Attitude towards financial risk and attitude towards flood risk do not play the same role in individual flood mitigation

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Abstract

In this paper, we study the relationship between domain specific risk attitudes and perceptions and people's intentions to invest in precautionary measures against floods. We focus on two domains: flood risks and financial risks. To this end, we first extend an existing psychological risk measurement scale to the flood domain and test its internal and external validity. We then compare risk attitudes and perceptions in the flood and financial domains and explain their impact on people's willingness to invest in individual precautionary measures against floods. We show that on average, people are less inclined to take risks relating to floods than financial risks, which we explain by differences in the perception of risk. Finally, our results show that attitudes towards risk significantly influence the intention to invest in precautionary measures. However, while the negative attitude towards flood risks plays positively on the willingness to take measures, a negative attitude towards financial risks plays negatively on it. This result implies that precautionary measures against flood cannot be considered as self-insurance.

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1. Introduction

Nearly all real life situations contain some uncertainty or involve taking some risk. Studying people's attitudes towards risk can help understand and predict their behavior. Indeed, since a person's attitude towards risk is linked to his/her propensity or disinclination to accept or engage in risky situations, it strongly influences the decisions he/she takes when dealing with such situations. For a long time the economic literature has focused on general aspects of risk and uncertainty, most often embedded in expected utility theory (Eeckhoudt, Gollier, & Schlesinger, 2005; Gollier, 2004). However, in line with empirical studies, many authors now recognize that behaviors in the above situations vary with the framing of the problem (Tversky & Kahneman, 1981) and are context dependent (Tversky & Simonson, 1993). Moreover, attitudes towards a specific risk depend on the domain to which the risk belongs (Reynaud & Couture, 2012; Weber, Blais, & Betz, 2002), i.e. people do not behave in the same way in the face of different types of risk, such as health risks and financial risks, although some underlying general "risk preference" may exist as suggested by Vieider et al. (2015).

There are many ways to manage uncertainties and risks: gathering information, diversifying portfolios, saving money, taking out insurance, undertaking prevention actions etc. Most are outcomes of financial investment decisions: how much money should we allocate to the reduction of atmospheric pollution? How much should we save for retirement? How much should we spend to protect our home against natural disaster? If these decisions can be seen as financial investments, attitudes towards financial risk should influence them, along with other attitudes that are specific to the domain to which they apply. Although many of those decisions are collective and may even give rise to public goods, some are individual and only profit the decision makers.

In this paper, we deal with individual decision making and one particular domain of risk, the risk of flooding. Our research question is: what are the relationships between attitudes towards flood risk, attitudes towards financial risk, and people's intentions to invest in precautionary measures to protect themselves against floods?

In 2014, floods accounted for more than one third of the total estimated damage caused by natural disasters worldwide[1] and it is expected that in the future, increasing numbers of individuals will be exposed to natural disasters, including floods (Bouwer, Bubeck, & Aerts, 2010). Individuals have several options to address such risks: avoidance consists in moving away from flood prone areas; insurance may pay financial compensation for economic damage; set-asides may serve for repair; precautionary measures may reduce the negative impacts of floods on a dwelling. Precautionary measures have been identified as particularly cost-efficient (Botzen, Aerts, & Van den Bergh, 2009) and it is thus important to understand why individuals may or not be reluctant to invest in such measures (Kunreuther, 1996). Precautionary measures can be structural (e.g. installing electrical wiring and boilers higher up in the walls, raising ground floors or making an opening on the roof to facilitate evacuation) or non-structural (using pumps, storing valuables upstairs, or having all main rooms on upper floors) and may completely or partially prevent financial or non-financial damage. Risk perceptions have been shown to be an important driver of people's intentions to invest in precautionary measures (Bubeck, Botzen, & Aerts, 2012; Richert, Erdlenbruch, & Figuières, 2016), but the impact of attitudes towards different risks on these decisions has not yet been investigated in the literature.

[1] http://www.emdat.be/disaster_trends/index.html

Before examining the relationships between attitudes towards financial or flood risk, and investments in precautionary measures, we first recall the definitions and measurement methods of attitudes towards risk proposed in the literature. In this paper, we choose to measure attitudes using psychometric scales as correlations between actual behaviors and attitudes towards risk measured by psychometric scales are generally greater than correlations between actual behaviors and risk aversion assessed by lotteries (Charness, Gneezy, & Imas, 2013). .

We examine several assumptions. First, we assume that the disinclination towards flood risk increases willingness to invest in precautionary measures: the more individuals dislike flood risks, the more they would like to protect themselves. Second, attitude towards financial risk may play in opposite ways. If the main objective of precautionary measures is to reduce monetary losses, i.e. precautionary measures are self-insurance (Carson, McCullough, & Pooser, 2013), the disinclination towards financial risks should enhance the willingness to invest in such measures. On the other hand, precautionary investments can compete with other forms of investments, such as savings, and it may be more profitable to invest in such alternative funds, for example because they are less risky and provide a higher financial return. In that case, the disinclination towards financial risks should decrease the willingness to invest in precautionary measures, because they have random returns (Kunreuther & Slovic, 1978). Finally, precautionary measures may aim mostly at preventing non-financial damage. Therefore, financial investments and investments in precautionary measures could be unrelated. In that case, the literature on mental accounting models (Thaler, 1999) suggests that attitudes towards financial risks may have no influence on protection decisions.

We base our work on a survey of 331 inhabitants of flood-prone areas in France. We collected data on their intentions to invest in precautionary measures against floods in their households and on their attitudes towards different risks. Interviewees completed several subscales of the DOSPERT psychometric scale (Weber et al., 2002), for different risk domains, in particular financial risks.[2] Because there was no domain for natural hazards, we created an additional subscale that was specifically designed to assess perceptions and attitudes towards the risk of flooding.

