Department für Agrarökonomie
und Rurale Entwicklung

2023

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Rurale Entwicklung
Universität Göttingen
D 37073 Göttingen
ISSN 1865-2697

Diskussionsbeitrag 2301

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Discussion Paper

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April 2023

Abstract

Extreme weather events pose an economic threat to farms. The risk management behaviour against such events is often studied using prospect theory as a framework, but empirically deriving corresponding parameters in the field involving farmers is challenging. To address this issue, we compare three methods of eliciting prospect theory parameters using a multiple price list design in Germany: a framed field experiment, a framed student experiment and an artefactual field experiment. The results show that these experiments generate different prospect theory parameters. The lower the probability the higher the differences, which is particularly important for managing risk from low-probability shocks. Despite these differences, the mean coefficients of the three experiments reveal a low willingness to pay for crop insurance. We find evidence that individual responses to the artefactual and student experiments correlate with the risk attitude self-assessment, whereas responses to the framed field experiment correlate with the purchase of crop insurance.

Keywords: prospect theory, risk management, catastrophic risk, behavioural economics, decision analysis

1 Introduction

Extreme weather shocks lead to yield losses and threaten the economic viability of farms. Yield insurance is one option for protecting against the financial consequences of such events. However, farmers' willingness to pay (WTP) for crop insurance is often too low to enable a comprehensive private insurance market (Feng et al., 2020). The prospect theory is often used to explain the WTP for insurance (e.g., Tversky & Kahneman, 1992; Feng et al., 2020). However eliciting its parameters is a challenge because complex economic experiments are necessary (Charness et al., 2013). We investigate to what extent the results of different experimental methods to elicit prospect theory parameters differ with a focus on low-probability shocks.[1]

The prospect theory according to Kahneman and Tversky (1992)[2], is an often-confirmed behavioural approach to explain risk behaviour (e.g., Bocquého et al., 2014; Bougherara et al., 2017). It contributes to explaining risk management decisions in the context of low-probability shocks (Barberis, 2013). Following Tversky and Kahneman (1992), two of its features are particularly important to explain the WTP for insurance against the risk of unexpected losses. First, people subjectively value risky monetary values; they tend to prefer an uncertain monetary loss over a *sure* loss of similar height. That means they have a general tendency to engage in risk-loving behaviour when dealing with monetary losses and, thus, farmers generally have a low WTP and do not insure losses due to crop damages. Second, people evaluate probabilities subjectively and overweight low probabilities which increases the WTP for low-probability shocks. Overweighting low probabilities can cancel out the risk-loving valuation of monetary values. The intensity of these two features is modelled with two separate prospect theory parameters.

While economists often use behavioural experiments to investigate decisions under risk (Iyer et al., 2020) the discussion on how to design these experiments is ongoing. Various agricultural economic studies conduct field experiments with farmers. They investigate prospect theory parameters in "artefactual field experiments" (following the terminology of Harrison & List, 2004). These experiments usually use specific abstract, multiple-price-list-based lottery games with a focus on low-stake monetary gains (e.g., Bocquého et al., 2014; Ward & Singh, 2015; Rommel et al., 2022). Other authors argue that using a "framed field experiment" could enhance the external validity of decisions under risk by framing the experimental tasks as real farm

[1] In our paper, we denote adverse low-probability and high-consequence shocks as "low-probability shocks".
[2] More precisely, we refer to the "cumulative prospect theory".

business decisions (Cerroni, 2020; Iyer et al., 2020). Especially behaviour in the context of low-probability shocks is expected to depend on context situations (Kahneman, 2011). However, framing an experiment in a specific farm business context reduces its replicability, its transferability to other decision-making situations and can be complex. The framing can add confounding factors that decrease the internal validity (Thoyer & Préget, 2019). The challenge is to counterbalance the advantages and disadvantages of a real and an abstract frame (Thoyer & Préget, 2019).

Another experimental method that is discussed in the literature is conducting an experiment with "standard subject pools", such as students, instead of conducting a field experiment (Harrison & List, 2004). Multiple studies use students to conclude on risk behaviour in the wider population (e.g., Bruhin et al., 2010; Tversky & Kahneman, 1992). Also, agricultural economists discuss the advantages of conducting experiments with students (Grüner et al., 2022). Students are usually easier to recruit. They are more homogeneous, making it easier to statistically measure factors in small samples (Belot et al., 2015). In agricultural economics in high-income countries, the advantage of students is particularly high, as financial compensation for farmers may become expensive and the proportion of farmers in the population is low.

Studying the differences between these methods is relevant for the interpretation of the experiments (Harrison & List, 2004). In the existing agricultural economics literature, studies compare the results of framed field experiments with artefactual field experiments with respect to farmers' risk attitude (Menapace et al., 2016; Rommel et al., 2019). Also, there are studies comparing the risk aversion of students of agricultural sciences with that of farmers (Grüner et al., 2022; Maart-Noelck & Mußhoff, 2014; Peth & Mußhoff, 2020). However, these comparative studies use the expected utility framework and do not consider probability weighting. Moreover, they do not address differences between the experimental methods with regard to low-probability shocks. They only examine risks in the domain of monetary gains but not risks of losses although dealing with risks of losses is very relevant for farmers and policymakers.

