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Report on the two economic experiments

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Introduction

This deliverable aims at summarizing the empirical research carried out within the PRIN project SUS-RISK, that articulates in two contextualized field experiments. One experiment (i.e., experiment 1), took place in the Autonomous Province of Trento (PAT, hereafter) with a sample of apple producers. The second (i.e., experiment 2), involved a representative sample of tomato producers from different regions of the North of Italy. Both studies aim at understanding farmers' preferences for innovative risk management tools. Experiment 1 focuses on the **Income Stabilization Tool** (IST, hereafter) for the apple sector in the PAT. Experiment 2 focuses on farmers' preferences for an innovative **index-based insurance scheme** designed to protect against extreme drought events in the tomato production sector. Both experiments involved the elicitation of farmers' willingness to pay for the proposed innovative risk management tool through a Becker-de Groot-Marschak auction. Given the uncertainty of future benefits of adopting such innovative tools, it is plausible that farmers may adopt selected heuristics in their risk management decisions (e.g., Duden et al., 2022). Heuristics are so-called "rules of thumb" (Tversky and Kahneman, 1992) that can influence an individual's decision-making process under risk and uncertainty. More specifically, we decided to focus on the availability heuristic that may occur when farmers estimate the probability of an event based on how similar it is to a known or previous situation (Duden et al., 2023). For example, in experiment 1 the willingness to pay for the apple IST may be influenced by how farmers' mentally retrieve information regarding past income shocks. Or, in experiment 2, tomato producers' willingness to pay for index-based insurance for drought events may be influenced by how vivid their past experiences with such extreme events have been.
Moreover, additional experimental tasks were proposed to participants to elicit their behavioral preferences (e.g., risk preferences, time preferences) that the current literature deems to be relevant in the risk management process in agricultural economy (see for example Arata et al., 2023).

1. Experiment 1

1.1 Introduction

Experiment 1 aims at eliciting the willingness to pay for IST of a representative sample of apple producers in the territory of the Autonomous Province of Trento (PAT), in Italy. Moreover, subjective beliefs regarding future income variations and risk preferences were elicited in the study. To this end we developed an online experiment with a representative sample of farmers in the PAT. Participants were randomly allocated into three different treatment groups: I) control, ii) individual past (IP), iii) general past (GP). The farmers in the IP and GP treatments were subjected to the activation of the availability heuristics (Tversky and Kahneman, 1974), while farmers in the control group were not.
To trigger the heuristic, farmers in the IP group were asked to report, before expressing their WTP in part one of the study, their average income from apple over the past 10 years (2013-2023) and then to indicate the years (between 2013 and 2023) in which their annual income fell by more than 20% below this 10-year average.

On the other hand, farmers in the GP treatment were informed about the average income from apple growing in the PAT in the period 2013-2023 and also in which years the annual income fell by more than 20% below this 10-year average. The aim of the project was to check if: i) triggering the heuristic has an effect on the WTP of farmers for the IST, ii) there is a difference in the effect between those farmers who are asked to provide information regarding their income compared to those farmers who are provided with the information.

1.2 Data and research methodology

The population from which we recruited participants is the population of apple growers in the Province of Trento. The recruitment campaign was facilitated by Co.Di.Pr.A which is a large farmer association in the Province of Trento. The association advertised the study through their communication channels. Farmers who showed their interest were then contacted via email. The email contained an information sheet with more specific information regarding the study. If farmers agreed to participate, they were allocated to sessions of approximately 10-15 participants. Farmers were provided with a weblink to the experiment (o-Tree), the time and the date of the session. The final sample target consisted of 146 farmers. The experiment was conducted online. Farmers were required to show their ID document on the camera at the beginning of the experiment. At the end of the experiment, they were requested to fill and sign a payment receipt and to scan it alongside a copy of their ID document. Payments were made by bank transfer. The experimental sessions were run between March and beginning of April 2024. The study lasted around 40-45 minutes. Table 1 provides an overview of the participants' characteristics.

