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NOTE

A note on European farmers' preferences under cumulative prospect theory

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Abstract

Explaining farmer decision making using cumulative prospect theory is of increasing importance. We present a systematic review on European farmers' preferences under the cumulative prospect theory framework. We identified 17 studies covering 2324 farmers from 12 European countries. All studies report that (on average) farmers are: (i) risk averse, (ii) loss averse, and (iii) overweight small probabilities and underweight large probabilities. However, there is a large heterogeneity across and within studies. These findings have implications for the analysis and design of policy and insurance.

KEYWORDS

farmer, preferences, prospect theory, risk & uncertainty, risk management

1 | INTRODUCTION

Risk and risk preferences are of key relevance for farmers' decision making regarding, for example, investments, input use and risk management (e.g., Chavas, 2004). Estimating farmers' risk preferences is thus a key question in agricultural economics and relies on a wide range of elicitation methods (e.g., Iyer et al., 2020).[1] While the majority of the empirical literature on farmer risk preference elicitation relies on the expected utility theory framework, an increasing emphasis is put on preferences in the framework of cumulative prospect theory (e.g., Rommel et al., 2023). Cumulative prospect theory is characterised by reference dependence, an asymmetry of behaviour towards risks of gains versus losses, and subjective weighting of small

[1]For example, risk preferences can be elicited using self-reported scales or lotteries, or can be inferred from observed economic behaviour.

versus large probabilities (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). Farmer preferences under cumulative prospect theory are of increasing relevance for industry and policy (e.g., Dalhaus et al., 2020), in particular because they can better explain farmers' input use, investments, climate change adaptation and crop insurance solutions decisions (e.g., Babcock, 2015; Liu & Huang, 2013; Villacis et al., 2021, 2023). Cumulative prospect theory is also increasingly used in simulation models for policy analysis (e.g., Huber et al., 2022). However, we currently lack coherent syntheses of farmers' preferences under cumulative prospect theory.

We contribute to filling this gap while providing a review and synthesis of all up-to-date empirical evidence for European farmers. We focus on Europe, as farmers are subject to similar policy and institutional environments and aligned goals of their agricultural policies, such as under the Common Agricultural Policy.

Our analysis extends and deepens earlier work by Iyer et al. (2020), who provided a review of studies (published until 2017) on risk preferences of European farmers and provided evidence on risk preferences for a wide range of theoretical frameworks and elicitation methods. The paper by Iyer et al. (2020) also included two studies of cumulative prospect theory preferences. However, many additional studies have been published since 2017. More specifically, 15 out of the 17 studies included in our paper have been published after 2017. We thus extend the existing evidence base while also providing in-depth insight into the conceptual and methodological background related to the elicitation of farmers' preferences under cumulative prospect theory.[2]

2 | BACKGROUND AND METHODOLOGY

Preferences under cumulative prospect theory are usually captured with three parameters: (1) α is the curvature of the utility function and is an anti-index of risk aversion, where values of $\alpha < 1$ indicate risk aversion in the gain domain (i.e., where no money can be lost);[3] (2) λ is an index of loss aversion, where values of $\lambda > 1$ imply that the utility function is steeper in the loss domain (loss aversion, i.e., where money can be lost relative to the reference point); and (3) γ is an anti-index of probability distortion, capturing the overweighting of small probabilities and the underweighting of large probabilities by values of $\gamma < 1$. See Appendix S1, Section A, for an extended theoretical framework.

To elicit preferences under cumulative prospect theory, researchers use experiments with (usually incentivised) gambles in multiple price lists. We here focus on studies using the most widely used method to elicit the preferences developed by Tanaka et al. (2010).[4] This approach comprises three multiple price lists with gambles to elicit the three parameters of risk preferences described above (see Appendix S1, Section B for an in-depth description and discussion). Focusing on papers from this specific elicitation method allows us to compare the parameters across studies.

To identify relevant studies, we conducted a systematic search following Moher et al. (2015). We used three predefined inclusion criteria: (i) the study elicits risk preferences under the framework of cumulative prospect theory based on the Tanaka et al. (2010) approach, (ii) population of interest are farmers in European countries, (iii) the study is

[2]See also Brown et al. (2023) for a synthesis of loss aversion estimates across all spatial scales and fields of applications.

