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Abstract

This study explores people's risk attitudes after having suffered large real-world losses following a natural disaster. Using the margins of the 2011 Australian floods (Brisbane) as a natural experimental setting, we find that homeowners who were victims of the floods and face large losses in property values are 50% more likely to opt for a risky gamble – a scratch card giving a small chance of a large gain ($500,000) – than for a sure amount of comparable value ($10). This finding is consistent with prospect theory predictions of the adoption of a risk-seeking attitude after a loss.

Keywords: Decision under risk, large losses, natural experiment

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One ongoing challenge in behavioral economics is to understand the variations observed in risk attitudes as a function of their context. Of particular interest is the effect of changes in wealth on risk attitudes. The research in this area, however, has faced at least two constraints. First, it is in practice difficult to study experimentally the effect of large changes in wealth on risk attitudes. Second, even in the case of small changes in wealth, it is in practice very hard to study the case of real losses.[1] This paper addresses that double limitation by providing evidence of the variation in risk attitudes following large losses induced by a natural disaster (the Brisbane floods).

Experimental economists have developed many techniques to elicit risk attitudes in both the laboratory and the field (see for instance Hey and Orme 1994, Holt and Laury 2002, Harrison, Lau, and Rutström 2007, Abdellaoui, Bleichrodt, and lHaridon 2008). The use of controled experiments to study risk attitudes have however in-built limitations which raise potential concerns relative to the external validity of their results. First, budget constraints usually mean that stakes are small, so risk attitudes are typically measured only on a limited range of small stakes. Although in theory the estimation of risk attitudes on small stakes in the laboratory could be used to extrapolate behavior for large stakes in the field, recent developments have questionned the possibility to use the measurement of risk attitudes on small stakes to credibly predict risky behavior for large stakes.[2] Second, because of ethical constraints, it is almost impossible to induce real losses for experimental participants, so the experimental study of risky behavior in the loss domain is more tentative than that when participants are faced with gains (Harrison and Rutström, 2008, p. 111–115; Wakker, 2010, p. 264–265). Third, the laboratory is an ill-designed setting for studying the effect of changes in wealth on risk attitudes. Rather, wealth effects are most often considered noise in the analysis of experimental data. This latter

[1] The research also face other difficulties such as the extent to which individuals subjectively combine current changes in outcome with their overall wealth (asset integration) when making choices (Andersen, Cox, Harrison, Lau, Rutström, and Sadiraj 2011). More fundamentally, there is no consensus on how to define wealth itself conceptually and operationally: should it be the current level of financial assets? Should it be the expected wealth over the life cycle?

[2] Cox and Sadiraj (2008) show that the most widely used decision models, expected utility and rank dependent expected utility (which includes prospect theory as a specific case), face either the Rabin (2000) paradox when the utility function on outcomes is bounded (estimation of risk aversion on small stakes give implausible risk aversion level for large stakes) or generalised St. Petersbourg paradoxes when the utility function is unbounded (they are predicted to be willing to pay an infinite amount to play some gambles). As pointed out by Cox and Sadiraj, these problems may be unconsequential as the paradox mentionned may only exist for ranges of income which individuals only rarely face (in particular in the case of generalised paradoxes which involve infinite expected values). In addition, Rabin's paradox can be explained by a reference dependent model where the risk attitude is not primarily driven by the curvature of the utility function but by the loss aversion relative to a reference point (Rabin 2000, Wakker 2010). De facto, experimental studies which study risk aversion assuming that individuals have a utility on the income earned during the experiment assume implicitly a reference dependent model where the reference point is the statu quo at the start of the experiment (Wakker 2010, p. 244). As pointed by Harrison and Rutström (2008, p 95–98) a proper study of individual risk attitude would require to take into account that the individual reference point may differ from the statu quo and could in particular be close to the earning participants expect to get in the session.

has led to the widespread adoption of the random lottery incentive by which participants, who make several choices during the experiment, are only paid, at the end, for one of their choices (Harrison and Rutström 2008).[3]

In the present paper, we provide new evidence on the effect of recent changes in wealth on risk attitude. Specifically, by exploring individual risk attitudes following the 2011 Australian floods (Brisbane), we investigate the effect of large losses shortly after the loss was incurred. We are therefore using a natural disaster as a natural experimental setting in which random wealth shocks can be observed in a population. The a priori random limit of the flood serves as a strategy by which to compare the reaction of very similar populations of homeowners facing a large difference in wealth shock; that is, homeowners who have just been affected by those floods versus those who were not affected. Our methodology is close in spirit to a regression over discontinuity, although the equivalent of a treatment – the subjective perception of the loss incurred by the flood – is not directly observable.

