decided not to pay forest owners for their participation, but we gave them the opportunity to have a free lunch (April 2007 session), and free refreshments (November 2007 session). Moreover, lots of experimental results prove the marginal effect of incentives on individual's attitude. Indeed, Camerer (1995) and Beattie and Loomes (1997) showed that when the questions of the experience are simple and when participants are interested by the thematic, no incentives are required. Consequently, our forest owners being really interested in the thematic linked to prevention against natural hazards in forest sector and the task that they must performed being a simple WTP questions and needing no particular knowledge, one can assert that the absence of incentives has no effect on their attitude to risk.

The 8 scenarios and 24 tasks (3 tasks by 8 scenarios) were presented in 13-page booklet. The order of the High vs. Low income scenarios was counterbalanced, with about half of the participants starting with the 4 High-income scenarios and the other half starting with the 4 Low-income scenarios. Within an income level, and between income levels, the order of presentation of the four policy instruments was always the same: all the participants were exposed to the 'No Help' policy first, followed by the 'Fixed Help' policy and the 'Conditioned Fixed Help' policy. The 'Insurance Subsidy' policy was always the last in the sequence order. Lastly, at the end of each scenario, the order of the 3 tasks was the always the same: all the participants started with the willingness to pay for insurance question, then they completed the choice task, and thirdly answered the WTP for self-insurance question.

As said above, we run a "paper-and-pencil" experiment. We did so because the members of the forest owner trade association organizing the training sessions told us that most forest owners are not familiar with computers and could react negatively to a computerized experiment. After a brief presentation of the study, the experiment started. On the average, participants required 45 minutes to complete the experiment.

## 4 Results

In this section, we first report the responses from the WTP for insurance (4.1 and 4.2). We then report the results for the WTP for self-insurance (4.3 and 4.4).

## 4.1 WTP for insurance: Preliminaries

Participants were asked to specify the maximum amount they would be willing to pay to be fully insured against the risk of fire. To make the comparison between the High-income (6000€) and the Low-income scenarios (3000€) easier, the WTP were normalized by the Expected Loss (6€ in the Low-income scenarios, and 12€ in the High-income scenario). In addition, the ratio WTP/EL also facilitates the analysis of risk attitude. When  $WTP/EL = 1$ , this means that the individual is risk neutral, because her/his willingness to pay for insurance is equal to the expected loss (see Kunreuther et al., 1995 for a similar normalization).

In addition to that normalization, we also log transformed our main dependent variables and performed the statistical analysis on the log (WTP/EL). Preliminary descriptive statistics indeed revealed that the WTP distributions violated the normality assumption and were highly skewed (Kurtosis coefficients lie between 4.40 and 15.87 and Skewness coefficients lie between 2.31 and 3.91). Although, the normality hypothesis is not crucial for a variance analysis (Bonneau, 1960; Bradley, 1964; Box, 1953 and 1954), we decided to log transform the distribution to be closer to the normality assumption and to counteract the effect of outliers (see Kunreuther et al. 1995 for a similar analysis).

Table 2 below reports the geometric means for  $WTP/EL$ <sup>1</sup> and  $\log(WTP/EL)$ . It shows that in all conditions, the  $WTP/EL$  was significantly smaller than 1, indicating that participants' WTP for insurance is smaller than the Expected Loss (risk seeking behavior). A series of t-tests confirmed that participants were risk seeker in all experimental conditions (including in the ambiguous scenarios).

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<sup>1</sup> The geometric mean of a variable X is equal to the antilog of  $\log(X)$ . In the subsequent analysis, we use the log (WTP/EL) as our main dependent variable.