Against this background, this paper aims to compare the prospect theory parameters of a framed field experiment, framed student experiment and an artefactual field experiment with respect to low-probability shocks. Our framed field experiment resembles a farm risk management decision with farmers. The framed student experiment is conducted with students of agricultural sciences instead of with farmers. The artefactual field experiment resamples a lottery game with farmers. Moreover, we investigate whether there is an effect of additionally focusing the experimental design of the framed field experiment on low-probability shocks. We define low-probability shocks as risks with ≤ 10% probability for an income drop of at least 50%. The experimental results on risk management behaviour are compared with subjects' risk attitude self-assessment and farmers' observed crop insurance decisions. To the best of our knowledge, we are the first to compare a framed field experiment with a framed student experiment and an artefactual framed field experiment in agriculture in the context of low-probability shocks using the prospect theory framework.

In Section 2, we refer to related literature and generate our hypotheses on differences between different experimental methods. Section 3 describes the experimental protocol, followed by Section 4, which outlines the prospect theory framework and our econometric strategy. We present and discuss the results in Section 5 before concluding this paper in Section 6.

2 Hypotheses

Many authors assume that the risk attitude depends on the decision context (Dohmen et al., 2011; Iyer et al., 2020). In this respect, we expect the prospect theory parameters in framed field experiments with farm risk management decisions to differ from prospect theory parameters in often applied artefactual field experiments with lottery games (Hypothesis 1a). Moreover, existing literature suggests that in affect-rich contexts the weighting of low probabilities is higher than in affect-poor contexts (Kahneman, 2011; Rottenstreich & Hsee, 2001). We assume that for farmers a framed field experiment is more affect-rich than an artefactual experiment, as it is closer to their real decision situations. Thus, we expect the weighting of low probabilities to be higher in the framed field experiment than in the artefactual field experiment (Hypothesis 1b).

We also investigate to what extent WTP differs for a decision experiment with a focus on low-probability shocks from an experiment with no such focus. A large body of literature suggests that in a decision situation with low-probability shocks, the WTP for risk mitigation depends strongly on individual and situation-specific decision rules (e.g., Kahneman, 2011; Kunreuther et al., 2013; Barberis, 2013). These can increase or decrease the WTP. The WTP for low-probability shocks is highly variable (Kahneman, 2011). We therefore expect that the prospect theory parameters of a situation in which the focus is on low-probability shocks differ from the situation with no such focus (Hypothesis 2). However, the direction of the influence is not clear.

Studies that conceptionally or empirically investigate the differences between farmers' and students' risk attitudes are scarce. Various studies find no difference between these two groups (Grüner et al., 2022; Peth & Mußhoff, 2020). In contrast, Maart-Noelck and Mußhoff (2014) find that students behave more risk-averse than farmers when dealing with monetary gains. However, this finding cannot directly be transferred to the loss domain and the prospect theory framework. Moreover, studies find evidence that risk attitude is influenced by age (Dohmen et al., 2011; van Winsen et al., 2016) and education level (Dohmen et al., 2011). Therefore, we expect that the prospect theory parameters differ between the farmer and student experiment (Hypothesis 3). We do not have a clear apriori expectation on the sign of the difference.

3 Experimental protocol

3.1 Artefactual field experiment

We employ a lottery-based multiple price list design which is often used to elicit prospect theory parameters (e.g., Bocquého et al., 2014; Tanaka et al., 2010). That means, we ordered multiple choice situations in rows and asked the participants to decide for each row whether they prefer a certain safe amount of money or whether they want to participate in a lottery. We offered two series of choice situations, with 14 rows each.

In the first series, the offered safe amount is €1,000. The offered lottery includes a high-gain outcome with 10% probability and a low-gain outcome with 90% probability. The high gain increases row by row from €2,600 to €28,000 logarithmically while the low gain remains constant at €500. In the second series, the offered safe amount is €4,000. The probability for a high-gain outcome of the lottery is 70% and for a low-gain outcome 30%. The values of the high gain increase row by row from €5,600 to €13,700 logarithmically, while the value of the low gain remains constant at €500. As the high-gain outcomes of the lotteries increase row by row, the lotteries become more attractive with each row. Participants had to specify the row at which they switched from preferring the safe amount to the lottery ("switching point"). With this design, we strictly follow Ward and Singh (2015; see their publication for more details and illustrations of the design). In contrast to Tanaka et al. (2010), the design of Ward and Singh (2015) includes a choice between a safe amount and a lottery instead of between two lotteries. Using one safe option simplifies the experiment, a technique that is often employed in the literature (Bruhin et al., 2010; Freudenreich & Mußhoff, 2018; Robinson & Botzen, 2020; Zeisberger et al., 2012).