Table1 1 – Summary statistics of experimental sample (n= 146)

Variable	**Description**	**Mean**	**SD**
WTP	Farmers WTP for Apple IST (€/hectare)	278.78	191.26
IST	Farmer participated in the Apple IST in 2023	0.6	0.49
Female	Farmers is female (= 1; =0 otherwise)	0.04	0.21
Age	Farmers' average age	50.18	12.27
Farm size	Farm size in hectare	4.04	3.27
Insured Value	Apple insured value (€)	121591.0	95537.26
Insurance Premium	Average insurance premium paid (€)	23412.84	19231.49
Rp_No	Farm using no on-farm protection (= 1; =0 otherwise)	0.61	0.44
Rp_Nets	Farm using only anti-hails nets (= 1; =0 otherwise)	0.25	0.43
Rp_Frost	Farm using only anti-frost system (= 1; =0 otherwise)	0.07	0.24
Rp_Mix	Farm using nets with anti-frost system (= 1; =0 otherwise)	0.07	0.25
Area_VSN	Farm located in Val di Non (= 1; =0 otherwise)	0.71	0.44
Area_VAL	Farm located in Valsugana (= 1; =0 otherwise)	0.06	0.23
Area_TSR	Farm located in Trento Sud – Rotaliana (= 1; =0 otherwise)	0.16	0.37
Area_BVL	Farm located in Bleggio – Valle dei Laghi (= 1; =0 otherwise)	0.07	0.25

1.3 Study design

There were three treatment groups and participants were randomly allocated to the groups. In each treatment, they completed 3 tasks in each treatment: 1) willingness to pay elicitation, 2) subjective beliefs elicitation and 3) risk preference elicitation. At the end of the experiment, socio-demographics data were collected through a short survey (task 4). Farmers assigned to Treatment 1: "Control group" completed the 3 tasks without the heuristic activation, instead they were asked an unrelated question about their attendance to events organized by the local producers' defense consortium. In Treatment 2: "General Past", subjects had the availability heuristic activated by informing them about the average income from apples in the period 2013-2023 and also in which years the annual income has been below -20% with respect to the average. Lastly, in Treatment 3: "Individual Past", the subjects were asked to report, before expressing their WTP in part one of the study, their average income from apples in the last 10 years (2013-2023) and then to tick in which years (between 2013 and 2023) their annual income has fallen below the -20% with respect to the 10 years average. The experiment consisted of 4 tasks. Table 2 provides a quick overview of the experimental design.

Table1 2– Overview experimental protocol

	CONTROL	**INDIVIDUAL PAST FRAMING**	**GENERAL PAST FRAMING**
	Neutral Task	Report of past information	Provision of past information
1	BDM to elicit WTP for apple IST	BDM to elicit WTP for apple IST	BDM to elicit WTP for apple IST
2	Subjective beliefs regarding future income variations elicitation task	Subjective beliefs regarding future income variations elicitation task	Subjective beliefs regarding future income variations elicitation task
3	BRET task	BRET task	BRET task
4	Socio demographic questionnaire	Socio demographic questionnaire	Socio demographic questionnaire

The experimental task 1 is a WTP elicitation task, where subjects were asked to express their WTP to buy the income stabilization tool in 2024 through a BDM auction (Becker, Degroot and Marschak, 1964). Participants were informed about the characteristics of the IST and the auction mechanism before the elicitation. Each participant was asked to express their WTP as if they had an average apple farm in the PAT with a net income of 25.000 € per hectare. Farmers were informed that this income was subject to variation due to income variation, their WTP and the IST market price. Income variations were simulated using a probability distribution calculated based on existing historical data on apple farmers' income and experts' opinions on the future income fluctuations. Experts' estimates were elicited during the preparatory work that was conducted to design the experiment. This consisted of several individual interviews with agents working or having strong links with the apple industry. Based on this probability distribution, we built a virtual-bag containing 100 tickets. On each ticket one of ten possible intervals of income variation (10 equally divided intervals from -50% to +%50) was reported.