Table 2: WTP/EL and log(WTP/EL) for all scenarios

			No Help	Fixed Help	Contingent Fixed Help	Insurance Subsidy	Total
RISK	Low income	Geometric Mean	0.08	0.04	0.09	0.06	0.07
		logWTP/EL	-1.1	-1.42	-1.07	0.22	-0.84
	High Income	Geometric Mean	0.08	0.04	0.08	0.05	0.06
		logWTP/EL	-1.09	-1.44	-1.12	-1.28	-1.23
AMB.	Low income	Geometric Mean	0.17	0.1	0.16	0.12	0.14
		logWTP/EL	-0.76	-1.01	-0.81	0.63	-0.49
	High Income	Geometric Mean	0.17	0.11	0.14	0.10	0.52
		logWTP/EL	-0.77	-0.96	-0.87	-0.97	-0.89

The statistical analysis was then designed to test whether the WTP depend on the quality of the probabilistic information (Risk vs. Ambiguity), and the type of insurance compensation scheme. The log(WTP/EL) were thus analyzed in a 2 (Population) x 2 (Order) x 2 (Probability) x 4 (Policy) x 2 (Income) MANOVA with repeated measures on the last two factors.

This analysis revealed no significant effect of Population ( $F_{1;70} = 0.482$ ;  $p = 0.49$ ), Order ( $F_{1;70} = 0.227$ ;  $p = 0.63$ ) and Income ( $F_{1;70} = 0.399$ ;  $p = 0.53$ ). In addition no significant interactions involving these factors were found. Having checked that these three factors did not have any significant effects on our dependent variables, we can now turn to the analysis of the effects on participants' WTP of the two main variables we manipulated in this study, i.e., the information about the probability of the risk and of the type of public intervention.

## 4.2 Findings for WTP for insurance

We first present the results concerning impact of public compensation programs on insurance demand and after, we observe the effect of ambiguity.

### 4.2.1 Insurance behaviour under different types of public policy instrument

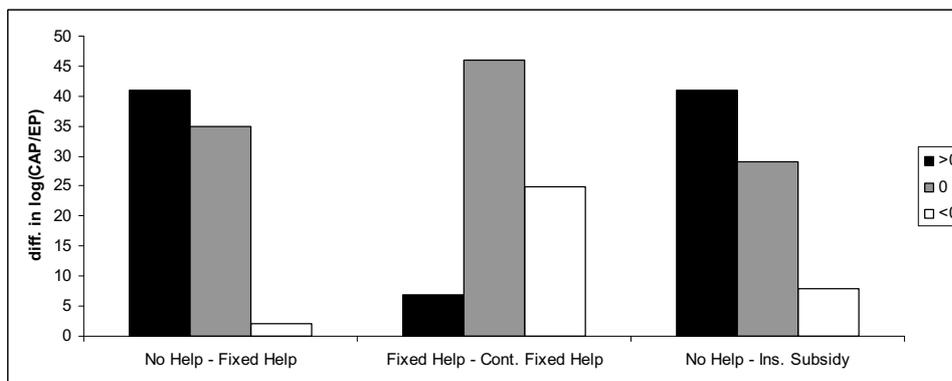
The MANOVA revealed that the main effect of Policy on normalized premiums was significant ( $F_{1.91;133.55} = 6.924$ ;  $p = 0.002$ )<sup>2</sup>. This means that the participants reacted to the different insurance compensation programs by stating different WTP. To complement this analysis, and test our three predictions on the impact of insurance compensation programs on WTP, we performed a

<sup>2</sup>Note that with within-subject measures, the variance-covariance matrix of the dependent variable should be spherical in form. The Mauchly's test of sphericity indicated that the assumption does not hold for Policy (Mauchly's  $W = 0.364$ ;  $p = 0.000$ ). The F and p value reported for Policy are therefore adjusted (Greenhouse-Geisser) to account for the violation of this assumption.

series of two-by-two comparisons (with Bonferroni adjustments).

The Figure 2 presents this two-by-two comparisons.