We first checked that the psychometric subscales, and especially the new flood subscale, are internally and externally consistent in our sample. Our results provide additional evidence that attitudes are domain dependent. They also suggest that attitudes towards flood risk and attitudes towards financial risk are important in explaining investment intentions for precautionary measures, but with opposite effects. They are in line with our assumption on the positive effect of the disinclination towards flood risks on precautionary investments. On the other hand, the disinclination towards financial risk plays negatively on precautionary investments.

The remainder of the paper is organized as follows: in section 2, we recall the concepts of risk, risk perception and attitudes towards risk and to clarify the definitions and methods we use in our study. In section 3, we explain the method we used to measure perceptions and attitudes towards financial risk and flood risk and their relation to precautionary investments. In section 4, we present the results, highlighting the differences in perceptions and attitudes in the flood domain and the financial domain, and showing their impact on the intention to invest in precautionary measures.

[2] They also completed the subscales related to the health and safety and social domains of the DOSPERT scale but the corresponding data are not used in the study presented here.

2. Risk, risk perception, and attitude towards risks

In this section, we first recall the definitions of risk, risk perception and attitude towards risk. We then examine how these two concepts can be measured and how they influence actual risk taking behaviors. We refer in the following to "microeconomic" and "psychological" approaches although these disciplines sometimes overlap (e.g. Dohmen et al. (2011)). The aim of this section is simply to clarify the definitions used in our study[3].

2.1. Concepts and measures of risk, risk perception, and attitude towards risk

According to microeconomic approaches, a risky situation is characterized by a set of consequences (called outcomes) each occurring with a probability of less than one (Gollier, 2004). Risk perceptions generally only relate to the probability of occurrence (e.g. Quiggin (1982); Tversky & Kahneman (1992)). Risk probabilities can be subjective or given by experts. By contrast, psychological approaches generally separate risks and benefits which can be two opposite aspects of a same situation (e.g. Fischhoff, Slovic, Lichtenstein, Read, & Combs (1978)). In other words, risks are defined as potentially harmful events generated by a choice or situation. Moreover, risk perceptions are described as intuitive judgments that depend on multiple dimensions of the risk concerned, such as voluntariness, dread, knowledge, or controllability. Risk probabilities do not appear to play an important role in the building of risk perceptions among the general public (Slovic, 1987).

These different representations of the concepts of risk and risk perception lead to different definitions of attitude towards risk. In microeconomic approaches, attitude towards risk can be conceptualized by risk aversion (e.g. Holt & Laury (2002), Binswanger (1980)). Indeed, an agent's choice under risk depends on the probabilities of occurrence and the desirability of the (risky) outcomes, which is evaluated by a utility function. Risk aversion influences the curvature of this utility function (Pratt, 1964). For small risks, risk aversion can be approximated by the Arrow-Pratt coefficient. An agent will thus take a specific risk if the value taken by his/her function when he/she evaluates this specific risk is higher than every value taken by the same function to assess the alternative options. As a result, risk aversion does not directly indicate the propensity of an agent to take a specific risk but is rather a general trait which characterizes the way the agent evaluates the outcomes of risky decisions: the lower this risk aversion, the lower the propensity to take risks in general (Pratt, 1964).

In psychological approaches, according to Ajzen & Fishbein (1973) "a person's attitude toward some object constitutes a predisposition on his part to respond to the object in a consistently favorable or unfavorable manner". Thus, attitude towards risk is a person’s tendency to respond favorably or unfavorably to a risky situation, given his/her perception of the risk, which can depend on several features, and on the benefits it provides. In fact, Weber et al. (2002) even propose to decompose attitude towards risk into two types of attitudes: the attitude towards the benefits provided by a risky situation and the attitude towards the perceived risk caused by the situation. The more favorable the attitude towards risk, the greater the risk-taking propensity. This decomposition is generally not done in economic approaches.

Given that only (objective or subjective) probabilities and outcomes matter to qualify a risk in microeconomic approaches (Starmer 2000), economists often use experimental settings that allow

[3] A thorough and general review of the concepts and measurement methods of attitude towards risk in economics and psychology is beyond the scope of this paper.

observation of people's preferences among risks whose probabilities and outcomes are known. Risk aversions are then inferred from people's choices. For instance, Holt & Laury (2002) designed a popular method to elicit risk aversion by using lotteries. Becker, DeGroot and Marschak (1964) introduced a popular method to measure respondents' certainty equivalent of a lottery to elicit risk aversion. One advantage of this approach is that monetary incentives can easily be included in the experiments in order to increase the realism of the decisions (Charness & Gneezy, 2012).

On the other hand, in psychological approaches, attitudes towards risk are assumed to depend on several and possibly different characteristics of the risks, in addition to their probability and desirability. Consequently, they could vary across contexts (Blais & Weber, 2006; Hanoch, Johnson, & Wilke, 2006; Szrek, Chao, Ramlagan, & Peltzer, 2012; Weber et al., 2002). As a result, questionnaires can be used to collect directly self-reported attitudes towards risk in different contexts. For example, Weber et al. (2002) designed the Domain-specific Risk-attitude (DOSPERT) scale, which aims to assess people's attitudes towards risk, their risk perceptions, and their perceptions of the benefits provided by risks in five domains: health/safety, ethical, social, financial, and recreational risks. This is the approach we will use in the following. The DOSPERT scale is a five-point Likert scale and consists of 40 items split into five subscales (one for each domain). Each item describes a risky situation or behavior (e.g. "Betting a day's income at the horse races", "Not wearing a helmet when riding a motorcycle"). People are asked to indicate 1) their likelihood of engaging in each activity or behavior, 2) how risky they perceive each situation or behavior to be, and 3) the benefits they would obtain from each situation.