Following the January 2011 floods, we sampled 220 residential homeowners in flooded Brisbane areas and offered those selected the opportunity to choose between a fixed sum – $10 – and a risky gamble, a lottery scratch card potentially worth $500,000 (with a $10 face value in retail shops). These participants, drawn from each side of the margin of the flood peak in 15 suburbs across the city, completed a raft of survey questions on the impact of the flood and their opinion of the reaction by national and local authorities. The survey also collected a range of demographic and personal background information on the homeowners and their families. Most especially, participants were asked about their beliefs about the value of their houses (before and after the flood) and whether they were insured against flood damage and their level of coverage.

Our main finding is that individuals whose properties were directly affected by the flood waters were much more likely to accept a risky gamble - the scratch card - than their unaffected immediate neighbors. This outcome supports prospect theory predictions of the adoption of risk-seeking attitudes after a large wealth loss. We also contribute to the literature on decision making under risk by providing the first (quasi) experimental evidence on the change in risk attitudes induced by a large negative wealth shock. Most particularly, our study provides supporting empirical evidence that individuals who have incurred a negative wealth shock are much more likely to accept a risky gamble.

1 Background

In his 2002 Nobel Laureate lecture, Daniel Kahnman explains how one of the key principle behind Prospect Theory (PT) is the rejection of what he calls the "Bernoulli's error" (Kahneman 2002). By this term, he means the widely stated hypothesis in applied economics that the carrier of utility is the total level of wealth. Although this hypothesis is not part of the expected utility

[3]See also Wakker (2010)[p. 136] and Harrison and Swarthout (2012) for a critique of the use of this incentive scheme in experiments.

(EU) theoretical framework as such, it has long been embraced by economists as a natural assumption. In their 1979 paper, however, Kahneman and Tversky put forward another hypothesis: that the carrier of utility is the change in wealth (or more generally, the changes in outcomes) relative to a particular reference point (typically, but not necessarily, the status quo). Within this framework, Kahneman and Tversky posited that people are likely to adopt a more risk averse behavior when faced with choices involving gains but become more risk seeking when faced with choices involving losses. This pattern, termed the "reflection effect", is modeled by a utility function that exhibits differing curvature for gains (concave = risk aversion) and for losses (convex = risk seeking).[4]

Most applications based on PT assume the current level of wealth as the reference point. However, this may not be case; for instance, because readjustment to a new level of wealth takes time (Rayo and Becker 2007). It is in this spirit that Kahneman and Tversky (1979) suggested that: "a person who has not made peace with his losses is likely to accept gambles that would be unacceptable to him otherwise" (p. 287). That is, following a loss, individuals using their previous situation as a reference point consider their present situation to be a loss. This suggestion is supported by the notion that gamblers take on too much risk to "chase their losses".

Studying risk behavior after losses in a laboratory setting is difficult, however, because an individuals' willingness to take risks is affected by the fact that (1) they are paid to participate and (2) they face no real possibility of losing their own money because ethical rules prevent experimenters from creating situations in which participants could face real losses.[5] Hence, to date, experimental studies have either focused on individual behaviors in the face of small losses following an initial gain (endowment) or relied on hypothetical losses (see Harrison and Rutström 2008). These two strategies, however, are subject to important limitations. On the one hand, the framing of a situation as a loss relative to the initial endowment assumes that participants consider the endowment and the loss separately. Given the short duration of most experiments, this assumption is questionable. In fact, experimental research on risk attitudes has shown that recently earned money like an endowment may lead to the taking of more risk, a phenomenon known as the "house money effect" (Thaler and Johnson 1990).One explanation is that the newly acquired sum has not yet been adopted as "personal property" but rather is considered a new gain that can be gambled without fear of loss. On the other hand, the use of hypothetical losses raises a question of the validity of the preference(s) elicited. A lack of incentives, for example, may lead to a hypothetical bias, one whose importance has clearly been established (Harrison and Rutström 2008, p. 123–124).