The proportion of the tickets followed the probability distribution we had estimated, and was not revealed to the subjects during this task. Secondly, farmers were informed that their WTP would be compared to the IST market price. The market price was unknown at the time of the study, so one market price was randomly simulated from a range of prices of the past IST prices. Farmers were informed about this range and that a price would be randomly selected from it. If the farmer's WTP was higher or equal to the simulated price, he/she had to buy the IST at the market price. In the other case he/she had not. At the end of the study the final income was calculated as the simulated income variations less the price of IST, when bought. Farmers pay-off was calculated by converting final income with a 1.15 exchange rate. The maximum payoff that can be earned was € 25.
In Task 2, we elicited apple growers' subjective probability distributions regarding the future income (year 2025) from the apple production. The subjective probability distributions (for each of the participants) were elicited by using the quadratic scoring rule (QSR) method proposed by Harrison et al. (2017). The subjects were provided with 100 tokens and must assign these among 10 different intervals (states of the world) according to their opinion about what interval would realize. Each interval represented an income range variation from the average income (calculated as the average of the three years 2021-2023). Based on their allocative decisions, farmers were shown the payoff (calculated using the QSR) that this task can provide. At the end of the experiment, if Task 2 was randomly selected, participants were paid using a probability distribution calculated based on existing historical data on income from apple production and experts' opinions on the future income fluctuations. Experts' estimates were elicited during the preparatory work that was conducted to design the experiment. This consisted of several individual interviews with agents working in or having strong links with the apple industry. Based on this probability distribution, we built a virtual-bag containing 100 tickets. On each ticket is reported one of the 10 intervals. The proportion of the tickets followed the probability distribution we had estimated, and was not revealed to the subjects during this task. A ticket was randomly drawn at the end of the experiment and this was used to identify the payoff to be paid. The maximum payoff that can be earned was € 15.
Task 3 aimed at eliciting the farmers' risk preferences. Risk preferences were retrieved with the Bomb Elicitation Task (BRET) (Crosetto and Filippin, 2013). The BRET asks subjects to decide at which point to stop collecting a series of 100 boxes, one of which contains a time bomb. Earnings increase linearly with the number of boxes collected but are equal to zero if one of them contains the bomb. The task is designed to avoid potential truncation of the data, so that subjects are free to choose any number between 0 and 100. At the end of the experiment, if Task 3 was randomly selected, participants were paid based on the number of boxes collected. Each box collected by the farmers added 0.15€. If the bomb was collected the payoff is equal to 0€.
The experiment concluded with a short questionnaire (Task 4) to collect subjects' socio-demographic characteristics, attitudes and usual risk management practice and preferences regarding the IST.

1.4 Results

The econometric analysis aimed at understanding if there were statistically significant differences in the reported farmers’ WTP between the different experimental treatments. Both regression analysis and non-parametric tests have been used to analyse farmers’ WTP. From early analysis both non- parametric tests (Kolmogorov-Smirnov test) and OLS do not detect differences in farmers’ willingness to pay between treatments.

Table 3 – Apple producers WTP for the Income stabilization Tool (IST), by treatments

CONTROL GROUP	INDIVIDUAL PAST FRAMING	GENERAL PAST FRAMING
Average WTP (€/hectare)	Average WTP(€/hectare)	Average WTP(€/hectare)
270.75 €/hectare	311.08 €/hectare	255.97 €/hectare