2.2. Empirical evidence comparing psychological and microeconomic approaches

Some comparisons of microeconomic and psychological methods suggest that they provide measures of attitudes towards risk that are significantly correlated (Dohmen et al., 2011; Vieider et al., 2015). According to these results, people have a global attitude towards risk and both types of methods can be used to elicit this general trait.

Going deeper into the investigation of the relationship between economic and psychological measures, Reynaud & Couture (2012) found that risk aversion elicited through lotteries is significantly correlated to the attitudes towards financial and recreational risks assessed by the DOSPERT psychometric scale, but not with attitudes towards risk in the health and safety, ethical, and social domains. Thus, even if people have a global propensity to take risks, their behaviors can differ across contexts and economic methods based on lotteries seem to assess attitudes towards risk in specific situations. Because we wished to better understand individual's attitude in the flood risk domain, we think the use of the DOSPERT psychometric scale is appropriate.

Moreover, some studies investigate the relationship between measures of attitudes towards risk and actual risk-taking behaviors. For instance, in an empirical survey, Wärneryd (1996) found that economic risk aversion measured by lotteries was related to recreational gambling but not to actual risky financial investments, whereas attitude towards financial risks measured by a psychometric scale explained actual risky financial investments but not recreational gambling. In another study conducted by Lönnqvist, Verkasalo, Walkowitz, & Wichardt (2015), questionnaire measures were related to behavior in a trust game whereas choices among lotteries were not. Finally, Szrek et al. (2012) found no relationship between measures of risk aversion and actual risky behaviors in the health domain whereas the psychological questions they used were generally significant in explaining these behaviors. In light of these findings,

Charness et al. (2013) suggest that the choice of using economic experiments or questionnaire measures to elicit attitude towards risks depends on the aim of the study. Indeed, since economic experiments provide a high level of control and are incentivized, they are more suitable to examine the effects of treatment and differences between individuals. On the other hand, questionnaire measures are less precise but have better explanatory power for actual risk-taking behavior. Thus, they may be more suitable to investigate actual attitude towards specific risks. Consequently, in this paper, we use questionnaire measures to examine the relationship between attitudes towards financial and flood risks and investments in precautionary measures against floods.

3. Method: Measuring attitudes towards financial risks and flood risks and their relation to precautionary investments

3.1. Underlying survey

3.1.1. Sample

We conducted a survey of 331 inhabitants of flood-prone areas in France using face-to-face interviews. The data collected covered a wide range of topics, including experience of floods, perceptions of financial and flood risks, attitudes towards financial and flood risks, intentions to implement precautionary measures, and sociodemographic features. Among the 331 respondents, 254 answered all the questions related to perceptions and attitudes regarding financial and flood risks. These respondents make up the sample used in subsequent analyses. As presented in Table 1, approximately half the sample is composed of women and half of men. All age categories are represented.

Table 1: Sociodemographic characteristics of the sample

Variable	Category	Sample distribution
Gender	Male	46%
	Female	54%
Age	<30	17%
	30-44	22%
	45-59	24%
	60-74	28%
	>74	9%

N=254.

3.1.2. DOSPERT extended to the risk of floods

The DOSPERT scale was designed in English and first validated in the United States by Weber et al. (2002). However, Blais & Weber (2006) then shortened it and translated the shortened version into French. They used it in a survey among French-speaking respondents residing in Quebec and found that, overall, the French version of the shortened DOSPERT scale was a reliable instrument to measure risk attitudes and perceptions in the domains of financial, health and safety, social, and recreational risks.

In order to examine the differences between financial risks and flood risks, we designed five additional items related to the latter. They were reviewed by five flood experts who confirmed they covered the main dimensions of these kinds of risks. These experts also gave their feedback regarding the financial items and mentioned that one item was difficult for French-speaking people living in France to understand. As a result, we slightly modified it to adapt it to the French context.[4] The experts also thought that the options "impossible" and "certain" were lacking in the Likert scale used by Blais & Weber (2006) to evaluate risk attitudes. We consequently modified it so its choice responses ranged from "impossible" to "certain". Finally, the scale we used in our survey comprises six items related to financial risks and five items related to flood risks. It is presented in Appendix A.

During the survey, participants were presented with all the items twice. The first time, they rated how risky they perceived each situation to be, from 0: "not at all risky" to 6: "extremely risky". The scores collected were used to estimate the respondents' perceptions of risk. The second time, we gathered data on the respondents' attitudes towards risk by asking them to assess their likelihood of getting involved in the situation described in each item from 0: "impossible" to 6: "certain". When presented to the participants, the items were randomized to mitigate order effects. The data collected also allowed assessment of perceived-risk attitudes. Indeed, Weber et al. (2002) propose decomposing attitude towards a risky option *S* as follows:

$$Attitude(S) = a * Expected\ benefits(S) + b * Perceived\ risk(S) + c \quad (1)$$

Hence, an agent's attitude towards risk in a specific domain results from the addition of two attitudes: the agent's attitude towards the expected benefits, which is captured by coefficient *a*, and his/her attitude towards perceived risk, which is represented by coefficient *b*. Since we obtained data on the respondents' attitudes to and perceptions of risk, we were able to estimate coefficient *b* using linear regressions. The method we used is described in more detail in section 3.2. To distinguish between the terms *Attitude* and *b* in equation 1, we call the former "conventional risk attitude" and the latter "perceived-risk attitude".

3.1.3. Intentions to invest in precautionary measures against floods

Semi-directive interviews with inhabitants of flood-prone areas in France and a literature review of private flood mitigation (Grothmann & Reusswig, 2006; Poussin, Botzen, & Aerts, 2014; Reynaud, Aubert, & Nguyen, 2013) enabled us to identify 11 main precautionary measures. Some of them are structural measures, which are features of the structure of homes aimed at preventing the negative consequences of floods. For instance, raised ground floors or raised crawl spaces are structural measures. The others are non-structural measures, which are all the other devices implemented to avoid damage caused by floods. Pumps and watertight doors are two examples of such measures.