3.2 Framed field experiment and framed student experiment

We framed the choices of the multiple price list design as a decision on payments for risk management. Similar to real risk management decisions, participants had to indicate their WTP for protecting themselves against a given risk of a weather-related yield loss. To this end, we asked participants to choose between the safe option "paying a fixed amount to prevent weather-related yield losses" and the risky option "taking the risk of a yield loss". A series of decisions consisted of 20 rows.[3] Within each series, the costs for risk prevention increased row by row and, again, participants were asked to make row-wise decisions. We collected the row at which participants switched to using risk management, instead of taking the risk ("switching point").

In the framed experiments, we implemented eight series, with 20 rows each, to analyse various probabilities and loss levels (Table 1). For instance, in the first series, a 50% drop in income occurs at 2.5% probability and no loss occurs at 97.5%. Expert interviews and pre-tests show that in Germany a 50% loss is understood as a realistic low-probability shock. We have also varied this value. Since high probabilities in connection with income drops ≥50% are not considered as realistic, we analysed only 10% income drops for high probabilities.

Table 1
Series, probabilities and losses of the framed field experiment and framed student experiment

Series	Probability of loss	Loss (in % of income)
1	2.5%	50%
2	5%	50%
3	10%	25%
4	10%	50%
5	10%	75%
6	30%	50%
7	70%	10%
8	90%	10%

We selected the monetary values of the risk prevention costs in a manner that enabled us to collect a wide spectrum of different risk preferences. That means, we selected the highest possible costs of risk prevention corresponding to the outermost risk preference parameters of Tanaka et al. (2010). The lowest offered cost for risk prevention was €1 (see Bruhin et al., 2010; Robinson & Botzen, 2019).

We used multiple measures to emphasise the farm business context. We stressed that "weather risk" (see Rommel et al., 2019) is the reason for damage. In the introduction to the experiment, "weather risk" is explained as the loss from extreme events of hail, heavy rain, storms, frost, drought, heat, or flooding. "Risk prevention" is referred to as the usage of typical risk management tools, such as the adaptation of production technology, cultivation methods, or insurance. Moreover, we strengthened the farm business context by making the financial loss and the fixed payment dependent on the individual farm profit level (Menapace et al., 2016). Introducing the experiment to the participants with "cheap talk" (Penn & Hu, 2018) and role-playing story (Thomas et al., 2019; Thoyer & Préget, 2019) are other measures we applied to

[3] A series consisted of 20 rows instead of 14 because otherwise it was not possible to offer a sufficient number of answer possibilities also for low probabilities and high stakes.

increase the contextualization and minimize the potential hypothetical bias. We asked participants to "imagine" that they face the loss risk on their own farm and "decide as if the experiment were about your own farm's money." To avoid charity hazard behaviour (see Miglietta et al., 2021), we told the participants that no public disaster reliefs are available. The adequacy of our framing was critically verified in our pre-test.

3.3 Incentivization and experiment implementation

We made the choices "incentive compatible" (Harrison, 2007) by randomly selecting 10% of the participants to receive a payment proportional to the experimental gains or losses (see Bauermeister et al., 2018; Vollmer et al., 2019). Farmers received payments up to €100 and students up to €50 to reflect their lower income. By providing a starting capital, we were able to claim experimental losses without making participants pay money for participation. As an additional non-financial incentive, the participants received an individual result report (see Menapace et al., 2016). An ethical committee approved our study design.

The experiment was conducted online between January and April 2021 in Germany. We recruited participants using mailing lists of farm consultants, universities, agricultural magazines, and social media. Before the experiment started participants had to answer control questions. The various series of our experiment were displayed in random order. We randomly assigned the farmers to two groups. One group conducted the framed field experiment and the other the artefactual field experiment.

3.4 Descriptive statistics and sample characteristics

Table 2 provides an overview of descriptive statistics. The participants of the student sample are substantially younger. They all belong to the age group below 25 and 40% already have a bachelor's degree. There are relatively more students from northern Germany and fewer from southern Germany, which is to the location of participating universities.

We collected participants' risk attitude self-assessment using the popular method of Dohmen et al. (2011). The participants had to indicate their risk attitude on an 11-point scale from 0 "I am not at all willing to take risks" to 10 "I am very willing to take risks". In our survey, the average risk attitude self-assessment varies between 5.62 and 6.22, depending on the sample.

