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Understanding Farmers' Behavior towards Sustainable Practices and Their Perceptions of Risk

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Abstract: Farmers, as the first link in the agri-food value chain, are key in assuring its sustainability. Farmers' behavior and attitudes towards implementing sustainable farm practices is influenced by their perceptions of risk affecting the farm and their household, either directly or indirectly. In this study, we elicit farmers' perceived risk perception and preferences and test their robustness and validity using a sample of Greek smallholder farmers since they represent the majority of Greek holdings. Results suggest that farmers exhibit risk aversion in most situations of farm-level decision making. In many situations, farmers will prefer on-farm environmental sustainability strategies over other risk mitigation strategies. More specifically, higher age, higher education, farm size, proportion of rented land, and the existence of a farm succession plan reveal an increase in farmers' preference for on-farm environmentally sustainable strategies and suggest reduced incentives towards implementing other on-farm or off-farm solutions.

Keywords: farm management; risk management; farm sustainability; risk perception; risk preferences

1. Introduction

Farmers, as the first, and as many would argue, most crucial link of the agri-food value chain are key in achieving sustainability of the entire value chain. Sustainable practices, however, are hard to maintain when faced with risk. Farming is an activity that involves daily decision-making in the face of risks [1]. Risks may be related to external factors, such as the economic and physical environment in which the farmer operates or to internal factors such as agricultural production and the financial operation of the farm. The strategies farmers employ to mitigate risks depend on their risk perception and attitudes. Particularly, the adoption of sustainable farm practices depends on farmers' perceptions of economic, environmental, and social risks, and their reaction to them.

A sound understanding of farmers' motivations and risk attitudes is required to assess policies aimed at improving the environmental performance of agriculture [2]. Future-looking decision-making impacts the environment in the long-run. Farmers' perceptions of risk affect their perceptions of future states of nature, directly affecting their ability to implement sustainable farm practices. Moreover, heuristics and biases affect individuals' risk perception and make objective probabilities of risk diverge from subjective probabilities [3]. Accounting for risk preferences is crucial to better understanding farmers' decision-making. Meuwissen et al. [4] suggest that a set of four contextualized business questions specific to farming is correlated with risk management choices. These four contextualized business questions capture how farmers perceive their risk response compared to other farmers

regarding production decisions, market and pricing decisions, financial decisions, and risk-facing farming in general.

Farmers, as rational decision-making agents, have a portfolio of choices over which they operate [5–8]. The wide range of choices they face and the complex economic and natural environment in which they function allows them a great number of choices and actions [9]. For this, it is important to study both on-farm risk and off-farm risk simultaneously. In the present study, we investigate a number of risk attitude elicitation methods and risk management strategies that can be employed by farmers, which are classified as on-farm economic sustainability strategies, on-farm environmental sustainability strategies, and off-farm economic sustainability strategies [10]. Following the methodology used by Meraner and Finger [11], we employ four agriculture-specific business statements (BS) as these reduce within- and across-method inconsistencies in risk preference elicitation [12] (in [11]). Furthermore, this paper contributes to the current state of the art by adding two indirect risk preference elicitation methods: smoking and seat belt use. This is important both from a methodological as well as from an empirical point of view, since data availability may permit indirect elicitation methods when direct elicitation methods are not readily available. Indirect elicitation of risk preferences has been employed to measure risk preferences [13–15] but it has not been compared to direct risk preference elicitation methods. Finally, a number of key risk sources, as pertaining to Greece and its present economic environment due to the ongoing financial and economic crisis, have been added to the sources of risk, adapting the questionnaire to a country still facing financial and economic uncertainty [16].

The aim of this paper is to determine factors affecting farmers' risk management decisions and to elicit their perceptions of risk and their choice of risk management strategies. For this, we estimate the potential correlations among risk management decisions and the possibility of simultaneous utilization of more than one risk management choice. Thus, we analyze the correlation between farmers' characteristics and risk management choices. Data were collected from a sample of Greek smallholder farmers from Northern Greece. Smallholder farming represents the majority of farmers in Greece as the average utilized agricultural area per farm holding is less than one hectare. The remainder of this paper is structured as follows. In the next section, the methodology is presented; this is followed by the results and discussion section and the conclusions section.

2. Methodology

Farmers' subjective risk perception was elicited across five risk categories—market risks, policy risks, production risks, macroeconomy risks, and other risks—using a five-point Likert-type scale from 1 (very unlikely for an event to occur) to 5 (very likely for an event to occur). Mean scores were calculated for each risk category and are reported in the summary statistics table (Table 1).

More specifically, market risks covered questions related to **farmers' perceptions** of changes in the prices of agricultural inputs, changes in the prices of agricultural outputs, changes in land prices, changes in livestock feed prices, and market competition. Policy risks included questions regarding further reductions in farm subsidies, increases in EU regulations, increases in regulations regarding livestock (animal welfare) and crops (environmental protection), policy changes in the EU related to market protection, further implementation of green policies, and reduced access to markets. Production risks questions were related to increases in yield variability due to climate change, yield loss due to extreme weather events, loss of livestock due to disease, increase in the resistance of pests to pesticides, and reduction in land availability. Macroeconomic risks covered questions related to reduced liquidity due to capital controls, reduction in financing availability, reduction in finance credit scoring, increases in interest rates, increases in taxes, and the departure of Greece from the Eurozone. Finally, other risks covered questions related to reduced availability of temporary/seasonal workers, problems regarding quality standards and their certifications, and accidents on the farm.