For each measure, the respondents stated whether or not they have implemented it in their home, and if not, whether or not they intended to do so. We constructed two binary variables: the first one takes the value 1 if at least one measure has already been implemented by the respondent's household and otherwise 0; the second variable takes the value 1 if the respondent intends to take at least one measure,

[4] We changed the item "Investir 10% de vos revenu annuels dans un fonds mutuel à croissance modérée", which translates: "Investing 10% of your annual income in a moderate growth mutual fund", to "Investir 10% de vos revenus annuels dans un fonds commun de placement peu risqué", which translates: "Investing 10% of your annual income in a mutual fund, which has little risk".

and otherwise 0. We used the second variable in subsequent analyses because in a previous study, we found that the implementation of a precautionary measure could have a negative feedback effect on risk perceptions and hence a positive feedback effect on conventional risk attitudes (Richert et al., 2016). As a result, the conventional risk attitudes elicited during our survey could differ from the ones that led the respondents to take precautionary measures in the past. In total, 42% of the respondents had already implemented at least one measure and 31% intended to take at least one measure.

3.2. Statistical treatment

Our first analyses tested the validity of the DOSPERT scale. We first conducted ordinary least square factor analyses of the scores on the perceptions and conventional attitudes scales. These analyses show whether the flood and financial subscales load on similar or different factors for risk perceptions and conventional risk attitudes. In other words, they reveal whether risk perceptions and conventional attitudes are similar in the two domains, or not. Second, we assessed the internal consistency of each subscale by computing their Cronbach's alpha. The external validity of our measures was assessed by examining gender differences and the relationship between experience of floods and risk attitudes.

Indeed, Byrnes, Miller, & Schafer (1999) conducted a meta-analysis of 150 studies that revealed that males are generally more prone to take risks than females. More recently Charness & Gneezy (2012) replicated the finding, and in an empirical study, Weber et al. (2002) found that on average, women had significantly lower scores for conventional risk attitudes and higher scores of risk perceptions than men for all subscales of the DOSPERT scale except the social one. However, women and men's perceived-risk attitudes did not differ significantly. Thus, we expected the same results in our study. As Kim & Lee (2014) found out that risk aversion increases with traumatic experience, we investigated whether conventional risk attitudes and perceived-risk attitudes in the flood and financial domains decrease with flood experience.

We used the same method to investigate the effect of gender and experience. We separated the sample into two groups: males and females, or respondents who had experienced at least one flood and respondents who had never experienced a flood. Then we conducted two types of analyses. First, to compare the distributions of conventional risk attitudes and risk perceptions in the financial and flood domains between the two groups, we used non-parametric tests because the data were not normally distributed (Wilcoxon, 1945). Second, to compare perceived-risk attitudes by domain between the two groups, we regressed conventional risk attitude on risk perception, with a separate regression for each group and each domain.[5] For each group, the coefficient associated with the variable risk perception is thus the average perceived-risk attitude for this group, as defined in equation 1. Finally, to assess the significance of the effect of gender (or flood experience) on perceived-risk attitudes, we conducted additional linear regressions of conventional risk attitude that included an interaction term between risk perception and gender (or flood experience) as explanatory variable. If the coefficient associated with this interaction term differs significantly from zero, gender (or flood experience) has a significant effect on perceived-risk attitude.

After assessing the internal and external consistencies of the financial and flood subscales, we investigated the differences between the two domains. First, we compared conventional risk attitudes and perceptions

[5] For these regressions, we used the scores for each item instead of the average per domain and per individual in order to account for a higher number of observations.

in the flood and financial domains using non-parametric tests and computing Pearson correlation coefficients. For each domain, we also calculated the average perceived-risk attitude for the whole sample. We compared the average perceived-risk attitudes in the financial and flood domains by regressing conventional risk attitude on risk perception, a dummy variable representing the domain, and an interaction term between this dummy variable and risk perception. If the coefficient associated with this interaction term differs significantly from zero, the difference in average perceived-risk attitude between the two domains is significant.

Finally, to examine the relationship between actual behavior related to flood risks and risk perception and conventional risk attitudes, we conducted six simple logistic regressions of the intention to take precautionary measures with six different explanatory variables: conventional risk attitude in the financial domain, risk perception in the financial domain, conventional risk attitude in the flood domain, risk perception in the flood domain, the ratio between conventional risk attitude in the flood domain and conventional attitude in the financial domain, and the ratio between risk perception in the flood domain and risk perception in the financial domain. Note we did not use perceived-risk attitude as explanatory variable because we only had five observations (one for each item) per individual and per domain. As a result, we were not able to estimate each respondent's perceived-risk attitudes. So, to explore the relationship between willingness to invest in precautionary measures and perceived-risk attitudes, we separated the sample into two groups: the respondents who planned to implement at least one measure and those who did not plan to take any measure. For each group and each domain, we conducted a simple linear regression of conventional risk attitude on risk perception in order to estimate average perceived-risk attitudes[6].

4. Results that differentiate flood risks and financial risks

4.1. Validation of the extended DOSPERT scale

4.1.1. Factor analysis to confirm the new subscale

Two factor analyses were conducted to examine whether risk perceptions and conventional risk attitudes differ in the domains of financial risks and flood risks. For each analysis, oblique rotations were used because we expected the factors to be correlated. Based on the number of hypothesized subscales, we specified a two-factor model for each analysis.

The two-factor model of risk perceptions is presented in Table 2. It accounts for 47% of variance. Five of the financial items load on the first factor, which accounts for 25% of variance. Only the fourth financial item loads on the second factor. On the other hand, all flood items load on the second factor, which accounts for 22% of variance.