[4]Formally, in prospect theory, risk attitudes are defined jointly by the curvature of a utility function on the outcomes (often called "value function") and a probability weighting function. The reflection effect is however traditionally attributed to a curvature of the utility function which is assumed to differ across the loss and gain domains. We discuss the possible role of the weighting probability function in section 3.3.

[5]See Etchart-Vincent and l'Haridon (2011) for a rare case of an experimental study using small real losses.

Outside the laboratory, only a few studies, have looked at changes in risky behavior after a change in wealth. One significant strand is the literature on the "disposition effect" in finance, which indicates that shareholders are more likely to hold on to losing shares after a drop in price (Odean 1998). This disposition effect is compatible with an increase in risk behavior after a loss predicted by PT. Nevertheless, the nonexperimental nature of these studies does not allow for the elimination of other confounding explanations (Barberis and Xiong 2009).

In addition, two recent studies have examined risk attitudes after a natural disaster. Though, they reporte conflicting results. On the one hand, Eckel, El-Gamal, and Wilson (2009) studied the risk attitudes of refugees after the Katrina Hurricane They identified an evolution of risk attitudes among the different waves of post-hurricane refugees, with the first refugee wave being more risk seeking. Unfortunately, the lack of a control group does not ensure that these observed differences are due to the causal impact of the hurricane as such. Refugee characteristics changed across waves, creating a possible confounding factor in the explanation of the observed differences in risk attitudes. On the other hand, Cameron and Shah (2011) examined risk attitudes in areas affected by floods and earthquakes in rural Indonesia a few years after the disaster. They found that populations in affected areas exhibited higher levels of risk aversion. They attributed this difference partly to an increase in the belief that possible future disasters might create a background risk, an attitude that has been shown to lead to a higher risk aversion under some conditions (Gollier and Pratt 1996, Guiso and Paiella 2008). They also attributed part of the difference to the effect of the incurred loss in income under the assumption of decreasing absolute risk aversion utility functions. Their study, however, was unable to fully control for for possible post-disaster migrations which can lead to specific characteristics of the population deciding to stay in areas which have been affected by disasters.

2 Method and data

2.1 Quasi-experimental design

In this paper, we find a solution to the limitations of laboratory and nonexperimental field studies by using the peak of an unexpected urban flood in Brisbane (the capital and most populous city of Queensland, Australia) as a natural experimental setting. This 2011 flood, an extreme event that inundated approximately 78% of the state (an area larger than that of France and Germany combined), affected over 2.5 million people (Queensland Floods Commission of Inquiry 2011) and caused an estimated $5 billion in flood damages. Against this backdrop, we investigate whether people may be more prone to take risky gambles shortly after experiencing a large loss in an attempt to return themselves to their initial reference point. This natural experiment provides the first evidence of a change in risk behavior caused by a large negative wealth shock.

One critical identification assumption of our study is that the population of homeowners is comparable on both sides of the flood limit, a reasonable hypothesis given that the flood limit was a priori unpredictable. Before this event, the last serious flood had been over 35 years earlier (1974), and over the 10-year period before the flood, Queensland had undergone a drought. Homeowners, therefore, had no relevant information ex ante to anticipate the 2011 flood line at the time they purchased their homes. In fact, the risk assessment performed by the Brisbane City Council (Department of Environment and Resource Management 2011), which is available to residents online, showed no statistically significant difference (p=0.90) in the risk of flood over a 20-year time frame between the properties of participants just above and just below the flood limit. Hypothetically, homeowners could have used the limits of the 1974 flood peaks in their decision to buy a house. In practice, however, 30 years after the 1974 floods, such concerns were likely to be limited, and casual information suggests that the peak of the 1974 flood limit was only imperfectly known by residents.[6] In addition, it was generally believed that the construction of the Wivenhoe Dam after the 1974 floods would prevent future disasters of this sort (Humphries 2011). Nevertheless, in theory, the 1974 flood peak could have provided salient information leading risk averse homeowners to avoid properties below this line. Fortunately for our analysis, however, the level of the 1974 flood peaks was significantly higher than in 2011: 5.5m versus 4.46m. We can therefore be fairly sure that any significant difference in behavior observed within 1m of the 2011 flood line is not due to home owner selection around the 1974 flood limit. Moreover, most of the effect we observe takes place within the range of 1m around the flood line.

To ensure that our identification hypothesis is as valid as possible, we focus our analysis on a sample of residents very close to the flood limit. We also provide evidence that homeowners around the flood line are similar on the observable characteristics collected in our survey.