Risk preferences were elicited with four different methods. First, a self-assessment (SA) of risk preferences was evaluated. For consistency of results with the other risk preference elicitation methods employed, the self-assessment values were inverted so that higher values imply higher risk aversion.

Second, an assessment of 'relative risk attitude' based on four business statements was evaluated. The benefit of relative risk attitude assessments based on business statements are that they are simple to comprehend, fast to complete, and they permit contextualization directly relating to the main sources of risk in farming [11]. Third, farmers were asked to choose between income maximization and income stability. The question asked whether they preferred a higher but variable income to a lower but stable income [17,18]. This question highlights an important business decision, i.e., profit maximization versus risk aversion. Evidence suggests that farmers aren't necessarily profit maximisers but have other priorities [19]. Fourth, two questions were employed as indirect measurements of off-farm risk: the frequency with which they wore a seatbelt when travelling in an automobile and whether they were smokers. These questions were first employed by Hersch and Viscusi [13] as proxies to elicit risk preferences among workers of all industries. They have since been employed as proxies in other studies where risk is not directly observable [14,15]. The aim in the present study is to analyze their correlation with direct measures of risk preferences.

Finally, the survey included a list of fourteen risk management strategies adapted from Meraner and Finger [11]. These various risk management strategies are the ones most commonly applied in farming and cover a wide range of on-farm and off-farm activities. Since individuals can select a combination of risk management strategies in practice, we classified the fourteen risk management strategies into three distinct groups, as viewed from the prism of sustainability. First, 'on-farm economic sustainability', where resources are kept on the farm, focuses on increasing production and on-farm income. Second, 'on-farm environmental sustainability', where the resources are shifted towards risk management strategies on the farm, focuses on improving, adapting, or mitigating the environmental conditions. Third, 'off-farm economic sustainability', where the resources are shifted off-farm to activities other than farming, aims to increase farmers' off-farm income. The first category, 'on-farm economic sustainability', includes the following risk management strategies: agricultural adaptation (e.g., selection of cultivation timing), use of robust varieties and breeds, agricultural diversification (e.g., use of winter and summer cultivars), contractual farming, increasing stocks (liquidity), harder work/reducing private spending, and cooperation with other farmers. The second category, 'on-farm environmental sustainability', includes investment in technologies that adapt to climate change, agri-environmental diversification (e.g., direct sales, agritourism, and energy production, etc.), and use of protective equipment during pesticide applications. It should be noted that direct sales (or short supply chains) are considered here as environmentally friendly due to the short distance products travel between producer and consumer [20]. However, we should note that there is also evidence to the contrary [21]. Finally, the third category, 'off-farm economic sustainability', includes off farm labor, off-farm investments, additional farm insurance, and legal protection insurance. Farmers were then categorized by maximizing the mean over all choices in each risk management category.

The factors affecting farmers' risk management behavior were estimated using a multinomial probit regression [22], as the unobserved error term may not be independent [11]. We assumed that choices are affected by farmers' risk perceptions and preferences and by the socioeconomic characteristics of the farmer, their household, and the farm. Following Meraner and Finger [11], we estimated farmers' probability of choosing a risk management strategy out of three choices: on-farm economic sustainability, on-farm environmental sustainability, and off-farm economic sustainability strategies. More specifically, we estimated the following:

$$y_{ij}^{*} = \beta_{ij} x_j + \varepsilon_{ij},\ \varepsilon_{ij} \sim N(O, \Sigma)\ and\ j = (0, 1, 2) \quad (1)$$

In these equations, for farmer i, j = 1 if the farmer chooses mainly on-farm economic sustainability-related risk management strategies, j = 2 if the farmer chooses on average mainly on-farm environmental sustainability-related risk management strategies, and j = 0 if the farmer chooses on average mainly off-farm economic sustainability strategies to manage risk. Error terms were assumed to be multivariate normally distributed with a zero mean and the estimation was

repeated for each of the nine risk preference elicitation methods included in order to test which preference elicitation method represented farmers' risk management choice best.

Data were collected from smallholder farmers in Northern Greece during the spring of 2018. Smallholder farmers account for the vast majority of farms in Greece, as the average farm holding size is less than one hectare. Smallholder farmers may not have the portfolio of strategies available to farmers with larger holdings. The survey design followed that employed by Meraner and Finger [11,23] in a sample of German farmers, guaranteeing a pre-tested questionnaire with a user-friendly layout and easily understandable questions. The questionnaire was translated into Greek and a total of 82 questionnaires were collected. Questionnaires were administered by the authors to ensure answers were properly recorded. Summary statistics for the full sample are provided in Table 1 (summary statistics for the sub-samples are provided in Table A1 in Appendix A).

Table 1. Summary statistics. Legend: SA, self-assessment; BS, business statement.