Figure 2: Two-by-two comparisons for the variable Policy



This series of tests first showed that normalized premiums were significantly smaller ( $p = 0.002$ ) under the Fixed Help programme (Mean  $\log(\text{WTP}/\text{EL}) = -1.19$ ) than under the No Help one (Mean  $\log(\text{WTP}/\text{EL}) = -0.93$ ). This result supports our prediction 1A that a Fixed Help compensation program significantly decreases WTP for insurance. This result clearly appeared in the figure above where difference between  $\log(\text{WTP}/\text{EL})$  for No Help case and  $\log(\text{WTP}/\text{EL})$  for Fixed Help case showed that 41 participants had a positive difference indicating that their WTP for insurance in No Help scheme were higher than in Fixed Help one. Only 2 participants have an inverse behavior while the WTP for insurance was the same in the two situations for the others.

Secondly, comparing the effects of the two Fixed Help compensation programs, we found that normalized premiums under the Fixed Help program were smaller (Mean  $\log(\text{WTP}/\text{EL}) = -1.19$ ) than under the Fixed Help Contingent program (Mean  $\log(\text{WTP}/\text{EL}) = -0.96$ ). This effect was significant ( $p = 0.008$ ). This result therefore confirms our Prediction 2A that conditioning the Fixed Help to an insurance contract increases WTP for insurance. The figure lets appear that the majority of the participants (41/78) had a similar WTP for insurance in the two Fixed Help compensation programs. Nevertheless, around 25 participants had a higher WTP for insurance when the Fixed Help is contingent than when it was not, while only 7 subjects exhibit an inverse tendency.

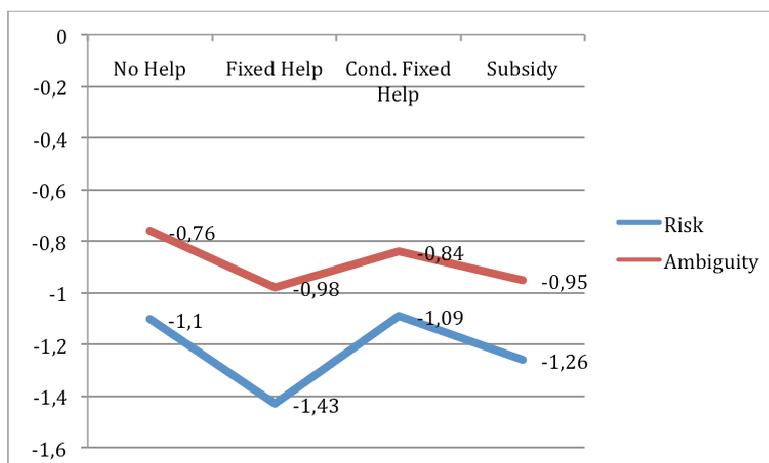
Lastly, to test our Prediction 3A, we compared normalized premiums under the No Help programme (Mean  $\log(\text{WTP}/\text{EL}) = -0.93$ ) and under the Insurance Subsidy one (Mean  $\log(\text{WTP}/\text{EL}) = -1.11$ ). Result of a statistical test showed that the Subsidy compensation program significantly ( $p$

=0.001) reduces normalized WTP. Indeed, the figure showed that 41 participants have a tendency to pay more in No Help scheme than in Insurance Subsidy scheme while only 8 exhibits an inverse tendency.

#### 4.2.2 Insurance and attitude to ambiguity

Results of the MANOVA also revealed that normalized WTP varied as a function of the quality of the probabilistic information ( $F_{1;70} = 4.49$ ;  $p = 0.038$ ). More specifically, we found that participants were significantly averse to ambiguity: on average, they were willing to pay less for a full insurance coverage under risk (Mean  $\log(\text{WTP}/\text{EL}) = -1.21$ ) than under ambiguity (Mean  $\log(\text{WTP}/\text{EL}) = -0.90$ ). In addition, consistent with our prediction 4, we found that the interaction effect between InfoProba and Policy was not significant ( $F_{1.91;133.5} = 0.597$ ;  $p = 0.62$ ). This means that the relative effects of the different insurance compensation programs on normalized WTP were the same under risk and under ambiguity. In other words, for each compensation program, participants reacted to an ambiguous probabilistic message by shifting up the WTP for insurance stated for a “risky” risk, as shown in the Figure 3 below.