2.2 Data

The data in this study consist of the choices and responses of 220 individual homeowners surveyed over the weekends of March 12-13 and 19-20, 2011, only a few weeks after the flood reached its peak on January 13-14, 2011. These study participants answered a survey questionnaire and chose to be rewarded for their participation either with a fixed sum of $10 (all amounts are in Australian dollars) or with a lottery scratch card worth $10 at local newsagents but having a maximum prize of $500,000. This choice between a sure amount and a scratch card is, to our knowledge, new in field experimentation to elicit differences in risk attitudes.[7] In our context, the scratch card presents signif-

[6] No regulation compels it to be included in the description of properties when they are bought.

[7] A scratch card, in contrast to standard risk elicitation procedures, has no known outcome probabilities for the participant. The study of risk attitudes is usually made with experiment proposing risky choices with clear probabilities (Hey and Orme 1994, Holt and Laury 2002). Studying risk attitudes under uncertainty is possible but more difficult (Abdellaoui, Baillon,

icant advantages. First, it is a perfectly ecologically valid situation of choice. That is, because the scratch cards used are readily available from newsagents all around the city, even individuals who have never bought a card are likely to have seen them and considered whether or not to buy one. Therefore, unlike the laboratory experiments so often criticized for presenting subjects with unusual situations that can lead to atypical behavior, we can be reasonably sure that our participants understood the choice proposed to them. A second advantage is that a scratch card is a simple choice, easily inserted into a survey. Because participants were met on their doorsteps, a minimalist and simple experimental protocol was necessary to minimize the cost of participation and ensure reasonably high response rates. A third key advantage is that the choice offered can appear to be a natural choice between two rewarding options for completing the survey. We are thus likely to minimize the risk of a "Hawthorne effect" by which participants try to modify their behavior as a function of their beliefs about what the experimenters expect. In our context, given the short time span between the flood and the experiment, a set of questions that stressed the measurement of risk attitudes could have raised concerns. That is, recent victims of the flood could have self-consciously perceived that we were trying to elicit their risk attitudes because of the flood and could have modified their behavior as a result, which would have prevented any analysis of the flood's causal effect on risk attitudes. Overall, our use of a scratch card to infer differences in risk attitudes toward losses is not too different from the literature on the "disposition effect", which looks at trader decisions between a sure prospect (selling at a loss) and an uncertain prospect without known distribution of probabilities (holding the asset).

Three screening questions were used to exclude non-homeowners from the experiment. First, participants were chosen from specifically targeted houses and streets from across 16 suburbs, with every property selected through an identical process: selection of streets on the margin of the peak using visual analysis of aerial/satellite (Nearmap) photos taken after the flood peak (January 14). To limit variation in income/wealth and property value, the target areas were limited to single streets, one of whose sides was flood affected and the other not. This criterion was expanded to include flooding across rather than along the street, to localize and maintain the marginal nature of cross flooding, a limited number of houses were selected on each side of the flood line. After a comparison of topological maps (PDOnline Interactive Mapping) and satellite photos, the houses selected were sorted into control and treatment groups. Surveys were administered only if the resident was home on the day of the visit and chose to participate in the study. Given the relatively low height of the flood waters around the houses at the margin, affected homeowners were in most cases still residing in their houses, producing a relatively high response rate on both sides of the margin: 21% for nonaffected houses and 20.6% for affected houses (difference: p=0.89).

Placido, and Wakker 2011). In the context of our study, we chose not to elicit utility functions of probability weighting function but to study variations in risk attitudes with a choice between a certain prospect and a risky prospect.

Because the same flood level may affect houses differently depending on whether their doorsteps are at street level or on stilts (very common in Brisbane), we estimated the distance to the flood limit using the lowest habitable level of the house. We relied first on Brisbane City Council contour plot maps to estimate the height of the lowest part of the house and compared it to the height of the flood in the area, as estimated by the Brisbane City Council. We also asked homeowners to give an estimation of the vertical height of the flood relative to the lowest habitable level of the house. We used homeowner estimates of the height of the flood when it reached the house (in many cases, very precise because of measurements made by an insurance company). In cases in which the flood did not reach the house, we used mostly map information but also looked at the homeowners' survey responses, which often revealed a significant difference from the map estimate because the house was on stilts. In case of a discrepancy between the map estimate and the homeowner response, we checked the architectural disposition of the house using the street view tool from Google Map and retained the homeowner estimate when the house was on stilts.