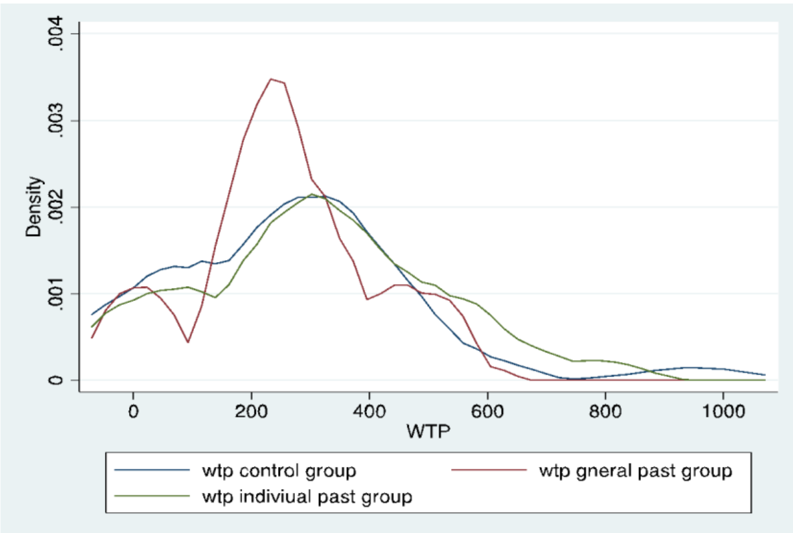

Figure 1 – Kernel distribution of apple producers WTP for the Income stabilization Tool (IST), by treatments

Regarding farmers’ risk preferences, from the analysis of the BRET task, farmers are found to be risk averse with a coefficient of risk aversion of 0.883 (with an average of 36.24 boxes collected in the task). Finally, farmers' beliefs regarding future income variation appear to be normally distributed and very similar to the experts’ assumed distribution, as shown in Figure 2.