[6] To assess the significance of the effect of the willingness to invest in precautionary measures on perceived-risk attitude, we conducted additional linear regressions of conventional risk attitude on risk perception, a dummy variable that takes the value 1 for the respondents who plan to invest in precautionary measures, and an interaction term between these two variables. Thus, if the coefficient associated with this interaction term differs significantly from zero, the willingness to invest in precautionary measures has a significant effect on perceived-risk attitude.

Table 2: Factor analysis of the risk perception scale

	Factor 1	**Factor 2**
Financial 1	**0.83**	0.00
Financial 2	**0.58**	-0.17
Financial 3	**0.78**	0.06
Financial 4	0.17	**0.60**
Financial 5	**0.89**	-0.02
Financial 6	**0.49**	0.19
Flood 1	-0.07	**0.45**
Flood 2	-0.17	**0.46**
Flood 3	0.02	**0.65**
Flood 4	0.03	**0.68**
Flood 5	-0.04	**0.83**
Proportion of variance explained	0.25	0.22

N=254. Loadings greater than or equal to 0.30 are in bold.

The two-factor model of conventional risk attitudes is presented in Table 3. It accounts for 54% of variance. Five of the financial items load on the first factor, which accounts for 32% of variance. Only the fourth financial item loads on the second factor. On the other hand, all flood items load on the second factor, which accounts for 22% of variance.

Table 3: Factor analysis of the conventional risk attitude scale

	Factor 1	Factor 2
Financial 1	**0.95**	0.02
Financial 2	**0.76**	-0.21
Financial 3	**0.87**	0.07
Financial 4	0.22	**0.55**
Financial 5	**0.90**	0.03
Financial 6	**0.60**	0.11
Flood 1	0.01	**0.38**
Flood 2	-0.11	**0.30**
Flood 3	0.00	**0.72**
Flood 4	0.05	**0.74**
Flood 5	-0.04	**0.86**
Proportion of variance explained	0.32	0.22

N=254. Loadings greater than or equal to 0.30 are reported in bold.

Since the fourth financial item ("Investing 5% of your annual income in a very speculative stock") did not load on the first factor in either of the two factor analyses, it was not included in subsequent analyses.

4.1.2. Internal consistency: Cronbach alpha coefficients

Table 4 lists the alpha coefficients for each risk perception and conventional risk attitude subscale. The financial subscale is the most reliable for both scales. However, the internal consistency of the flood subscale remains acceptable for both scales since alpha coefficients are greater than or equal to 0.70 (George & Mallery, 2003). As a result, it makes sense to average the scores per respondent for each scale in the two domains in order to construct four variables: perception of financial risks, perception of flood

risks, conventional risk attitude in the financial domain, and conventional risk attitude in the flood domain.

Table 4: Internal consistency of the subscales

	Risk perception		Conventional risk attitude	
	Financial	Flood	Financial	Flood
Cronbach alpha	0.84	0.73	0.90	0.70

N=254.

4.1.3. External consistency: relationship with gender and experience

In order to examine the external consistency of the subscales, we studied their relationships with gender and experience.

Relationship with gender

Table 5 lists the results of the comparison of risk perceptions and conventional risk attitudes of women and men in the financial and flood domains. It reveals that, among the respondents, women have significantly lower conventional risk attitudes than men in the financial and flood domains at the 0.1 level. Hence, they are less likely to get involved in a risky situation. However, women and men's risk perceptions do not differ significantly in either domain.

Table 5: Means and standard deviations of risk perception and conventional risk attitude ratings by gender[a]

	Females, N=137 Mean (Standard deviation)	**Males, N=117** Mean (Standard deviation)
Domain	**Risk perceptions**	
Financial	3.98	3.74
	(1.27)	(1.31)
Flood	4.83	4.74
	(0.84)	(0.83)
Domain	**Conventional risk attitudes**	
Financial	1.35**	1.64**
	(1.44)	(1.42)
Flood	1.09***	1.29***
	(0.96)	(0.89)

[a] N=254. The significance levels indicated come from Mann-Whitney-Wilcoxon tests between females and males. Significance levels: * p<0.1; ** p<0.05; *** p<0.01.

Table 6 presents the effect of gender on perceived-risk attitude. In both domains, women and men's average perceived-risk attitudes are significantly negative at the 0.01 level. Moreover, since the coefficient associated with the interaction term between risk perception and gender is not significantly different from zero at the 0.1 level in the financial and flood domains, we do not reject the hypothesis, however, that

women and men have a similar average perceived-risk attitude in both domains, similar to the findings obtained by Weber et al. (2002).

Table 6: Effect of gender on perceived-risk attitude[a]

	Females, N=685 Estimate (Std error)	**Males, N=585** Estimate (Std error)	**Difference, N=1270** Estimate (Std error)
Financial	-0.61*** (0.03)	-0.62*** (0.03)	-0.00 (0.04)
Flood	-0.58*** (0.04)	-0.55*** (0.05)	0.03 (0.06)

[a] The second and third columns show estimates and standard errors of the coefficients of perceived-risk attitude for females and males estimated by linear regressions of conventional risk attitude on risk perception. The fourth column shows the estimates and standard errors of the coefficients of an interaction term (between gender and risk perception) after linear regressions of conventional risk attitude on risk perception, gender, and this interaction term. Gender is a dummy variable that takes the value 0 for females and 1 for males. Significance levels: * $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Relationship with flood experience

Table 7 gives the results of the comparison of conventional risk attitudes of the respondents who have flood experience and of those who have none. It shows that conventional risk attitudes do not significantly differ between respondents who have experienced a flood and those who have not. Both have thus similar propensity to get involved in risky situations.