Table 2

Sample description of three subject groups with a total of N=213 participants

Mean (SD)	Field experiment		Student experiment
	Framed	Artefactual	Framed
Age [a]	45.62 (13.20)	43.97 (11.77)	20 (0.0) [c]
University degree [b]	0.44	0.53	0.40
Male [b]	0.92	0.91	0.78 [c]
Region north [b]	0.56	0.55	0.75 [c]
Region east [b]	0.12	0.1	0.11
Region south [b]	0.15	0.19	0.02 [c]
Region west [b]	0.16	0.15	0.13
Uses crop insurance – hail [b]	0.78	0.81	not available
Uses crop insurance – heavy rain [b]	0.11	0.14	not available
Uses crop insurance – storm [b]	0.21	0.19	not available
Uses crop insurance – frost [b]	0.05	0.04	not available
Uses crop insurance – drought [b]	0.04	0.06	not available
Uses crop insurance – no. of insured perils	1.24 (0.91)	1.19 (0.94)	not available
Risk attitude self-assessment	6.22 (1.88)	5.62 (2.10) [c]	6.13 (2.04)
Relative risk premium paid in the experiment			
Loss domain	-0.40 (0.40)		-0.21 (0.48) [c]
Gain domain		0.15 (0.26)	
N	80	78	55

Note. a) In accordance with the data protection rules and public statistics, age has been surveyed in classes. The six classes are 20: age < 25, 30: age between 25 and 34, 40: age between 35 and 44, 50: age between 45 and 54, 60: age between 55 and 64 and 70: age ≥ 65. b) Equals 1 if true, otherwise 0. c) Kruskal–Wallis test with H_0 of equal means when compared with participants of the framed field experiment was rejected at 5 %-level.

We describe the response of the risk experiments with the relative risk premium (see, e.g., Bruhin et al., 2010; Fehr-Duda & Epper, 2012) to make the WTP comparable for different probabilities and risky stakes. The relative risk premium is $RRP = (EV - CE)/|EV|$, where EV is the expected value of the risky option, and CE is its certainty equivalent. The certainty equivalent is the maximum (minimum) save monetary value a participant prefers over the risky monetary gain (loss). A negative risk premium indicates risk-loving behaviour and a positive risk-averse behaviour. The mean relative risk premia in the framed experiments are negative. In the gain domain in the artefactual field experiment, the risk premium is positive. These differences between the gain and loss domain are in line with the prospect theory.

4 Procedure of parametric analysis

4.1 Prospect theory framework

We explore the effect of heuristics based on the prospect theory framework. According to this framework, the utility U for an option with two possible outcomes y_m $(m = (1,2))$ and their associated probabilities p and $1 - p$ is calculated as:

$$U = v(y_1) \cdot w(p) + v(y_2) \cdot \big(1 - w(p)\big), \tag{1}$$

where w is a function that reflects the weighting of probability p, and v is a function that determines people's valuation of monetary outcomes y. Following Tversky and Kahneman's (1992) the weighting function is:

$$w(p) = \frac{p^\gamma}{(p^\gamma + (1-p)^\gamma)^{1/\gamma}} \tag{2}$$

Parameter γ determines the curvature of the probability weighting function. If $\gamma < 1$, the function has an inverse-S-shaped curvature. In this case, low probabilities are overweighted ($w(p) > p$), and high probabilities are underweighted ($w(p) < p$). If $\gamma = 1$, the relationship is linear ($w(p) = p$). If $\gamma > 1$, the function has an S-shaped curvature, which includes underweighting of low probabilities and overweighting of high probabilities.

The value function v is assumed to be concave in the gain domain and convex in the loss domain. Such a curvature implies that the valuation of monetary values is risk-averse in the gains and risk-loving in the loss domain. Following Tversky and Kahneman (1992), it is parameterized as follows:

$$v(y_m) = \begin{cases} y_m^\sigma & if\, y_m \geq 0\ (gain) \\ 0 & if\ y_m = 0 \\ -(-y_m)^\sigma & if\, y_m < 0\ (loss) \end{cases} \tag{3}$$

The parameter σ is between 0 and 1. A smaller σ indicates an increasing concavity (convexity), implying ceteris paribus an increased risk-averse (risk-loving) behaviour. For our parametric analysis, we follow the many studies that assume σ is identical in the gain and loss domain when eliciting prospect theory parameters (e.g., Tanaka et al., 2010; Bocquého et al., 2014) and applying them to explain specific insurance behaviour (e.g., Chavas, 2019; Feng et al., 2020). We define loss as any reduction in the farmer's wealth due to their experimental decisions (cf. "reference point"; Bocquého et al., 2014; Kahneman & Tversky, 1979).

In contrast to several applications of the prospect theory, our value function does not include a second parameter for "loss aversion". The loss aversion parameter is used when people have to compare gains and losses in a single decision. Since this is not necessary to analyse risk behaviour for low-probability shocks (see "fourfold pattern" in Tversky & Kahneman, 1992) and our experiment does not contain mixed lotteries, this parameter is cancelled out (Bruhin et al., 2010).

4.2 Parameter estimation

We applied the maximum likelihood approach in accordance with Harrison and Rutström (2008) and to estimate the prospect theory parameters, γ and σ, and their correlation with individual characteristics. Assuming that farmers are maximizing their utility, their choice is determined by the difference in utility between options A and B, which can be modelled with the latent decision index $\Delta U_i = (U_i^A - U_i^B)/\mu$. The parameter μ is a structural noise parameter, which was introduced by Fechner and popularized by Hey and Orme (1994).