Figure 3: Mean  $\log(\text{WTP}/\text{EL})$  by Policy and InfoProba



To summarize, the results supported most of our predictions on the impact of ambiguity and insurance compensation programs on willingness to insure. As predicted, we indeed found that the participants’ WTP to insure is higher when the government is committed not intervene in the insurance market (P1A). We also found that a Contingent Fixed Help program decreases the willingness to pay for insurance less than a Fixed Help program does (P2A). Lastly, the results

also supported our prediction that ambiguity significantly raises participants' willingness to pay for insurance (ambiguity aversion).

### 4.3 WTP for self-insurance: Preliminaries

We asked the subjects to indicate the amount of money they were willing to pay in order to implement prevention activities such as clearing or pruning, for instance. Such activities are self-insurance activities because they allow reducing the magnitude of the losses after a fire occurrence. Once again, a preliminary statistical analysis showed that WTPsi distributions did not respect the normality assumptions (Kurtosis coefficients lie between 4.49 and 6.77 and; Skewness coefficients lie between 2.26 and 2.61). We therefore performed a log transformation. Table 3 below reports the mean for WTPsi/EL and  $\log(WTPsi/EL)$  for the main experimental conditions (note that to facilitate the comparisons between the different scenarios, we also normalized the WTP for self-insurance by the expected loss).

Table 3: Mean  $\log(WTP/EL)$  by policy and InfoProba

			No Help	Fixed Help	Contingent Fixed Help	Insurance Subsidy	Total
RISK	Low income	Geometric Mean	0.30	0.32	0.32	0.35	0.32
		$\log WTP/EL$	-0.52	-0.49	-0.49	-0.45	-0.49
	High Income	Geometric Mean	0.19	0.21	0.18	0.19	0.19
		$\log WTP/EL$	-0.72	-0.68	-0.74	-0.72	-0.72
AMB.	Low income	Geometric Mean	0.22	0.17	0.18	0.15	0.18
		$\log WTP/EL$	-0.66	-0.76	-0.74	-0.83	-0.75
	High Income	Geometric Mean	0.16	0.13	0.13	0.11	0.13
		$\log WTP/EL$	-0.79	-0.88	-0.89	-0.95	-0.88

### 4.4 Findings for WTP for self-insurance

As for the WTP for insurance, the WTP for self-insurance were analyzed in a 2(Population) x 2(Order) x 2(Probability) x 4(Policy) x 2(Income) MANOVA with repeated measures on the last two factors. We found no significant effect of InfoProba ( $F_{1;70} = 0.609$ ;  $p = 0.438$ ) and of Policy ( $F_{2.111;0.050} = 1.029$ ;  $p = 0.363$ )<sup>3</sup>, and no significant interactions involving these factors. These results therefore do not support our predictions on the impact of the type of public intervention (P1B to P3B) and of the information about the probability of the risk (P4B) on willingness to self-insure.

<sup>3</sup>The Mauchly's test of sphericity revealed that the variance-covariance matrix of the dependent variable Policy is not spherical in form (Mauchly's  $W = 0.434$ ;  $p = 0.000$ ). F and p values reported for Policy are therefore adjusted (Greenhouse-Geisser) to account for the violation of this hypothesis.

## 4.5 Discussion and conclusion

In order to conclude this analysis, we discuss our results regarding the risk-seeking behavior of our subjects and the link between attitude to risk and attitude to ambiguity.