In an explicit effort to avoid researcher bias, none of the survey questionnaires was administered by the researchers. Rather, a team of 22 research assistants (RAs) first underwent a training session prior to being placed in the field and were at no time told the objectives or purpose of the survey. These RAs were provided with a set script so that all questionnaires could be administered in as similar a manner as possible, creating a consistent approach across all surveys and reducing extraneous noise. The RAs were also randomly allocated to houses within each street to ensure that each RA interviewed houses on both sides of the flood limits in each street.

2.3 Empirical methodology

Our experimental design takes advantage of the fact that around the flood limits, homeowners experienced very different fates in terms of their wealth evolution. First, homeowners that were directly affected faced costly floodwater-caused damage to houses and their contents. Second, house values changed markedly around the new flood limit, with affected houses incurring a large negative risk premium (at least for some time after the flood). Hence, although our methodology is in spirit close to a regression over discontinuity design, it differs in two important ways. First, because the treatment of interest is homeowners' feelings of loss following the floods, the "treatment" is not observable. Second, this treatment will differ among homeowners for a given distance to the flood limit not only because homeowners may update their beliefs about their property value loss differently, but because architectural differences can have a critical impact on the monetary effect of floods for homeowners. In flooded areas, many ground-based houses are adjacent to houses on stilts whose habitable rooms are 3m above ground. Likewise, the amount of personal valuables located in the flooded portions of the home may vary, as might the propensity of the insurance company to reimburse the flood damage (e.g., in the 2011 Brisbane floods, one company decided to reimburse all cases, while another dismissed some cases as not covered by the insurance policy).

As a result, the characteristics of the observed data do not allow precise estimation of a regression discontinuity model. Nevertheless, within the carefully selected sample of close neighbors around the flood limits, we can assume that the conditional expectation of the subjective feeling of loss changes markedly as a function of the distance to the flood limits. We can also assume that this variation can be considered exogenous relative to homeowner characteristics for homeowners "close enough" to the flood line, an assumption borne out in the results for our sample (see Section 3.1). As important, participant responses were collected only 8-9 weeks after the devastating flood, which ensured that the impact of the event was likely to be very fresh and very real in the minds of the participants (lack of habituation).

To estimate the impact of the floods on risk attitude, we place each observation on one dimension that represents the vertical distance between the estimated height of the house doorstep and the flood height in the area, as estimated by the Brisbane City Council (Department of Environment and Resource Management 2011). We then use a nonparametric local linear regression to estimate the proportion of risk takers in our sample as a function of their location relative to the flood line (in vertical distance). Because our observations are concentrated around small positive and negative distances from 0, we opt for a nearest neighbor estimator that adapts the smoothing window to the local density of observations. This choice allows our estimator to be more precise around the flood limit (zero) but have less variance away from the flood limit where observations are scarcer.

The dependent variable in our analysis is a dummy indicating whether an individual chose to accept the risky gamble or not (accepted=1). The analysis relies on the identification assumption that homeowners located near the flood limits have similar characteristics. To ensure the credibility of this identification assumption, we only use observations from homeowners whose houses were located within 2.5m (vertically) of the flood line, a boundary outside of which very few observations were collected in the field experiment. The resulting sample consists of 201 observations (94 affected participants and 107 nonaffected).

3 Results

3.1 Flood level, monetary losses and risk seeking

The left panel of Figure 1 depicts the result of the local estimation of the proportion of risk takers as a function of their distance to the flood lines. Our results show a marked increase in risk taking around the point at which the flood limits reach the habitable part of the house. Most notably, the greatest amount of change in risk taking occurs within 1.5 meters around the height of the house. Risk taking increases by 50% between homes where the flood was 0.75m below the house level and homes where it reached 0.75m above.