Table 7: Means and standard deviations of conventional risk attitude depending on flood experience

	Flood experience, N=207 Mean (Standard deviation)	**No flood experience, N=47** Mean (Standard deviation)
Financial	1.51 (1.39)	1.34 (1.60)
Flood	1.11 (0.79)	1.49 (1.37)

The Mann-Whitney-Wilcoxon tests between the two groups of respondents did not reveal any significant differences.

Table 8 presents the effect of flood experience on perceived-risk attitude. In both domains, the average perceived-risk attitudes of respondents who had experienced a flood and of those who had not are significantly negative at the 0.01 level. Moreover, since the coefficients associated with the interaction terms between risk perception and flood experience are significantly negative at the 0.01 level in the financial and flood domains, respondents who had experienced a flood have a significantly lower average perceived-risk attitude than respondents who had not experienced a flood, in both domains. Hence, experience of flood is an important factor to explain the extent to which people value perceived risk negatively.

Table 8: Effect of flood experience on perceived-risk attitude[a]

	Flood experience N=1035 Estimate (Std error)	**No flood experience** N=235 Estimate (Std error)	**Difference** N=1270 Estimate (Std error)
Financial	-0.65*** (0.02)	-0.47*** (0.07)	-0.18*** (0.06)
Flood	-0.61*** (0.03)	-0.40*** (0.08)	-0.20*** (0.07)

[a] The second and third columns show estimates and standard errors of the coefficients of perceived-risk attitude for respondents who had experienced at least one flood and respondents who had never experienced a flood estimated by linear regressions of conventional risk attitude on risk perception. The fourth column shows the estimates and standard errors of the coefficients of an interaction term (between flood experience and risk perception) after linear regressions of conventional risk attitude on risk perception, flood experience, and this interaction term. Flood experience is a dummy variable that takes the value 0 for respondents who have never experienced a flood and 1 for respondents who have experienced at least one flood. Significance levels: * p<0.1; ** p<0.05; *** p<0.01.

4.2. Comparison of perceptions and attitudes in the domains of financial and flood risks

As shown in Table 9, risk perceptions and conventional risk attitudes differ significantly at the 0.01 and 0.1 levels between the two domains. Indeed, flood risks are perceived as significantly more risky than financial risks and the respondents said they were significantly more inclined to take financial risks than flood risks. In addition, risk perceptions are not significantly correlated in the two domains which is another element in favor of the separation of the domains. On the other hand, we observe a medium positive correlation (Cohen, 1977) between conventional risk attitudes in the two domains, which could be an indicator that there is also some kind of general attitude towards risks (but which is not strong in our sample).

Table 9: Means and standard deviations of risk perceptions and conventional risk attitudes by domain[a]

	Financial domain	**Flood domain**
		Risk perception
Mean	3.87***	4.79***
Standard deviation	1.29	0.84
Pearson correlation coefficient	0.07	
		Conventional risk attitude
Mean	1.48*	1.18*
Standard deviation	1.43	0.93
Pearson correlation coefficient	0.27***	

[a] N=254. The significance levels indicated next to the mean values come from paired Mann-Whitney-Wilcoxon tests between the financial and floods domain. Significance levels: * p<0.1; ** p<0.05; *** p<0.01.

Table 10 shows the average perceived-risk attitudes for each domain. They are both significantly negative at the 0.01 level. However, since the coefficient associated with the interaction term between risk perception and domain is not significantly different from zero at the 0.1 level, we do not reject the hypothesis that perceived-risk attitudes are similar in the flood and financial domains. Hence, risk perceptions are greater in the flood risk domain than in the financial domain and people are less inclined

to get involved in situations linked to flood risks than in situation linked to financial risks. However, perceived-risk attitudes may be similar in the two domains.

Table 10: Perceived-risk attitudes according to the domain[a]

	Financial domain, N=1270	**Flood domain**, N=1270	**Difference**, N=2540
Estimate	-0.62***	-0.57***	0.05
Standard error	0.02	0.03	0.04

[a] The second and third columns show estimates and standard errors of the coefficients of perceived-risk attitude in the financial and flood domains estimated by linear regressions of conventional risk attitude on risk perception. The fourth column shows the estimates and standard errors of the coefficients of an interaction term (between domain and risk perception) estimated by a linear regression of conventional risk attitude on risk perception, domain, and this interaction term. Domain is a dummy variable that takes the value 1 for observations relating to the flood domain. Significance levels: * p<0.1; ** p<0.05; *** p<0.01.

4.3. Influence of risk attitude on willingness to invest in precautionary measures

According to Table 11, the willingness to take precautionary measures against floods increases with conventional attitude towards financial risks and decreases with conventional attitude towards flood risks. Hence, the smaller people's propensity to face flood risks, the greater their willingness to invest in precautionary measures. On the other hand, the greater people's propensity to get involved in financially risky situations, the greater their willingness to invest in precautionary measures. Moreover, the willingness to take precautionary measures against floods decreases with risk perception in the domain of financial risks and increases with risk perception in the domain of flood risks. Hence, the greater the perceived risk in the flood domain, the greater the willingness to invest in precautionary measures. On the other hand, the greater the perceived risk in the financial domain, the smaller the willingness to invest in precautionary measures. Finally, the willingness to take precautionary measures also decreases when the ratio between conventional attitude towards flood risks and conventional attitude towards financial risks increases. By contrast, it increases when the ratio between perception of flood risks and perception of financial risks increases.