We estimated the influence of individual characteristics X_i (these characteristics also include dummies for the experimental design) on each of the prospect theory parameters, γ and σ. We assume a linear relationship between X and the parameters γ and σ, respectively. For the instance of γ, $\gamma = \beta_\gamma X$. Vector β includes the coefficients to be estimated. For σ, we proceeded similarly. Since noise can bias risk preferences (Andersson et al., 2016), we also consider μ to be dependent on X_i (see Harrison & Rutström, 2008). As a result, we can describe decision c between options A and B depending on X_i with the following latent regression model:

$$c_i^* = \Delta U_i(X_i) + \varepsilon_i \text{ and } c_i = \begin{cases} A & if\ c_i^* > 0 \\ B & otherwise \end{cases}, \tag{4}$$

The error term ε is normally distributed with mean 0 and standard deviation μ. Consequently, from Equation (4), we can derive that the probability of choosing option A corresponds to the standard normally distributed cumulative distribution function $\Phi\big(\Delta U_i(X_i)\big)$. This "probit" function converts ΔU_i into a number between zero and one. We used the probit function derived from Equation (4) to establish the following conditional likelihood function, which estimates the prospect theory parameters γ and σ:

$$\ln\big(L(\gamma, \sigma; c_k, X_k)\big) = \sum_{k=1}^{K} \big[\ln\big(\Phi(\Delta \mathrm{U}_k)\big) \cdot I(c_k = A) + \ln\big(1 - \Phi(\Delta \mathrm{U}_k)\big) \cdot I(c_k = B)\big] \tag{5}$$

where I is an indicator function, which equals 1 [0], if participants chose option B [A]. Variable k is an index of all observations, including all individuals, series, and rows of the series.

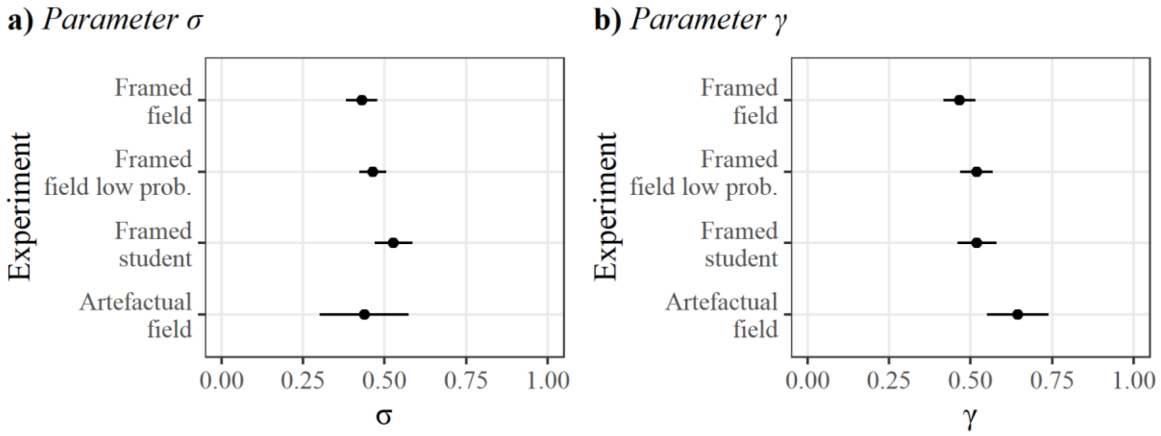
5 Results and discussion

5.1 Comparing experiments based on the prospect theory framework

We estimated the prospect theory parameters using Equation (5). Figure 1 gives an overview of the prospect theory parameters for the framed field experiment, the framed student experiment and the artefactual field experiment. In addition, the figure shows the coefficients for the "framed field experiment with a focus on low probabilities", which is an extended analysis of the framed field experiment and only includes series with ≤30% probability and ≥50% income drop. Although 30% is not a low probability, we had to include it to obtain stable estimation results. All estimated parameters are smaller than 1, which means that our results are consistent with prospect theory and confirm the results of numerous empirical studies with farmers (e.g., Bougherara et al., 2017).

Figure 1

Overview on coefficients (point) with 95% confidence intervals (whiskers) of prospect theory parameters (N=213)



Compared to the framed field experiment, the estimated prospect theory parameters, σ and γ, on average, are higher in the artefactual field experiment (Table 3a; confirming Hypotheses 1a and 1b). Our results are supported by Menapace et al. (2016), who also found an effect of experimental framing on risk attitude.

The elicited prospect theory parameters are affected in the field experiment if the framing specifically focuses on low-probability shocks (Table 3b; confirming Hypothesis 2). We find that when focusing on low-probability shocks σ and γ increase.

Table 3

Estimated difference of prospect theory parameters in different experiments

a) *Framed vs. and artefactual field experiment*

	σ	γ
Artefactual [a]	0.05	0.16**
	(0.06)	(0.06)
Constant	0.43***	0.47***
	(0.02)	(0.02)
Log likelihood	-7,201.75	
Obs./clusters	15,530/158	

Note. Standard errors in parentheses; * p < 0.1, ** p < 0.05, *** p < 0.001. a) =1 if yes.

b) *Framed field experiment vs. framed field experiment focused on low-probability shocks*

	σ	γ
Focus on low-probability shocks	0.07***	0.04
	(0.02)	(0.03)
Constant	0.40***	0.47***
	(0.03)	(0.03)
Log likelihood	-5,547.83	
Obs./clusters	12,800/80	

Note. Standard errors in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.001. a) =1 if yes.