		All Farmers *N* = 82		
Variable Name	**Variable Definition**	**Mean**	**SD**	**Mode**
Farmer characteristics				
Risk preferences	General risk preferences from 0 (= very unwilling to take risks) to 10 (= very willing to take risks)			
SA		5.54	2.78	5.00
BS	Willingness to take more risks than my colleagues with respect to . . .			
	Production	2.83	1.10	3.00
	Markets	2.83	1.10	3.00
	Macroeconomics/finance	3.09	1.28	3.00
	Farming in general	2.83	1.19	3.00
Average BS		2.89	1.03	3.00
RiskReturn	0 = prefer larger variable income, 1 = prefer smaller stable income	0.74	0.44	1.00
Age	Years	47.72	10.35	53.00
Gender	1 = female	0.07	0.26	0.00
Education	Years of formal education	13.15	2.59	12.00
Experience	Years of farming	21.05	11.27	13.00
Full time	= 1 full-time farmer	0.83	0.38	1.00
Optimism	Life satisfaction during past year from 1 (= not satisfied) to 10 (= very satisfied)	7.04	1.88	8.00
	Expected life satisfaction in the next year from 1 (= not satisfied) to 10 (= very satisfied)	7.16	1.92	8.00
Subjective numeracy	Mean subjective numeracy score	2.32	0.97	1.00
Smoking	1 = yes	0.54	0.50	1.00
Seat belt	Frequency of wearing seat belt in automobile (1 = never to 6 = always)	4.67	1.54	6.00
Risk perception	Perceived probability of occurrence			
	Market risk	3.17	0.65	3.40
	Political risk	3.33	0.57	3.625
	Production risk	3.30	0.73	3.40
	Macroeconomic risk	3.41	0.77	3.40
	Other risk	2.76	0.88	2.67
Experienced losses	Experienced losses during the past 5 years (= 1)	0.93	0.26	1.00
Household characteristics				
Workforce	Number of full workforce personnel	2.32	1.68	2.00
Farm succession	1 if succession is planned and sure, 0.5 if succession is planned and quite sure, 0 if succession is not planned in the next 15 years, –0.5 if succession is quite unsure, –1 if succession is unsure	0.12	0.76	0.50
Household size		3.70	1.29	4.00
Farm characteristics				
Further education	Participation in lectures, seminars, laboratories in a year	1.49	1.21	2.00
Agricultural area	in hectares	15.68	17.33	-
Proportion rented land		0.26	0.32	0.00
Organic cultivation	= 1 if cultivate fully or partially organic	0.83	0.38	1.00
Income	In thousand euros	23.09	29.04	15.00
Livestock	In cattle equivalent	12.40	35.15	0.00

Number of observations = 82. Where mode is (-) there is more than one value with the highest frequency.

3. Results and Discussion

The results of farmers' choice of risk management strategy include their subjective perception of risk and beliefs relating to the probability of risky outcomes occurring. We assume farmers are utility maximizers. Results suggest that farmers are on average risk averse. First, based on the self-assessment of risk preferences, farmers show a mode of 5 but a mean of 4.46, indicating relatively risk neutral to slightly risk-averse behavior. Second, based on the four business statements, most farmers identify a relatively risk-neutral behavior in all four relevant categories (mode = 3.00), in accordance with results by Meraner and Finger [11] in a sample of German farmers and by Meuwissen et al. [4] in a sample of Dutch farmers. Third, three quarters of farmers prefer a smaller stable income over a larger variable income, exhibiting clear risk aversion. This finding also raises important concerns regarding the use of profit maximization assumptions. Finally, regarding off farm activities, slightly less than half of the sample are smokers (46%) and most of the farmers (mode = 1.00) always wear a seat belt in an automobile, again exhibiting risk aversion.

We proceeded by first analyzing the consistency of the various risk elicitation methods. A Spearman correlation coefficient was estimated (Table 2). Results indicate a strong positive correlation for almost all risk preference elicitation methods, suggesting that all risk preference elicitation methods exhibit consistent estimation of farmers' risk preferences. This is true for the direct risk preference elicitation methods and is consistent with Meraner and Finger [11] but is also true for the indirect risk elicitation methods using proxies and is consistent with previous findings by Hersch and Viscusi [13], Hersch and Pickton [15], and Nastis et al. [14]. Thus, our findings suggest that both direct and indirect risk elicitation methods may be employed, adding credibility to the use of risk proxies when data are not readily available.

Table 2. Spearman correlation coefficients of elicitation methods.

N = 82	SA	Average BS	BS Production	BS Market	BS Economy	BS General	Max. versus Stability	Smoking	Seat belt
SA	1.000								
Average BS	0.385 ***	1.000							
BS production	0.396 ***	0.913 ***	1.000						
BS market	0.315 ***	0.865 ***	0.796 ***	1.000					
BS economy	0.326 ***	0.860 ***	0.659 ***	0.694 ***	1.000				
BS general	0.288 ***	0.864 ***	0.810 ***	0.628 ***	0.624 ***	1.000			
Max. versus stability	0.418 ***	0.077 ***	0.074 ***	0.084 ***	0.011	0.094	1.000		
Smoking	0.005	0.216 *	0.150	0.175	0.228 **	0.210 *	−0.083	1.000	
Seat belt	0.042	0.068	−0.066	0.016	0.167	0.084	0.066	0.307 ***	1.000

* Significant at the 10% level; ** significant at the 5% level; and *** significant at the 1% level. Results were obtained from the Stata 14 statistical package.