Table 11: Simple logistic regressions of the intention to take precautionary measures against floods

Explanatory variable	Estimate (Standard error)	Marginal effect at the mean
Perception of financial risks	-0.81*** (0.13)	-0.16***
Perception of flood risks	0.72*** (0.19)	0.15***
Conventional attitude towards financial risks	0.78*** (0.11)	0.15***
Conventional attitude towards flood risks	-0.41** (0.17)	-0.09**
$\frac{\text{Perception of flood risks}}{\text{Perception of financial risks}}$	2.52*** (0.38)	0.51***
$\frac{\text{Conventional attitude towards flood risks}}{\text{Conventional attitude towards financial risks}}$	-2.26*** (0.37)	-0.40***

N=254. Significance levels: * p<0.1; ** p<0.05; *** p<0.01.

The marginal effects show that the financial domain has a greater impact on the intention to invest in precautionary action than the flood risk domain, both concerning risk perceptions and conventional risk attitude. Moreover, focusing on each domain, risk perception has a greater marginal effect than conventional risk attitude.

Table 12 shows that the respondents who intend to take precautionary measures have a significantly lower average perceived-risk attitude in the domain of financial risks than the respondents who do not plan to take precautionary measures. On the other hand, perceived-risk attitudes in the domain of flood risks do not significantly differ between the two groups.

Table 12: Relationship between willingness to take precautionary measures and perceived-risk attitude[a]

	At least one measure planned, N=390 Estimate (Std error)	**No measure planned,** N=880 Estimate (Std error)	**Difference,** N=1270 Estimate (Std error)
Financial	-0.71*** (0.04)	-0.48*** (0.03)	-0.23*** (0.05)
Flood	-0.60*** (0.05)	-0.55*** (0.04)	-0.05 (0.07)

[a]The second and third columns show estimates and standard errors of the coefficients of perceived-risk attitude for respondents who planned to take precautionary measures and respondents who did not, estimated by linear regressions of conventional risk attitude on risk perception. The fourth column shows the estimates and standard errors of the coefficients of an interaction term (between the willingness to invest in precautionary measures and risk perception) after linear regressions of conventional risk attitude on risk perception, willingness to invest in precautionary measures and this interaction term. Willingness to invest in precautionary measures is a dummy variable that takes the value 1 for respondents who intend to take precautionary measure. Significance levels: * p<0.1; ** p<0.05; *** p<0.01.

5. Discussion

5.1. Reliability of the financial and flood subscales

Since the two psychometric subscales used in this study load on two different factors and are internally consistent for both risk perceptions and conventional risk attitudes, they assess four different constructs. Moreover, they appear to be appropriate to measure conventional risk attitude and perceived-risk attitude. Indeed, we replicated two types of findings from previous studies.

Regarding the relationship between attitude towards risk and gender, our results suggest that men have a higher inclination towards risks in the flood and financial domains but that men and women have similar average perceived-risk attitudes in both domains. These findings reproduce the effect of gender highlighted by Weber et al. (2002) in the financial, health and safety, recreational, and ethical domains. In addition, the respondents who had experienced at least one flood had a lower average perceived-risk attitude than those who had never faced such an event in both domains. In other words, their disinclination towards financial and flood risks is higher. This finding is in line with the positive effect of traumatic experience on risk aversion found by Kim & Lee (2014).

However, in contrast to Weber et al. (2002), and also to Gustafsod (1998), who conducted a meta-analysis on the relationship between gender and risk perception, we did not find a significant difference in risk perception between genders. Since this lack of significant effect of gender also applied to the subscale related to financial risks, which has previously been tested and validated in French (Blais & Weber, 2006), this result does not invalidate the relevance of the subscale we designed to measure risk perception in the flood domain.

Finally, our additional subscale appears able to reliably measure risk attitude and perception in the domain of flood risks.

5.2. How flood risks differ from financial risks

Financial and flood risks appear to be treated differently by the respondents. First, risk perceptions were on average higher in the flood domain than in the financial domain and perceived riskiness of flood risks was not correlated with perceived riskiness of financial risks. As a result, we cannot classify the respondents according to the way they perceive risks in general: some found flood risks very risky but financial risks little risky and vice versa. This lack of a general tendency to assess riskiness across domains could be due to the fact that risks can be decomposed into several dimensions that can vary across domains and that people weigh those dimensions differently (Slovic, 1987).

Second, conventional risk attitudes were significantly higher in the financial domain than in the flood domain. Moreover, the two conventional attitudes only exhibited a medium correlation. Hence, we cannot conclude that respondents have a strong general inclination or disinclination that applies to both flood risks and financial risks. Nevertheless, we cannot exclude a general trait. Moreover, average perceived-risk attitudes in the flood and financial domains did not differ significantly. This suggests that the respondents could have a general inclination or disinclination towards the risks they perceive. Hence, the difference in conventional risk attitudes between the two domains appears to stem directly from the fact that the respondents perceive financial risks differently than flood risks. In other words, the domain specificity of attitude towards risks could be mainly due to differences in risk perceptions. Our findings

are in agreement with the results of the study by Weber et al. (2002) according to which risk perceptions and conventional risk attitudes differ across domains but perceived-risk attitudes are more stable. We would have to measure perceived-risk attitudes at the individual level to be sure they do not differ across domains.

5.3. Domain dependent effects on the intention to invest in precautionary measures

Measures of attitudes towards risk appear relevant to predict actual behavior in some risky contexts (Lönnqvist et al., 2015; Szrek et al., 2012; Wärneryd, 1996). We thus examined whether they influence the willingness to reduce flood risks by investing in precautionary measures.

Our results suggest that conventional risk attitudes significantly influence the intention to invest in precautionary measures. However, they have opposite effects depending on the domain to which they belong. In line with the hypothesis formulated in the introduction, disinclination towards flood risks increases the willingness to take measures. Conversely, conventional risk attitude in the financial domain has a positive effect on the willingness to invest in precautionary measures. In other words, disinclination towards financial risks decreases the willingness to implement precautionary measures. This corroborates the hypothesis that precautionary measures against flood cannot be considered as investments aimed at reducing a financial risk. These measures thus cannot be treated as self-insurance. Instead, one possible interpretation of this result is that flood risks and financial risks are substitutes. Indeed, the higher the disinclination towards flood risks compared to financial risks, the higher the likelihood the person intends to take measures.