Table 4 shows the estimated differences between the prospect theory parameters of the framed field experiment and the framed student experiment. Parameters σ and γ are higher in the field experiment than in the student experiment (difference of σ confirmed by a hypothesis test; confirming Hypothesis 3). By adding age and other explanatory variables to the estimation, the effect of the student status decreases substantially. We conclude that the difference between students and farmers is mainly due to age rather than student status. In the literature also Maart-Noelck and Mußhoff (2014) found differences between farmers' and students' risk attitudes. However, they did not control for age effects. In contrast, Grüner et al. (2022) found no differences between farmers' and students' risk attitudes.

Table 4

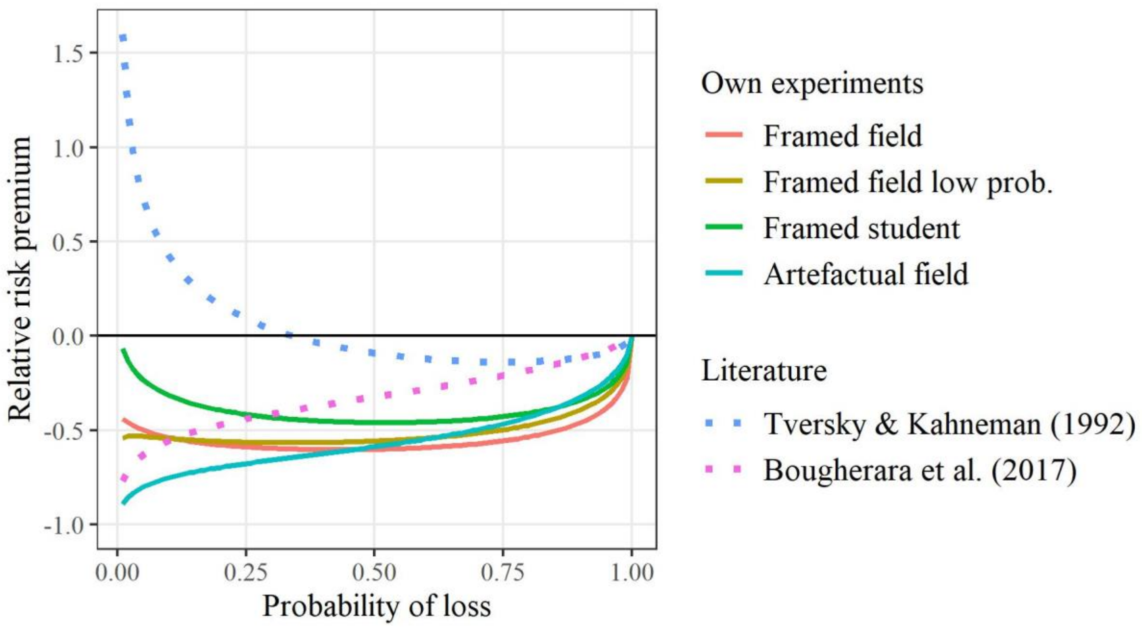
Estimated difference of the framed field experiment and the framed student experiment

Models M1 to M3 with various covariates	M1: Covariate student		M2: (M1) + age		M3: (M2) + further farm characteristics	
	σ	γ	σ	γ	σ	γ
Student	0.10**	0.05	-0.00	-0.02	0.01	-0.01
	(0.04)	(0.04)	(0.06)	(0.06)	(0.06)	(0.06)
Age			-0.04*	-0.03	-0.04**	-0.03
			(0.02)	(0.02)	(0.02)	(0.02)
University degree					0.05	0.03
					(0.04)	(0.04)
Male					0.10**	0.12**
					(0.04)	(0.04)
Region east					0.09	-0.00
					(0.06)	(0.06)
Region south					-0.05	0.02
					(0.06)	(0.07)
Region west					0.01	-0.02
					(0.04)	(0.05)
Constant	0.43***	0.47***	0.57***	0.57***	0.46***	0.46***
	(0.02)	(0.02)	(0.08)	(0.08)	(0.08)	(0.09)
Log likelihood	-9,552.81		-9,469.10		-9,261.17	
Obs./clusters	21,600/135					

Note. Standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.001$. a) =1 if yes.