Next, we estimated separate multinomial probit models for each risk preference elicitation method. More specifically, the risk preference elicitation methods that were estimated independently were self-assessment, average BS, BS production, BS market, BS finance, BS general, income stability, smoking, and seatbelt use. The results showed that 26 farmers have on average mostly off-farm economic sustainability risk management strategies, 23 farmers have on average mostly on-farm economic sustainability risk management strategies and the greatest fraction, 33 farmers, have on average mostly on-farm environmental sustainability risk management strategies, confirming findings from Meraner and Finger [11]. It should be noted that for all multinomial probit models estimated, the hypothesis of identical probabilities for each category cannot be rejected (Tables 3 and A2).

Table 3. Multinomial probit estimates.

	Self-Assessment		Average BS		Income Stability	
***N* = 78**	**Off-Farm Economic Sustainability**	**On-Farm Economic Sustainability**	**Off-Farm Economic Sustainability**	**On-Farm Economic Sustainability**	**Off-Farm Economic Sustainability**	**On-Farm Economic Sustainability**
Risk aversion	0.070 (0.138)	−0.100 (0.121)	−0.948 (0.606)	−0.732 (0.350)	0.442 (1.066)	−0.791 (0.768)
Age	−0.073 (0.300)	0.139 (0.286)	−0.179 (0.312)	0.058 (0.292)	0.031 (0.312)	0.122 (0.290)
Age squared	0.001 (0.003)	−0.001 (0.003)	0.003 (0.004)	0.000 (0.003)	0.000 (0.004)	−0.001 (0.003)
Education	0.171 (0.159)	0.008 (0.128)	0.214 (0.177)	−0.03 (0.135)	0.229 (0.174)	−0.012 (0.136)
Optimism today	−0.031 (0.242)	0.152 (0.214)	−0.162 (0.281)	0.239 (0.207)	−0.012 (0.245)	0.248 (0.229)
Subjective numeracy	0.041 (0.459)	0.078 (0.347)	−0.163 (0.459)	−0.263 (0.394)	0.069 (0.456)	0.083 (0.346)
Extra training	0.101 (0.379)	−0.344 (0.285)	0.140 (0.416)	−0.246 (0.294)	0.016 (0.382)	−0.426 (0.322)
Market risk	−0.923 (0.615)	−0.104 (0.473)	−1.139 * (0.691)	0.085 (0.482)	−1.081 * (0.604)	−0.182 (0.482)
Political risk	0.172 (0.092)	0.036 (0.639)	0.127 (1.008)	0.106 (0.672)	0.239 (0.893)	−0.283 (0.679)
Production risk	1.084 (0.690)	0.775 (0.627)	1.246 (0.794)	0.667 (0.618)	1.319 * (0.712)	1.092 (0.686)
Macroeconomic risk	0.056 (0.634)	−1.017 ** (0.449)	0.188 (0.682)	−1.280 ** (0.509)	−0.100 (0.653)	−1.012 ** (0.479)
Other risk	−1.054 * (0.578)	−0.232 (0.393)	−0.973 * (0.572)	−0.020 (0.416)	−1.168 * (0.606)	−0.275 (0.395)
Workforce	0.729 *** (0.279)	−0.194 (0.209)	0.939 *** (0.325)	−0.094 (0.217)	0.756 *** (0.285)	−0.193 (0.217)
Farm succession	−1.030 ** (0.506)	−1.130 ** (0.495)	−1.366 ** (0.597)	−1.406 ** (0.559)	−1.263 ** (0.560)	−1.069 ** (0.492)
Household size	−0.574 (0.350)	−0.009 (0.228)	−0.752 ** (0.381)	−0.082 (0.236)	−0.617 * (0.354)	0.013 (0.238)
Agricultural area	0.069 ** (0.033)	−0.009 (0.024)	0.077 ** (0.038)	−0.012 (0.025)	0.085 ** (0.039)	−0.008 (0.025)
Proportion of rented land	−11.552 *** (4.395)	0.355 (1.189)	−14.496 *** (5.403)	−0.017 (1.264)	−13.319 *** (5.034)	0.076 (1.246)
Wald $Chi^2(34)$	24.29		23.31		23.85	
Log likelihood	−53.104294		−50.415626		−51.870825	
Prob > chi^2	0.8905		0.9165		0.9027	

* Significant at the 10% level; ** significant at the 5% level; and *** significant at the 1% level. Results were obtained from the Stata 14 statistical package.

More specifically, the results confirm that greater risk aversion increases the probability that farmers choose on-farm economic sustainability strategies when risk preferences are measured using self-assessment, the average over all BSs, BS production, BS market, BS finance, and BS general, confirming Meraner and Finger [11]. Furthermore, greater risk aversion increases the probability that farmers choose on-farm environmental sustainability strategies compared to choosing off-farm economic sustainability strategies when risk preferences are measured using the average over all BSs, BS production, BS finance, BS general, smoking, and seatbelt use, as has also been previously found [14,15].