### 4.5.1 Insurance demand against disaster-type risks

There is empirical evidence that people usually have a tendency to fail to buy insurance against low-probability high-consequences risks, compared to the predictions from the expected utility theory. Expected utility theory says that individuals are generally risk averse. Consequently, they should always purchase actuarially fair insurance. However, experiments (Schoemaker and Kunreuther, 1979; Mc Clelland and al., 1993; Ganderton and al., 2000) and field studies (Coursey and al., 1987) have shown that individuals often choose not to buy insurance against low-probability, high-loss hazards when such insurance is sold at a fair, or even better, price. These authors generally conclude that people either worry too much about the risk and pay premiums that are considerably in excess of the expected loss, or decide not to worry about them and neglect to purchase insurance against them. More recently, Kunreuther and Pauly (2004) provided a new explanation why people fail to buy insurance for low-probability, high-loss hazards. They developed a model of insurance purchasing behavior which implies that people fail to buy such insurance because of search costs involved in finding the information necessary to make the optimal decision. In the same way, Papon (2008) provides a new possible explanation about the fact that people usually fail to obtain insurance for low-probability, high-loss events. He tests the role of commitment period on insurance coverage. The study reveals that insurance behaviors may depend on the length of the commitment period of insurance policies as well as prior risk occurrences and subjective risk perception.

The results from our experimental study that investigates insurance behaviors in disaster-type risks reveal some new reasons for which people usually fail to insurance against low-probability, high-loss events. The first reason is that people are risk seeking in presence of such risks. Because they are few confronted with such events and have ambiguity about the probabilities of insurable hazards, then they perceive the probability of such events as negligible. Consequently they are not reluctant to take risk and they dismiss the low-probability, high-loss risk. This seems to influence their willingness to pay for coverage. People do not make optimal insurance-purchasing decisions and pay premiums that are fewer than the expected loss. As a result, people that are risk seeking rationally decide not to buy insurance. The second reason is the presence of public intervention compensating the losses due to the low-probability, high-loss events. This financial help program

creates a risk moral problem. People have the feeling to be protected against disaster-type risk and they do not adopt the optimal insurance behaviors. This reason strengthens the first argument of explaining the fact that people usually under-insure against low-probability risks.

#### 4.5.2 The separation of attitudes towards risk and ambiguity

Our experimental study suggests that people are risk seeking and ambiguity averse in presence of disaster-type risks and ambiguity about the probabilities of insurable hazards. Some previous works (Cohen and al., 1985; Hogarth and Einhorn, 1990; Di Mauro and Maffioletti, 2004; Chakravarty and Roy, 2008) found that attitudes towards risk and attitudes towards ambiguity are uncorrelated. Nevertheless, Lauriola and Levin (2001), Potamites and Zhang (2007) and Bossaerts and al. (2007) report a positive correlation between risk aversion and ambiguity aversion. In a theoretical paper, Gollier (2006) proves that, contrary to the intuition, ambiguity aversion may yield an increase in the demand for risky and ambiguous asset and a reduction in the safe and unambiguous one. The interaction among individual attitudes towards risk and ambiguity generally depends on the sign of the outcome domain (gains or losses). From some experimental studies there appears a reflection effect in both risky and ambiguous tasks. The reflection effect is the fact that people who are risk/ambiguity averse in the domain of gains become risk/ambiguity seeking in the domain of losses and vice versa. Our experiments investigate insurance-decision behaviors in low-probability risks. Therefore the decision task belongs to the loss domain. The results of our experiments suggest that subjects are risk seeking and ambiguity averse in this domain. In a risk context, subjects reduce their willingness to pay for insurance whereas, in an ambiguous context, they have a higher insurance demand.

In order to deep this observation, we made a correlation test between  $\log(\text{WTP}/\text{EL})$  which revealed attitude to risk and the ratio  $\log(\text{WTP}/\text{EL})$  for ambiguous context in  $\log(\text{WTP}/\text{EL})$  for risky situation. This last ratio lets appeared attitude to ambiguity. If the ratio is superior to 1 then participants have higher  $\log(\text{WTP}/\text{EL})$  for insurance when the risk is ambiguous than when it is risky. This test is original in the sense that generally, the two variables are designed to capture preferences towards risk or ambiguity while our two variables are deduced from our experiment in order to observe attitudes to risk and ambiguity. We find that the Pearson correlation between the risk and ambiguity attitudes is  $Cor(r, a) = 0.463$ . This correlation is significant using a two-sided t-test ( $p = 0.071$ ). Consequently, we find a significant and positive correlation between attitudes to risk and ambiguity confirming the previous results of authors such as Lauriola and Levin (2001).

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