Figure 2 illustrates the relative risk premium for loss risks based on the estimated mean prospect theory parameters. The figure allows us to conclude on the WTP based on the σ and γ values of our experiments for various probabilities. The relative risk premia in the framed field experiment, the framed field experiment with a focus on low probabilities and the artefactual field experiment are negative and thus indicate risk-loving behaviour. This holds also for very low probabilities. Other studies in agriculture find similar results. For instance, the relative risk premium resulting from the artefactual field experiment of Bougherara et al. (2017), the only known study conducted with loss-risk and European farmers, is also very low (see Figure 2).[4] In contrast, the relative risk premium resulting from Tversky and Kahneman's (1992) study becomes positive at probabilities lower than 34% (see Figure 2), since their σ (σ =0.88) is greater than the σ found in our experiments. Thus, we conclude that the *general* observation of a low WTP for risk mitigation, even for very low probabilities, does not depend on the analysed experimental designs. In this sense differences between *mean* prospect theory values of our experimental design seem to be less relevant as the resulting risk premiums are all substantially below zero and below Tversky and Kahneman's (1992) results. Nevertheless, the differences between the framed field experiment, the framed student experiment and the artefactual field experiment increase the lower the probability of loss.

Figure 2
Relative risk premium resulting from estimated mean prospect theory parameters depending on the probability of loss



5.2 Comparison of experimental responses with other indicators of risk behaviour

Finally, we compare farmers' and students' experimental responses with their risk-attitude self-assessment and the farmers' responses with their actual crop insurance purchases. This is to shed light on the validity of the various experiments.

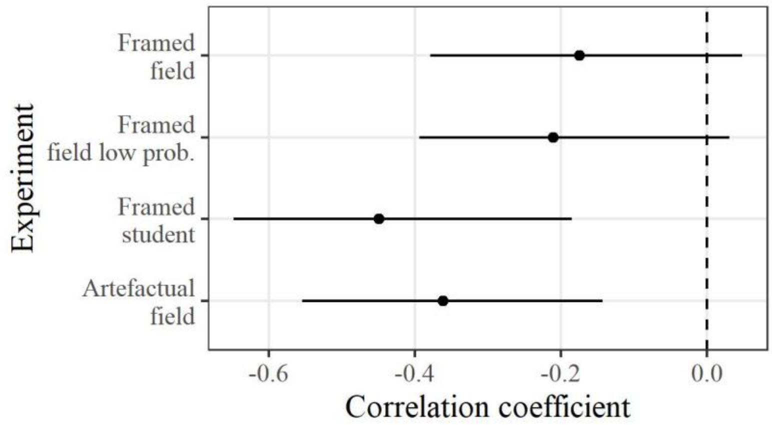
Various studies show that the risk attitude self-assessment is able to predict risk behaviour (Dohmen et al., 2011), often better than more complex measures of risk attitude (Charness et

[4] Relative risk premiums predicted with other studies such as the frequently cited study of Bocquého et al. (2014) or the replication study of Rommel et al. (2022) are even lower than the risk premiums resulting from Bougherara et al. (2017).

al., 2020). The self-assessment differs methodologically from our experiments. Therefore, we use the risk attitude self-assessment as a proxy for risk behaviour to validate our experimental results. Figure 3 shows the correlation coefficient between the relative risk premium and the risk attitude self-assessment. As expected, the correlation coefficients are all negative which means the higher the risk premium the lower the self-assessed willingness to take risks. The correlation coefficients of the framed field experiment are lower than the other experiments' correlation coefficients; also a hypotheses test does not confirm that the framed field experiments' coefficient is different from zero.

Figure 3

Spearman correlation of the relative risk premium and the risk attitude self-assessment (N=213)

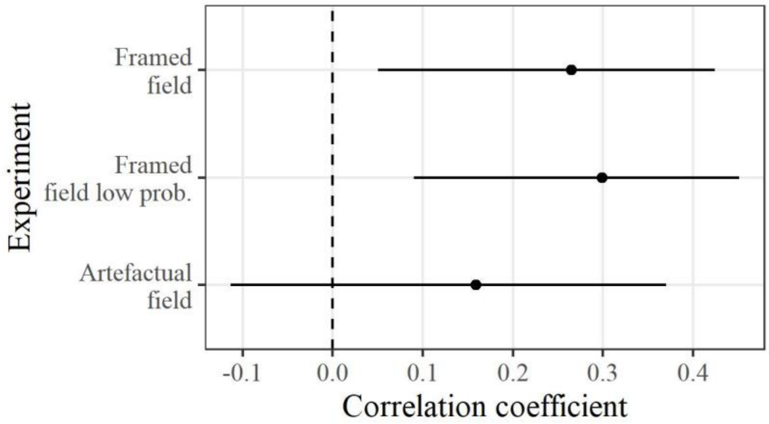


Note. Point: correlation coefficient. Whiskers: 95% bootstrapped confidence intervals.

Figure 4 shows the correlation coefficient between the relative risk premium and farms' crop insurance purchases. The student experiment is not included in this analysis because students do not buy crop insurance. As expected, the correlation coefficients are all positive. However, the correlation between the artefactual experiment and insurance purchase is low compared to the other experiments. A hypotheses test cannot confirm that they are different from zero. Our results are in line with Menapace et al. (2016) who find a correlation between the framed field experiment and crop insurance participation but no strong evidence for a correlation between artefactual field experiments and crop insurance participation. The observed correlation with the framed experiments is an interesting finding, as multiple studies generally do not find strong evidence for a correlation between risk experiments and real-world insurance decisions (Charness et al., 2020; Rommel et al., 2019).