We found that farmers that indicate a better farm succession plan are much more likely to select on-farm environmental sustainability strategies compared to on-farm economic sustainability strategies and off-farm economic sustainability strategies for all model specifications. This result highlights an important element of sustainability, namely, the existence of a farm succession plan, and displays clearly that the need for environmental sustainability becomes stronger when a farm succession plan is in place. More specifically, results indicate that older farmers are more likely to choose on-farm environmental sustainability strategies in seven of the nine models. Furthermore, farmers with more education are more likely to choose on-farm environmental sustainability strategies compared to on-farm economic sustainability strategies in seven of the nine models estimated.

Optimism also increases the probability that farmers will select on-farm environmental sustainability strategies compared to off-farm economic sustainability strategies in all model specifications. Moreover, higher perceptions of market risk, macroeconomic risk, or other risk will increase the probability that farmers will select on-farm environmental sustainability strategies in most model specifications.

Furthermore, the results of the analysis suggest that farmers have a preference for on-farm environmental sustainability strategies over other on-farm and off-farm economic sustainability strategies the older and more educated they are, the larger the farm size, and the clearer the farm succession plan is. This is not the case for smaller farms, where farmers have a clear preference for off-farm economic sustainability strategies. These results suggest that farmers have a clear understanding of their situation as smallholder farmers in an uncertain economic environment but are nevertheless willing to take the necessary risk when the conditions are right, as found by Meraner and Finger [11]. This result is also connected with the final finding, that an increase in the proportion of rented land increases the probability of selecting off-farm economic sustainability strategies compared to other strategies. This result suggests that for Greek farms, increasing rented land is not a long-term solution to increasing on-farm sustainability.

4. Conclusions

This paper has assessed farmers' behavior and attitudes towards implementing sustainable farm practices as a first and key step of achieving sustainability within the agri-food value chain. Farmers have a portfolio of choices over which they operate that allows them to mitigate risk. These choices involve both on-farm and off-farm managerial actions, mostly related to improving the economic sustainability of the farm and agricultural household or the environmental sustainability of the farm. Actions related to improving the environmental sustainability of the farm can be considered long-term, as their benefits are accrued in the longer term.

The analysis firmly concludes that farmers are risk averse, as has been previously found in the literature. Furthermore, the fact that they prefer a smaller, more stable income over a higher, more variable income raises important questions regarding the use of profit maximization assumptions in modelling farm and farmers' behavior [19,24].

Furthermore, it is evident from the analysis that farmers select a portfolio of actions to mitigate risk on all fronts. Even when there is a clearly preferred mix of risk management strategies, all strategies are still employed, but to various degrees. Therefore, a portfolio of risk management strategies should be the course of action and the recommendation towards risk management, following a holistic risk

management approach to on-farm and off-farm actions. Finally, clearly farmers do not separate on-farm and off-farm activities but rather combine them in the mix that is optimal for their farm characteristics.

This highlights the multiactor role of the farmer, who has to balance short-term and long-term decisions both on-farm and off-farm. Farming decisions are not singular decisions but encapsulate the multifaceted nature of modern agricultural practice, where choices are complex. Sustainability of farming is affected in the long-run by on-farm environmental sustainability strategies but in the short term by on-farm economic sustainability strategies. Furthermore, when particular conditions are in place, farmers will diversify towards off-farm economic sustainability strategies. Thus, both in modelling farmers' decision-making processes and in educating farmers, the multifaceted nature of farming has to be taken into account. This is key in ensuring that the agri-food chain is sustainable.

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Appendix A

Table A1. Summary statistics.