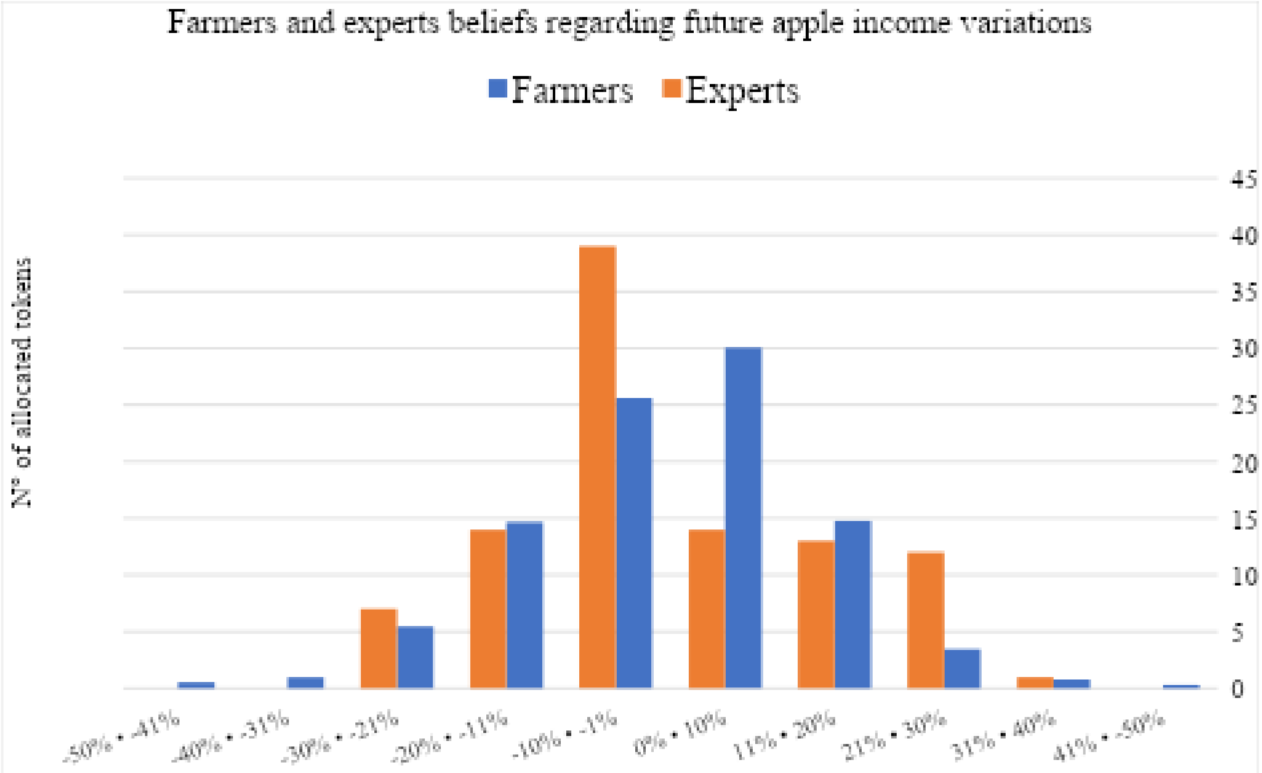

Figure 2 – Farmers’ and experts’ distribution of token in task 2

2. Experiment 2

2.1 Introduction

Experiment 2 aimed at eliciting the willingness to pay for an innovative risk management tool (i.e. index-based insurance for drought events) of a representative sample of tomato producers in the territory of the North of Italy. Moreover, subjective beliefs regarding future rainy precipitation, along with time and risk preferences were elicited in the study. To this end we developed an online experiment with a representative sample of 150 tomato producers. Participants were randomly allocated into three different treatment groups: I) control, ii) individual past (IP), iii) individual future (IF). The farmers in the IP and IF treatments were subjected to the activation of the availability heuristics, while farmers in the control group were not. To trigger the heuristic, farmers in the IP group were asked, before expressing their WTP for an index-based insurance, to report the percentage of damages to their tomato crop (as % of total production) due to drought events in the last 7 years (2017-2023). On the other hand, farmers in the IF treatment were asked to predict the same information for the next 7 years (2024 - 2031). The aim of the project was to check if: i) triggering the heuristic has an effect on the WTP of farmers for an index-based insurance, ii) there is difference in the effect between those farmers who were asked to provide information regarding their past damages due to drought events compared to those farmers who were asked to provide their opinions regarding future damages.

2.2 Data and research methodology

The population from which we recruited participants is the population of tomato producers in the territory of the North of Italy, mostly from the region Emilia Romagna. The recruitment campaign was facilitated by the Condifesa Piacenza and AINPO which are large farmer associations in the Province of Piacenza and Parma. The association advertised the study through their communication channels. Farmers who showed their interest were then contacted via email. The email contained an information sheet with more specific information regarding the study. If farmers agreed to participate, they were allocated to sessions of approximately 2-10 participants. Farmers were provided with a weblink to the experiment (o-Tree), the time and the date of the session. The final sample consisted of 103 farmers. The experiment was conducted online. Farmers were required to show their ID document on the camera at the beginning of the experiment. At the end of the experiment, they were requested to fill and sign a payment receipt and to scan it alongside a copy of their ID document. Payments were made by bank transfer. The experimental session started in March 2024 and ended in May 2025. The long time required for data collection was due to the fact that farmers are usually available to participate only during the low season, which runs from November to the end of February. After that, the transplanting season begins, bringing with it complexities that make conducting the study difficult. The study lasted around 40–45 minutes.
Table 4 provides an overview of the participants' characteristics.

Table 4 – Summary statistics of experimental sample (n= 103)

Variable	Description	Mean	SD
Female	Farmers is female (= 1; =0 otherwise)	0.08	/
Age	Farmers' average age	49	14.03
Farm size	Farm size in hectare	135.26	186.68
Farm size (tomatoes)	Hectares of tomatoes cultivated	54.81	107.40
Farm yield	Average farm yield (quintals per hectare)	138.1	144.65
Insurance Premium	Average insurance premium paid (€)	778.87	472.00

2.3 Study design

There were three treatment groups and participants were randomly allocated to the groups. In each treatment, they completed 3 tasks: 1) willingness to pay elicitation, 2) subjective beliefs elicitation and 3) risk preference elicitation. At the end of the experiment, socio-demographics data were collected through a short survey. Subjects in Treatment 1: "Control group" did not complete the heuristic activation, instead they were asked an unrelated question about their attendance to events organized by the local producers' defense consortium. For farmers in Treatment 2: "Individual future" the availability heuristic was activated by asking them to predict the magnitude of damages to their tomato production due to drought events for each year between 2024 and 2031. Last, for farmers in Treatment 3: "Individual Past" the availability heuristic was activated by asking them their past experiences about the magnitude of damages to their tomato production due to drought events for each year between 2023 and 2017.