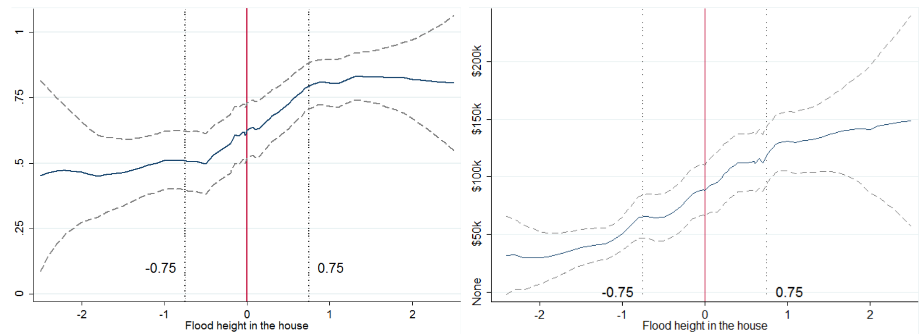

Figure 1: Proportion of risk takers (left) and subjective loss in property values (right) around the flood line. On the x-axis, the flood level in the house is estimated relative to the lowest habitable level. The confidence interval of the estimation is represented by dotted lines.

Our hypothesis is that this change is induced by the loss provoked by the flood. The right panel of Figure 1 displays the declared loss in house value expected by homeowners. The expected loss as a function of the distance to the flood line mirrors the evolution of risk taking, which suggests that most of the subjective loss experienced by homeowners occurs within this range. On average, we observe an estimated jump in losses of $70,000 between -0.75m and +0.75m, the range in which most of the variation in risk attitude takes place. This subjective estimate, however, does not include the losses from personal property, which are also likely to jump around the flood limit.

To check the validity of our assumption that homeowners on both sides of the flood limits do not systematically differ in characteristics, we use questionnaire responses to test for differences across the two groups on such variables as income, house value before the flood, level of content and house insurance, age, gender, and religiosity of the respondent. We also use the Brisbane City Council's estimate of the flood risk for each property in the Brisbane area (Department of Environment and Resource Management 2011). As clearly shown in Table 1, there are no significant differences between homeowners below and above the flood line over a range of different windows, which supports our assumption that the flood margins provide a natural experimental setting that allows us to study the effect of the floods on risky behavior in a population in which the treatment and control groups have identical characteristics.

The confidence interval displayed in Figure 1 suggests clearly a statistically significant shift around the flood line in terms of risk attitude. We run a probit model to measure the impact of the flood level on the propensity to take the risky gamble around the flood limit. To ensure robustness, we vary the window of observations around the estimated flood limit between 1m and 2.5m on each side, Table 2 shows the results. Despite the smaller sample of observations, the shift in risk attitude is robustly significant around the flood line even when the window is only 1m on each side. Hence, the smaller the window, the more

	Distance window (on each side)			
	1m	1.5m	2m	2.5m
Income	1.18	−0.15	−2.77	−3.23
	(11.21)	(10.23)	(9.35)	(8.79)
	9.73	−33.38	−68.84	−60.39
	(114.06)	(100.17)	(91.00)	(85.64)
Content insurance	48.12	35.54	29.36	27.30
	(33.66)	(26.76)	(23.27)	(21.67)
House insurance	−4.10	−11.19	−13.68	−17.80
	(65.24)	(54.54)	(47.78)	(44.79)
Age	−0.52	−0.68	0.61	1.00
	(2.39)	(2.22)	(2.06)	(2.00)
Male	0.03	0.00	−0.03	−0.04
	(0.09)	(0.08)	(0.07)	(0.07)
Religious	−0.02	0.07	0.07	0.07
	(0.08)	(0.07)	(0.07)	(0.06)
Flood risk 5 years (ex ante)	0.00	−0.01	−0.01	−0.01
	(0.00)	(0.02)	(0.01)	(0.01)
Flood risk 20 years (ex ante)	0.26	0.06	−0.00	−0.04
	(0.35)	(0.32)	(0.29)	(0.29)
Flood risk 50 years (ex ante)	0.29	0.02	−0.08	−0.11
	(0.51)	(0.46)	(0.41)	(0.40)
Flood risk 100 years (ex ante)	0.33	0.02	−0.11	−0.14
	(0.58)	(0.53)	(0.46)	(0.46)
Nb of observations	125	155	187	201

Differences estimated by OLS, robust SE in brackets. Monetary variables in thousand dollars. The flood risk is estimated as the expected maximum flood height in meters over the period for the house. It was publicly available on the Brisbane City Council website before the floods.

Table 1: Tests of pre-existing differences between home owners affected and not affected.

compelling the assumption that the populations of homeowners are similar on both sides of the flood line.