		All Farmers $N = 82$			Off-Farm Economic $N = 26$			On-Farm Economic $N = 23$			On-Farm Environmental $N = 33$		
Variable Name	**Variable definition**	**Mean**	**SD**	**Mode**	**Mean**	**SD**	**Mode**	**Mean**	**SD**	**Mode**	**Mean**	**SD**	**Mode**
Farmer characteristics													
Risk preferences													
SA		5.54	2.78	5.00	5.81	2.53	5.00	5.36	3.12	5.00	5.54	2.78	4.00
BS	Willingness to take more risks than my colleagues with respect to . . .												
	Production	2.83	1.10	3.00	2.81	1.17	3.00	2.94	1.12	3.00	2.83	1.10	3.00
	Markets	2.83	1.10	3.00	2.85	1.05	3.00	2.91	1.13	3.00	2.83	1.10	2.00
	Macroeconomics/finance	3.09	1.28	3.00	2.92	1.20	3.00	3.24	1.32	3.00	3.09	1.28	2.00
	Farming in general	2.83	1.19	3.00	2.85	1.26	4.00	3.00	1.30	3.00	2.83	1.19	3.00
Average BS		2.89	1.03	3.00	2.86	1.02	2.75	3.02	1.11	3.00	2.89	1.03	3.00
RiskReturn	0 = prefer larger variable income, 1 = prefer smaller stable income	0.74	0.44	1.00	0.69	0.47	1.00	0.82	0.39	1.00	0.74	0.44	1.00
Age	Years	47.72	10.35	53.00	46.73	11.11	49.00	46.82	10.06	53.00	47.72	10.35	52.00
Gender	1 = female	0.07	0.26	0.00	0.08	0.27	0.00	0.06	0.24	0.00	0.07	0.26	0.00
Education	Years of formal education	13.15	2.59	12.00	13.46	2.79	16.00	13.06	2.52	12.00	13.15	2.59	12.00
Experience	Years of farming	21.05	11.27	13.00	18.12	10.67	13.00	22.64	11.06	16.00	21.05	11.27	17.00
Full time	= 1 full-time farmer	0.83	0.38	1.00	0.96	0.20	1.00	0.82	0.39	1.00	0.83	0.38	1.00
Optimism	Life satisfaction during past year	7.04	1.88	8.00	7.35	1.62	8.00	7.12	1.88	8.00	7.04	1.88	7.00
	Expected life satisfaction in the next year	7.16	1.92	8.00	7.62	1.83	9.00	6.94	2.05	8.00	7.16	1.92	7.00
Subjective numeracy	Mean subjective numeracy score	2.32	0.97	1.00	2.20	1.17	1.00	2.30	0.84	1.71	2.32	0.97	1.85
Smoking	1 = yes	0.54	0.50	1.00	0.50	0.51	0.00	0.48	0.51	0.00	0.46	0.50	0.00
Seat belt	Frequency of wearing seat belt in automobile (1 = never to 6 = always)	4.67	1.54	6.00	4.81	1.65	6.00	4.39	1.71	6.00	4.67	1.54	6.00
Risk perception	Perceived probability of occurrence												
	Market risk	3.17	0.65	3.40	2.95	0.56	3.00	3.24	0.65	3.40	3.17	0.65	3.80
	Political risk	3.33	0.57	3.625	3.35	0.54	3.625	3.30	0.65	3.875	3.33	0.57	3.375
	Production risk	3.30	0.73	3.40	3.19	0.62	3.40	3.27	0.76	4.00	3.30	0.73	4.20
	Macroeconomic risk	3.41	0.77	3.40	3.53	0.59	3.20	3.47	0.95	3.00	3.41	0.77	3.40
	Other risk	2.76	0.88	2.67	2.62	0.74	2.67	2.83	0.92	3.00	2.76	0.88	2.67
Experienced losses	Experienced losses during the past 5 years (= 1)	0.93	0.26	1.00	0.92	0.27	1.00	0.91	0.29	1.00	0.93	0.26	1.00

Table A1. *Cont.*

		All Farmers *N* = 82			Off-Farm Economic *N* = 26			On-Farm Economic *N* = 23			On-Farm Environmental *N* = 33		
Variable Name	**Variable definition**	**Mean**	**SD**	**Mode**	**Mean**	**SD**	**Mode**	**Mean**	**SD**	**Mode**	**Mean**	**SD**	**Mode**
Household characteristics													
Workforce	Number of full workforce personnel	2.32	1.68	2.00	3.12	1.97	3.00	1.97	1.53	2.00	2.32	1.68	2.00
Farm succession	1 if succession is planned and sure, 0.5 if succession is planned and quite sure, 0 if succession is not planned in the next 15 years, –0.5 if succession is quite unsure, –1 if succession is unsure	0.12	0.76	0.50	0.25	0.76	1.00	0.26	0.73	0.50	0.12	0.76	1.00
Household size		3.70	1.29	4.00	3.73	0.87	4.00	3.70	1.42	4.00	3.70	1.29	4.00
Farm characteristics													
Further education	Participation in lectures, seminars, laboratories in a year	1.49	1.21	2.00	1.50	1.07	2.00	1.61	1.37	0.00	1.49	1.21	2.00
Agricultural area	In hectares	15.68	17.33	-	14.13	13.23	-	18.30	21.32	-	15.70	17.34	-
Proportion rented land		0.26	0.32	0.00	0.04	0.20	0.00	0.30	0.31	0.00	0.26	0.32	0.00
Organic cultivation	= 1 if cultivate fully or partially organic	0.83	0.38	1.00	0.92	0.27	1.00	0.85	0.36	1.00	0.83	0.38	1.00
Income	In euros	23092.59	29041.04	15000.00	25120.00	16874.09	50000.00	20757.58	13338.81	15000.00	23092.59	29041.04	15000.00
Livestock	In cattle equivalent	12.40	35.15	0.00	0.00	0.00	0.00	16.55	43.37	0.00	12.40	35.15	0.00

Number of observations = 82. Where mode is (-) there is more than one value with the highest frequency.

Table A2. Multinomial probit estimates.