Table 4– Overview experimental protocol 2

	CONTROL	**PAST FRAMING**	**FUTURE FRAMING**
	Neutral Task	Provision of past information	Provision of future information
1	BDM to elicit WTP for different type of insurance	BDM to elicit WTP for different type of insurance	BDM to elicit WTP for different type of insurance
2	Subjective beliefs regarding future drought events elicitation task	Subjective beliefs regarding future drought events elicitation task	Subjective beliefs regarding future drought events elicitation task
3	Time preferences elicitation task	Time preferences elicitation task	Time preferences elicitation task
4	BRET task	BRET task	BRET task
	Socio demographic questionnaire	Socio demographic questionnaire	Socio demographic questionnaire

The experiment consisted of four tasks. In the experimental Task 1 subjects were asked to express their WTP for a traditional insurance for drought events and for different index-based insurances through a BDM auction (Becker, Degroot and Marschak, 1964). Participants were informed about the characteristics of the different types of insurances and the auction mechanism before the elicitation. Each participant was asked to perform the task knowing that they have an average tomato farm with a net income of 13.000 € per hectare. Farmers were informed that this income is subject to variation due to income variation, their WTP and the insurance market price. Income variations were simulated using a probability distribution calculated based on existing historical data on rain precipitation and a damage function that associated each precipitation level to a percentage loss of the tomato production. The data regarding precipitation were collected from the Agri4Cast database. Based on this data we developed a probability distribution. From this distribution we built a virtual-bag containing 100 tickets. On each ticket was reported one of ten possible precipitation levels, and to each of them was associated a percentage damage to the tomato crop. Both the proportion of the tickets following the probability distribution and the damage function were not revealed to the subjects during this task. Secondly, farmers were informed that their WTP would be compared to the insurance market price. The market price was unknown at the moment of the study, so one price was randomly extracted from a range of prices of the past insurance prices. Farmers were informed about this price range and the random selection of the price. If the farmer's WTP was higher or equal to the simulated price, he/she bought the insurance at the market price. In the other case he/she was not. In total farmers expressed 5 WTPs. One for the traditional insurance and 4 for the index-based insurance. The index-based insurances differed for two attributes: level of subsidy provided, and percentage of the deductible. Farmers were informed that only one of the 5 insurances would be randomly chosen to calculate their payoff. At the end of the study the final income was calculated according to the simulated income variation and the purchase (or not) of the randomly selected insurance. Farmers were paid by converting their final income with a 1.06 exchange rate. The maximum payoff that could be earned was € 15. Farmers received a 10€ show up fee for completing the Task 1. In Task 2 we elicited tomato

producers' subjective probability distribution regarding the future rain precipitation (year 2024). The first-order subjective probability distributions (for each of the participants) was elicited by using the exact matching interval method. The subjects were provided with 100 tokens and they must assign these among 10 different intervals (states of the world) according to their opinion about which interval will be realized. Each interval represents a precipitation range (in mm). Based on their allocative decisions, farmers were paid using a probability distribution calculated based on existing historical data on rain precipitation. The maximum payoff that could be earned was € 15.
Task 3 elicited farmers' time preferences by asking them to choose between two options (A and B) in 5 different pairwise choices. The option given to the farmers was to receive 10 € in 6 months (option A constant across the 5 pairwise choice situation) or a payoff (from 11€ to 15 €) in 12 months (option B linearly increasing from choice situation 1 to 5). Also this task was incentivized. If Task 3 was randomly selected, one among the 5 choice situations presented was randomly chosen, and the farmer was paid according to his/her preferred option.
In Task 4 we retrieved farmers' risk preferences. Risk preferences were elicited with a Bomb Elicitation Task (BRET) (Crosetto and Filippin, 2013). Farmers had to decide at which point to stop collecting a series of 100 boxes, one of which contained a time bomb. Earnings increased linearly with the number of boxes collected but were equal to zero if one of them contained the bomb. The task was designed to avoid potential truncation of the data, so that subjects were free to choose any number between 0 and 100. At the end of the experiment, if Task 4 was randomly selected, participants were paid on the number of boxes collected. Each box collected by the farmers added 0.15€. If the bomb was collected, the payoff was equal to 0€. At the end of the experiment, farmers were asked to complete a short questionnaire to collect subjects' socio-demographic characteristics, attitudes and usual risk management practice and preferences regarding the farmers' tomato production.