To estimate the link between loss in property and the tendency to choose the risky gamble, we estimate an IV probit using the flood height around the flood limit as an instrumental variable for the incurred loss in property value. Arguably, the answers to our survey questions on the value of the owner's property before and after the flood are likely to be characterized by some significant measurement error, thereby creating an attenuation bias in the regressions. When running a simple probit to explain the effect of property values loss on risky decisions, the coefficient is positive, but not significant. Instrumentation by flood level corrects for a possible downward bias under the assumptions that the flood level is not correlated with either observed or unobserved characteristics in our sample and that the flood only has an effect via its impact on home owners' losses.[8]

Table 2 displays the results of the IV estimations. Overall, the effects are strongly significant and suggest that the loss of $10,000 in property value – around a loss of $100,000 – increases the likelihood of homeowners taking the risky gamble by 6 to 8%.

	Probit			
	1m	1.5m	2m	2.5m
Flood level	0.63^{***}	0.50^{***}	0.35^{***}	0.32^{***}
	(0.20)	(0.13)	(0.09)	(0.08)
Nb of observations	125	155	187	201
	IV Probit			
	1m	1.5m	2m	2.5m
Loss in property value (AUD10,000s)	0.07^{***}	0.08^{***}	0.06^{***}	0.06^{***}
	(0.02)	(0.01)	(0.01)	(0.02)
Nb of observations	107	133	162	171

Standard errors in brackets. *** denotes significance at the 0.001 level.

Table 2: Effect of the wealth loss on risk attitude.

3.2 The possible role of background risk

In their study of risk attitudes in areas affected by floods and earthquake in Indonesia, Cameron and Shah (2011) found that concerned populations have higher risk aversion, a finding they suggest is largely due to the "background risk" of future disaster. The potential role of such additional risk in the background of a given decision on a decision maker's risk attitude has been stressed in several theoretical works. Research has also shown that in the expected utility framework, if the absolute risk aversion index of the utility function is decreasing and convex, a background risk will lead a decision maker to be less likely to opt for a risky option (Gollier and Pratt 1996, Eeckhoudt, Gollier, and Schlesinger 1996). The necessary link between background risk and more risk

[8]Home owners' losses are not limited to property losses. We can consider property losses as a proxy for the total losses incurred.

aversion has been contested by Quiggin (2003) who showed that for generalized EU theory, such as Yaari's (1987) dual theory, background risk can actually lead to the opposite effect of that suggested in the EU framework, thereby increasing the propensity of a decision maker to opt for a given risky option. Recent empirical evidence seems to support the link expected from the EU theory (Harrison, List, and Towe 2007).

In our setting, although increased belief in the risk of future flooding could create background risk in participants' minds, this factor cannot explain the observed pattern – that homeowners are actually more risk seeking when they have been affected by the floods – within an EU framework. Moreover, it seems to us unlikely that home owners felt a significant background risk at the time of the study and that such a feeling would have been significantly higher below the flood limit. At the time of the survey collection, the wet season was at its end in Queensland so homeowners would not be expecting any new floods before the following year. Moreover, many psychological studies have found that people have a tendency to believe that the probability of an event is lowered when this event has recently occurred, the so-called "gambler's fallacy" (Tversky and Kahneman 1974). Given the rarity of widespread floods in Brisbane, such a psychological bias would lead residents to believe that a new flood is unlikely so soon after the last one.

We can, however, further check the credibility of background risk as an explanation for the pattern of observed risk attitudes using responses to a survey item that asked our participants to rate the likelihood of their home being flooded in the next 15 years. When we regress these responses, measured on a 7-point Likert scale from "extremely likely" to "extremely unlikely", on the flood level around 2.5m from the flood limit, we do find some evidence that homeowners affected by the flood are more likely to expect their home to be flooded again within the next 15 years ($p=0.04$). However, answers to this question are not at all predicting the risky choices in the experiment. Using a probit with the choice of the scratch card as the dependent variable, the distance to the flood limit as a first explaining variable and the belief in the risk of future flood as a second explaning variable, we find that while the distance to the flood is a highly significant predictor ($p<0.001$), the belief in future floods is nowhere near significant ($p=0.55$). This suggests that differences in feelings of background risk are unlikely to be the factor driving the observed variations in risk attitude around the flood limit.

This indicates that differences in feeling of background risk are unlikely to be the factor driving the observed variations in risk attitude around the flood limit.