	Self-Assessment		Average BS		BS Production		BS Market		BS Finance		BS General		Income Stability		Smoking		Seat belt	
N = 78	Off-Farm Economic Sustainability	On-Farm Economic Sustainability	Off-Farm Economic Sustainability	On-Farm Economic Sustainability	Off-Farm Economic Sustainability	On-Farm Economic Sustainability	Off-Farm Economic Sustainability	On-Farm Economic Sustainability	Off-Farm Economic Sustainability	On-Farm Economic Sustainability	Off-Farm Economic Sustainability	On-Farm Economic Sustainability	Off-Farm Economic Sustainability	On-Farm Economic Sustainability	Off-Farm Economic Sustainability	On-farm Economic Sustainability	Off-Farm Economic Sustainability	On-Farm Economic Sustainability
Risk aversion	0.070 (0.138)	−0.100 (0.121)	−0.948 (0.606)	−0.732 (0.350)	−0.311 (0.467)	−0.548 * (0.301)	0.104 (0.437)	−0.587 * (0.317)	−1.609 ** (0.673)	−0.483 * (0.274)	−0.538 (0.359)	−0.640 ** (0.311)	0.442 (1.066)	−0.791 (0.768)	−1.400 (0.932)	0.733 (0.614)	−0.067 (0.253)	0.452 * (0.248)
Age	−0.073(0.300)	0.139 (0.286)	−0.179 (0.312)	0.058 (0.292)	−0.093 (0.305)	0.099 (0.289)	−0.050 (0.301)	0.102 (0.293)	−0.260 (0.331)	−0.003 (0.288)	−0.170 (0.308)	0.016 (0.295)	0.031 (0.312)	0.122 (0.290)	−0.472 (0.383)	0.084 (0.282)	−0.051 (0.309)	−0.014 (0.289)
Age squared	0.001 (0.003)	−0.001 (0.003)	0.003 (0.004)	0.000 (0.003)	0.001 (0.003)	−0.001 (0.003)	0.001 (0.003)	−0.001 (0.003)	0.003 (0.004)	0.000 (0.003)	0.002 (0.004)	0.000 (0.003)	0.000 (0.004)	−0.001 (0.003)	0.006 (0.004)	−0.001 (0.003)	0.001 (0.004)	0.000 (0.003)
Education	0.171 (0.159)	0.008 (0.128)	0.214 (0.177)	−0.03 (0.135)	0.173 (0.164)	−0.020 (0.134)	0.163 (0.163)	−0.017 (0.133)	0.325 (0.201)	−0.017 (0.135)	0.171 (0.166)	−0.033 (0.133)	0.229 (0.174)	−0.012 (0.136)	0.098 (0.171)	0.029 (0.128)	0.159 (0.162)	−0.033 (0.137)
Optimism today	−0.031 (0.242)	0.152 (0.214)	−0.162 (0.281)	0.239 (0.207)	−0.087 (0.236)	0.197 (0.203)	−0.057 (0.217)	0.220 (0.209)	−0.392 (0.348)	0.268 (0.210)	−0.098 (0.245)	0.227 (0.202)	−0.012 (0.245)	0.248 (0.229)	−0.158 (0.287)	0.218 (0.210)	−0.154 (0.250)	0.257 (0.203)
Subjective numeracy	0.041 (0.459)	0.078 (0.347)	−0.163 (0.459)	−0.263 (0.394)	−0.043 (0.450)	−0.204 (0.386)	0.044 (0.461)	−0.202 (0.391)	−0.310 (0.540)	−0.248 (0.398)	−0.086 (0.445)	−0.203 (0.381)	0.069 (0.456)	0.083 (0.346)	−0.113 (0.546)	0.190 (0.381)	−0.006 (0.455)	0.027 (0.366)
Extra training	0.101 (0.379)	−0.344 (0.285)	0.140 (0.416)	−0.246 (0.294)	0.063 (0396)	−0.350 (0.287)	0.119 (0.387)	−0.227 (0.298)	0.367 (0.507)	−0.271 (0.294)	0.183 (0.404)	−0.230 (0.297)	0.016 (0.382)	−0.426 (0.322)	0.854 (0.622)	−0.366 (0.290)	0.176 (0.459)	−0.551 * (0.309)
Market risk	−0.923 (0.615)	−0.104 (0.473)	−1.139 * (0.691)	0.085 (0.482)	−0.962 (0.608)	0.095 (0.474)	−0.972 * (0.580)	0.108 (0.493)	−1.936 ** (0.867)	−0.060 (0.485)	−0.901 (0.625)	0.149 (0.486)	−1.081 * (0.604)	−0.182 (0.482)	−0.798 (0.693)	−0.079 (0.465)	−1.076 (0.617)	−0.145 (0.476)
Political risk	0.172 (0.092)	0.036 (0.639)	0.127 (1.008)	0.106 (0.672)	0.113 (0.938)	0.009 (0.656)	0.309 (0.875)	0.041 (0.658)	1.047 (1.264)	0.366 (0.697)	0.066 (0.941)	0.005 (0.648)	0.239 (0.893)	−0.283 (0.679)	0.430 (1.070)	0.373 (0.658)	0.348 (0.915)	0.048 (0.646)