2.4 Preliminary Results

Table 5 shows the mean WTP for the different types of insurance. Specifically, the highest WTP was expressed for the third option, which represents the policy including the following features: a deductible of €1,200 per hectare, a subsidy covering up to 30% of the premium.

Table 5– WTP for the different types of insurance

Variable	Description	Mean	SD
WTP_TRADITIONAL	Farmers WTP for insurance (€/hectare) traditional	237.00	268.15
WTP_INDEX_1	Farmers WTP for insurance (€/hectare) index type 1	301.51	333.60
WTP_INDEX_2	Farmers WTP for insurance (€/hectare) index type 2	266.28	340.48
WTP_INDEX_3	Farmers WTP for insurance (€/hectare) index type 3	353.23	370.39
WTP_INDEX_4	Farmers WTP for insurance (€/hectare) index type 4	238.06	344.99

We estimated an OLS model with random effects, which indicates that farmers have a higher WTP for an index-based policy compared to an indemnity-based one, confirming previous findings in the literature. Results confirm that the third option has the highest WTP. On the other hand, the results demonstrate that the heuristic does not have a significant effect on farmers' WTP for insurance contracts.

Table 5– Preliminary results experiment 2- OLS regression with random effects

Coefficient	Estimate	Std.error	p-value
Intercept	297.31	53.05	0.000***
Ind1_dummy	57.18	26.62	0.032*
Ind2_dummy	42.46	26.62	0.111
Ind3_dummy	122.10	26.62	0.000***
Ind4_dummy	0.62	26.62	0.982
Treatment_future	-75.10	77.73	0.334
Treatment_past	-121.94	80.45	0.130
Ind1_dummy:treatment_future	41.79	39.01	0.284
Ind1_dummy:treatment_past	-22.18	40.38	0.583
Ind2_dummy:treatment_future	-1.29	39.01	0.974
Ind2_dummy:treatment_past	-43.79	40.38	0.278
Ind3_dummy:treatment_future	15.84	39.01	0.685
Ind3_dummy:treatment_past	-38.10	40.38	0.345
Ind4_dummy:treatment_future	-11.35	39.01	0.771
Ind4_dummy:treatment_past	14.38	40.38	0.722

Note: ***p<0.01, ** p<0.05, *p<0.10.

3. Conclusions

The experiments conducted as part of the PRIN SUS-RISK project provide critical insights into the behavioral dynamics underpinning farmers' adoption of innovative risk management tools. By engaging apple producers in the Autonomous Province of Trento and tomato producers across Northern Italy, the study elucidated preferences and decision-making processes in contexts of income stabilization and drought risk mitigation, respectively. The experimental design, grounded in rigorous methodologies such as Becker-de Groot-Marschak auctions and elicitation tasks, underscored the influence of availability heuristics on willingness to pay (WTP). Results revealed that triggering heuristics could shape perceptions of risk and valuation, though differences in WTP across treatment groups were not statistically significant in the case of apple producers for the Income Stabilization Tool and of tomato producers for an innovative index-based insurance product. Furthermore, the nuanced interplay of risk aversion and subjective beliefs about future income or environmental conditions was highlighted, demonstrating alignment between farmers' expectations and expert assessments. For tomato producers, the elicitation of preferences for different insurance schemes showcased a diversity of responses tied to framing effects and individual risk profiles. These findings underline the complexity of fostering sustainable risk management in agriculture, emphasizing the need for tailored strategies that consider psychological and contextual factors. By enhancing our understanding of behavioral economics in agricultural decision-making, the study contributes to designing policies and tools that resonate with farmers' realities, ultimately supporting resilience in the face of growing environmental and market uncertainties.

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