Figure 4

Spearman correlation of the relative risk premium and the number of perils insured (N=158)



Note. Point: correlation coefficient. Whiskers: 95% bootstrapped confidence intervals.

6 Conclusion

The prospect theory is often used to explain risk behaviour for low-probability shocks. We compared three different experimental methods for estimating its parameters with a focus on implications for farm risk management against these shocks. The three experimental methods are (1) a framed field experiment collecting farmers' WTP for risk prevention against weather-related crop damages, (2) a framed student experiment with students of agricultural sciences instead of with farmers, and (3) an artefactual field experiment, in which farmers had to indicate their willingness to participate in a lottery.

We find evidence for differences between the mean prospect theory parameters obtained with the three methods. In the comparison between the framed field experiment and the framed student experiment, we could explain the difference with the age of the participants. Moreover, the differences between the predicted WTP of the three experiments increase as the probabilities become smaller. Thus, differences between the experimental methods are more important for low-probability shocks than for more frequent shocks. Nevertheless, the calculated WTP for protection against low-probability shocks is low regardless of the method. Finally, we find evidence that individual responses in the artefactual and student experiments correlate with the risk attitude self-assessment while responses of the framed field experiment correlate with farmers' purchase of crop insurances.

Given the lower transferability and replicability and the higher costs of framed field experiments compared to student and artefactual field experiments, a researcher should have good reasons why he chooses the framed method. While the correlation between the individual risk attitude and the use of risk management instruments is higher in the framed experiment, an artefactual field experiment or framed student experiment might be sufficient to investigate mean prospect theory values for more frequent shocks.

The low WTP, which is not larger than the fair premium, is in line with the literature (Feng et al., 2020) and explains to some extent why subsidies for crop insurance premiums are often discussed in agricultural policy (OECD, 2021). However, 79% of the farmers in the sample purchased hail insurance. A possible explanation for the high market penetration of hail insurance could be that farmers assess hail risk differently than other weather risks, for instance, in terms of damage probability or damage potential. Another explanation could be that hail insurance in Germany often includes low-impact hail events, because its deductible is usually low.[5] Receiving insurance payments for frequent, low-impact hail damages might increase farmers' WTP, as people are more likely to insure high-probability and low-impact events than low-probability and high-impact events (Browne et al., 2015).

Although we consider the degree of contextualization in our study higher as similar studies in agricultural economics (Menapace et al., 2016), it could be improved by future research by framing the decision tasks even more concretely, for instance, as drought insurance decisions. Moreover, future research should investigate the selection of the risky prospects' reference point.

[5] For example, the Vereinigte Hagel, Germany's largest crop insurer, usually makes indemnity payments if a single plot exceeds 8% yield loss. Once this threshold is reached, the insurance compensates the entire yield loss ("integral franchise"; Vereinigte Hagel, 2023).

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Department für Agrarökonomie und Rurale Entwicklung

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Die Wurzeln der **Fakultät für Agrarwissenschaften** reichen in das 19. Jahrhundert zurück. Mit Ausgang des Wintersemesters 1951/52 wurde sie als siebente Fakultät an der Georgia-Augusta-Universität durch Ausgliederung bereits existierender landwirtschaftlicher Disziplinen aus der Mathematisch-Naturwissenschaftlichen Fakultät etabliert.

1969/70 wurde durch Zusammenschluss mehrerer bis dahin selbständiger Institute das **Institut für Agrarökonomie** gegründet. Im Jahr 2006 wurden das Institut für Agrarökonomie und das Institut für Rurale Entwicklung zum heutigen **Department für Agrarökonomie und Rurale Entwicklung** zusammengeführt.

Das Department für Agrarökonomie und Rurale Entwicklung besteht aus insgesamt neun Lehrstühlen zu den folgenden Themenschwerpunkten:

- Agrarpolitik
- Betriebswirtschaftslehre des Agribusiness
- Internationale Agrarökonomie
- Landwirtschaftliche Betriebslehre
- Landwirtschaftliche Marktlehre
- Marketing für Lebensmittel und Agrarprodukte
- Soziologie Ländlicher Räume
- Umwelt- und Ressourcenökonomik
- Welternährung und rurale Entwicklung

In der Lehre ist das Department für Agrarökonomie und Rurale Entwicklung führend für die Studienrichtung Wirtschafts- und Sozialwissenschaften des Landbaus sowie maßgeblich eingebunden in die Studienrichtungen Agribusiness und Ressourcenmanagement. Das Forschungsspektrum des Departments ist breit gefächert. Schwerpunkte liegen sowohl in der Grundlagenforschung als auch in angewandten Forschungsbereichen. Das Department bildet heute eine schlagkräftige Einheit mit international beachteten Forschungsleistungen.

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