3.3 Other possible explanations

Given the prominence of prospect theory in economics of decision, studies looking at differences of risk attitudes in the loss domain and in the gain domain usually interpret the result only in relation to prospect theory predictions without discussing other possible explanatins. Our results clearly support prospect theory predictions. What about other possible explanations? First, it is important to stress that our results can be reconciled with expected utility if the utility function is not assumed homegeneously concave or convex. The classical paper by Friedman and Savage (1948) propose a utility function on wealth which is convex for mid-range of wealth and concave for small and large ranges of wealth. With such a utility function, one could suggest that our results comes from a fall from a high range of wealth associated to risk aversion to a lower range of wealth associated with risk seeking. This explanation seems to us implausible. Besides the fact that it is widely considered as an unlikely description of risk attitudes[9], this explanation would require for the average level of wealth to be significantly different on both sides of the flood limit. However, taking property values as a proxy of wealth[10], the initial wealth are widely different on both side of the flood line. As a consequence, even with the loss following the flood, the distribution of wealth of affected and unaffected households are largely overlapping. As a consequence the difference in estimated property values on both side of the flood line is not significant (p=0.74 within 1.5m of the flood line; p=0.48 within 2.5m). Overall, the wealth levels of our respondents are too heterogenous on both side of the flood line to drive our result. There is a sharp difference in losses around the flood line, not so much in average property values.

Within the prospect theory framework, it is also possible to consider other explanations. For instance, as our scratch card involves a very small probability of a large gain, our result could be driven by a change in likelihood sensitivity (for a formal definition Wakker 2010, p. 222–230) with home owners being more prone to overestimate small probabilities after large losses (less likelihood sensitive). However, the empirical literature on the probability weighting function does not suggest that this is a likely explanation. Studies tend to find that "behavior for losses is closer to to expected value maximisation" (Wakker 2010, p. 264). In practice, the probability weighting function is most often assumed, in empirical studies, to be the same in both the gain and loss domain.

Finally, as in the literature on the disposition effect, our study is about the choice between a certain option (here the $10) and an uncertain one (scratch card) where the exact probabilities on outcomes is unknown (in the disposition effect literature the uncertain option is to keep the losing asset). One possible explanation in such a situation is that individuals' ambiguity aversion can differ over both loss and gain domain. Indeed, the literature ambiguity aversion, although not unanimous, tends to find that individual are ambiguity averse in the gains and ambiguity seeking in the losses (Wakker 2010, p. 354). It is in our opinion an interesting explanation which has mostly been absent from the literature on the disposition effect and would warrant further examination. While this endeavour is beyond the realm of the present study, we can note that the traditional explanation and the ambiguity aversion explanation are not neces-

[9]In particular, Markowitz (1952) showed how the variations in concavity of the utility function leads to predictions which contradict common observations of individual behavior under risk.

[10]Our argument holds a fortiori if present and/or future income are included in the calculation of wealth as these are a priori not affected by the floods.

sarily exclusive. Klibanoff, Marinacci, and Mukerji (2005) modeled ambiguity aversion as arising from the curvature of a second order utility function on the expected utility of the possible lotteries (which have a probability to be the one being played). In this framework, an ambiguity seeking behavior in the loss domain would arise from a convex second order utility function, much in the spirit of prospect theory.

4 Conclusions

Although rare, choices made in situations in which large variations in wealth are at stake can have critical and long-lasting consequences in an individual's life. Yet, the effects of large variations in wealth are almost impossible to study using experimental techniques. We, are able to use a natural disaster as the setting for a natural experiment that provides support for the prospect theory prediction that individuals become more risk seeking after a loss. Specifically, our results demonstrate that individuals who have suffered the large wealth shock of flood waters in their houses are approximately 50% more likely to accept a gamble than their immediate neighbors who remained unaffected. As the flood transition point (around zero) is approached, we observe a distinct increase in the proportion of homeowners willing to accept a risky gamble with a high potential prize that could allow them to make up for their initial losses. This result is reflected in homeowner beliefs about the loss of wealth (house value) caused by the flood, in which the average cost of being affected in the floods resulted in a loss of approximately $70,000. No significant differences in observable characteristics emerge, however, between homeowners across the flood line, which supports our identification hypothesis that homeowners did not sort themselves ex ante around the realized 2011 flood limits when they bought their houses.

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