Production risk	1.084 (0.690)	0.775 (0.627)	1.246 (0.794)	0.667 (0.618)	1.157 (0.719)	0.667 (0.605)	1.212 * (0.688)	0.937 (0.652)	2.048 ** (0.963)	0.590 (0.597)	1.012 (0.745)	0.472 (0.610)	1.319 * (0.712)	1.092 (0.686)	1.257 (0.790)	0.683 (0.596)	1.282 * (0.728)	0.573 (0.609)
Macroeconomic risk	0.056 (0.634)	−1.017 ** (0.449)	0.188 (0.682)	−1.280 ** (0.509)	0.060 (0.640)	−1.206 ** (0.486)	−0.063 (0.619)	−1.271 ** (0.514)	0.221 (0.738)	−1.216 ** (0.507)	0.090 (0.625)	−1.234 *** (0.481)	−0.100 (0.653)	−1.012 ** (0.479)	0.379 (0.748)	−1.111 ** (0.459)	0.033 (0.643)	−1.050 ** (0.454)
Other risk	−1.054 * (0.578)	−0.232 (0.393)	−0.973 * (0.572)	−0.020 (0.416)	−1.031 * (0.565)	−0.077 (0.410)	−1.116 * (0.595)	−0.202 (0.414)	−1.304 ** (0.654)	−0.059 (0.411)	−0.861 (0.581)	0.084 (0.426)	−1.168 * (0.606)	−0.275 (0.395)	−1.309 ** (0.666)	−0.269 (0.403)	−1.066 * (0.577)	−0.241 (0.403)
Workforce	0.729 *** (0.279)	−0.194 (0.209)	0.939 *** (0.325)	−0.094 (0.217)	0.770 *** (0.285)	−0.148 (0.209)	0.734 *** (0.274)	−0.169 (0.212)	1.199 *** (0.409)	−0.084 (0.216)	0.844 *** (0.283)	−0.090 (0.216)	0.756 *** (0.285)	−0.193 (0.217)	0.892 *** (0.346)	−0.228 (0.214)	0.741 ** (0.280)	−0.287 (0.222)
Farm succession	−1.030 ** (0.506)	−1.130 ** (0.495)	−1.366 ** (0.597)	−1.406 ** (0.559)	−1.120 ** (0.537)	−1.239 ** (0.525)	−1.144 ** (0.535)	−1.356 ** (0.551)	−2.255 *** (0.848)	−1.411 ** (0.558)	−1.224 ** (0.553)	−1.303 ** (0.529)	−1.263 ** (0.560)	−1.069 ** (0.492)	−1.242 ** (0.583)	−1.107 ** (0.488)	−1.024 ** (0.514)	−1.017 ** (0.491)
Household size	−0.574 (0.350)	−0.009 (0.228)	−0.752 ** (0.381)	−0.082 (0.236)	−0.633 * (0.359)	−0.054 (0.233)	−0.625 * (0.356)	−0.027 (0.236)	−1.056 ** (0.466)	−0.081 (0.235)	−0.686 * (0.356)	−0.097 (0.243)	−0.617 * (0.354)	0.013 (0.238)	−0.731 * (0.398)	−0.050 (0.235)	−0.576 * (0.342)	−0.078 (0.239)
Agricultural area	0.069 ** (0.033)	−0.009 (0.024)	0.077 ** (0.038)	−0.012 (0.025)	0.073 ** (0.035)	−0.011 (0.025)	0.076 ** (0.034)	−0.016 (0.025)	0.130 ** (0.059)	−0.011 (0.025)	0.066 * (0.034)	−0.010 (0.024)	0.085 ** (0.039)	−0.008 (0.025)	0.045 (0.035)	−0.006 (0.024)	0.066 ** (0.033)	−0.014 (0.025)
Proportion of rented land	−11.552 *** (4.395)	0.355 (1.189)	−14.496 *** (5.403)	−0.017 (1.264)	−12.429 *** (4.727)	0.332 (1.234)	−12.002 *** (4.436)	0.275 (1.261)	−21.556 ** (8.674)	−0.064 (1.275)	−12.773 *** (4.552)	−0.326 (1.260)	−13.319 *** (5.034)	0.076 (1.246)	−12.375 *** (4.639)	0.318 (1.191)	−11.174 ** (4.375)	0.384 (1.193)
Constant	0.502 (8.335)	−2.398 (6.517)	5.840 (8.943)	1.217 (6.974)	2.649 (8.759)	0.114 (6.781)	0.678 (8.331)	−0.581 (6.771)	8.310 (9.434)	1.484 (6.981)	4.834 (8.649)	2.191 (7.104)	−2.061 (8.844)	−1.745 (6.897)	8.572 (10.025)	−3.410 (6.650)	1.123 (8.411)	−0.016 (6.786)
Wald $Chi^2(34)$	24.29		23.31		24.24		24.74		22.43		25.9		23.85		25.25		26.25	
Log likelihood	−53.104294		−50.415626		−51.833421		−51.561073		−47.941663		−50.894952		−51.870825		−49.76667		−51.538485	
Prob > chi^2	0.8905		0.9165		0.892		0.8773		0.9358		0.8389		0.9027		0.8614		0.8265	

* Significant at the 10% level; ** significant at the 5% level; and *** significant at the 1% level. Results were obtained from the Stata 14 statistical package.

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