The opposite effect of conventional risk attitude depending on the domain appears to stem from risk perception rather than perceived-risk attitude. Indeed, people who intend to take precautionary measures have a lower perceived-risk attitude than the others in the financial domain, and their perceived-risk attitude is lower but not significantly different than the others in the flood domain. However, risk perception has opposite effects depending on the domain: the willingness to invest in precautionary measures decreases with risk perception in the financial domain whereas it increases with risk perception in the flood domain.

Our results also suggest that the relative importance attached to flood risks compared to financial risks strongly influences the willingness to take precautionary measures. This finding highlights the relevance of measuring risk perception and attitude specifically related to floods in order to better understand decisions to invest in precautionary measures against floods.

6. Conclusion

In this article, we propose a reliable psychometric subscale to extend the DOSPERT scale to flood risks. In addition, our results highlight the importance of taking into account the multidimensionality of risks to better understand decision making in risky situations. Indeed, the domain specificity of conventional risk attitude seems to originate in different ways of assessing risks in different domains, whereas people exhibit a general attitude towards perceived risks that seems more stable across domains. In line with the wider literature, our results confirm the importance of risk perceptions both for explaining risk attitudes and for explaining decisions concerning precautionary measures. Finally, we provide support for the

hypothesis that precautionary measures cannot be considered as self insurance. This result implies that it might not be efficient to communicate about adaptation to floods by presenting precautionary measures as investments aimed at reducing financial losses. On the contrary, policy-makers could focus on other types of damage avoided thanks to these measures in order to encourage people at risk of flooding to implement them.

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Appendix: DOSPERT scale extended: financial and flood risks

French version

Table A 1: Instructions and scales used in the DOSPERT scale extended: French version used in our survey

Risk perception							
Instruction	Pour chacune des activités suivantes, indiquez le niveau de risqué que vous percevez de 0 : « Pas du tout risqué », à 6 : « Extrêmement risqué ».						
Scale	0	1	2	3	4	5	6
	Pas du tout risqué	Très peu risqué	Peu risqué	Modérément risqué	Risqué	Très risqué	Extrêmement risqué
Conventional risk attitude							
Instruction	Les phrases suivantes sont les mêmes que celles que vous avez vues précédemment. Pour chacune d'entre elles, quelle est la probabilité que vous adoptiez le comportement spécifié si vous vous retrouviez dans la situation décrite de 0 : « Impossible », à 6 : « Certain » ?						
Scale	0	1	2	3	4	5	6
	Impossible	Très peu probable	Peu probable	Moyennement probable	Probable	Très probable	Certain

Items of the financial scale

- **Financial 1.** Parier une journée de salaire aux courses de chevaux.
- **Financial 2.** Investir 10% de vos revenus annuels dans un fonds commun de placement peu risqué.
- **Financial 3.** Parier une journée de salaire lors d'une partie de poker à enjeu important.
- **Financial 4.** Investir 5% de vos revenus annuels dans des titres très spéculatifs.
- **Financial 5.** Parier une journée de salaire sur le résultat d'un événement sportif.
- **Financial 6.** Investir 10% de vos revenus annuels dans une nouvelle entreprise.

Items of the flood scale

- **Flood 1.** Emménager dans une maison au bord d'une rivière.
- **Flood 2.** Aller chercher les enfants à l'école alors qu'il y a une vigilance météo rouge (dans votre département).
- **Flood 3.** S'engager en voiture dans une rue inondée.
- **Flood 4.** Garer sa voiture en zone inondable alors qu'il y a une vigilance météo rouge dans le département.
- **Flood 5.** Partir en randonnée alors qu'il y a une vigilance météo orange dans le département.

English version

Table A 2: Instructions and scales used in the DOSPERT scale extended: English version

Risk perception							
Instruction	For each of the following statements, please indicate how risky you perceive each situation. Provide a rating from 0: "Not at all Risky" to 6: "Extremely Risky".						
Scale	0	1	2	3	4	5	6
	Not at all risky	Slightly risky	Somewhat risky	Moderately risky	Risky	Very risky	Extremely risky
Conventional risk attitude							
Instruction	The following statements are the same as those you have seen previously. For each of them, what is the likelihood that you would engage in the described activity or behavior if you were to find yourself in that situation from 0: "Impossible" to 6: "Certain"?						
Scale	0	1	2	3	4	5	6
	Impossible	Extremely unlikely	Somewhat unlikely	Moderately unlikely	Likely	Extremely likely	Certain

Items of the financial scale

- **Financial 1.** Betting a day's income at the horse races.
- **Financial 2.** Investing 10% of your annual income in a mutual fund, which has little risk.
- **Financial 3.** Betting a day's income at a high-stake poker game.
- **Financial 4.** Investing 5% of your annual income in a very speculative stock.
- **Financial 5.** Betting a day's income on the outcome of a sporting event.
- **Financial 6.** Investing 10% of your annual income in a new business venture.

Items of the flood scale

- **Flood 1.** Moving into a home along the banks of a river.
- **Flood 2.** Picking up the children at school while there is a red weather alert (in your area).[7]
- **Flood 3.** Driving into a flooded street.
- **Flood 4.** Parking your car in a flood-prone area while there is a red weather alert in the region.
- **Flood 5.** Going hiking while there is an orange weather alert in the area.

[7] The French National Meteorological Service emits alert bulletins for extreme weather events, among which heavy rainfall. There are four levels of alert: green (no risk), yellow (slight risk), orange (high risk), red (very high risk). Red level alerts may include a ban on leaving home or using designated roads.