[3]Reflection at the reference point, as common in the here reviewed studies, implies convexity in losses, i.e., risk-seeking behaviour in loss domains. See Appendix S1, Section A, for further details.

[4]For alternative approaches see, e.g., Bauermeister et al. (2018).

written in English. We considered peer-reviewed and non-peer-reviewed literature published until 31 August 2023.[5] The PRISMA flow diagram of this process and the detailed search terms are in Appendix S1, Section C. After full screening, we identified seven relevant papers[6] that contain in total 17 studies—a paper can comprise multiple experiments in different countries (studies). Note that one paper (Rommel et al., 2023) included studies by 11 different research teams, by replicating Bocquého et al. (2014) in various European countries (see Table 1). From the 17 studies, we extracted parameters under cumulative prospect theory and various additional information from the studies. See Appendix S1, Section C, for full details.

3 | RESULTS

Table 1 summarises the key results from the 17 studies, reflecting 12 countries and in total 2324 farmers. We find that all studies report that (on average) farmers are risk averse in the gain domain, that is, $\alpha < 1$. Moreover, all studies report that (on average) farmers are loss averse, that is, $\lambda > 1$, so that the utility function is steeper in the loss than in the gain domain. Finally, all studies report that farmers (on average) overweight small probabilities and underweight large probabilities, that is, $\gamma < 1$.[7]

However, there is a large range of coefficients across studies. Specifically, α ranges from 0.28 to 0.68 (mean weighted by studies' sample size 0.40), λ ranges from 1.19 to 2.64 (weighted mean 1.84), γ from 0.49 to 0.84 (weighted mean 0.61) (Table 1). There is also a considerable uncertainty associated with the coefficients estimated within the individual studies (see Appendix S1, Section D).

We find a Pearson correlation (weighted by studies' sample size) of +0.41 between α and λ, that is, studies reporting higher risk aversion report lower loss aversion. The correlation between α and γ is 0.70, indicating that, studies reporting higher risk aversion also report higher probability distortion. We find no clear relation (correlation of −0.10) between λ and γ, that is, between loss aversion and probability distortion.

Figure 1 visualises the relationship between the curvature of the utility function (α), loss aversion (λ) and probability distortion (γ) across all studies. Note that the size of the point reflects the probability distortion (γ), that is, a larger γ is reflected by a larger point. The figure reveals the large heterogeneity across studies. It also reveals that the studies of Bocquého et al. (2014) and the 11 studies reported by Rommel et al. (2023) (who replicate Bocquého et al., 2014) are very close to each other. This shows that, even though all studies presented in Figure 1 use the Tanaka et al. (2010) approach, differences in the execution, sampling and analysis related to this elicitation approach are relevant (see Appendix S1 for details and discussions).

4 | DISCUSSION AND CONCLUSION

We find that European farmers are (on average): (i) risk averse, (ii) loss averse, and (iii) overweight small probabilities and underweight large probabilities. The identified parameters

[5]We consider the databases Scopus and Web of Science (for peer-reviewed) as well as Ideas/RePEC (for non-peer-reviewed) studies (see Appendix S1, Section C).

[6]Other papers that focus on European farmers but were excluded as they did not report comparable parameters are Coelho et al. (2012), Villanueva and Gómez-Limón (2023), Bougherara et al. (2021), Ocean and Howley (2021), as well as Čop et al. (2023).

[7]Note that the structural estimate of Bonjean (2023) has a parameter greater than one; here we use the estimate obtained from the mid-point method.

TABLE 1 Overview of the identified studies and farmer preferences under cumulative prospect theory.

Study	Country	α Coefficient (curvature of the utility function)	λ Coefficient (loss aversion)	γ Coefficient (probability distortion)	Sample size	Notes
Bocquého et al. (2014)	France	0.28	2.28	0.66	107	
Bonjean (2023)	Belgium	0.61	2.64	0.68	136	
Bougherara et al. (2017)	France	0.61	1.37	0.79 in gains; 0.84 in losses (difference is statistically significant)	197	
Duden et al. (2023)	Germany	0.45	n/a	0.54	237	Duden et al. (2023) do not estimate a parameter for 'loss aversion' because they only consider monetary losses in their experiment
Kreft et al. (2021)	Switzerland	0.62	4.35	0.58	105	Parameters are reported in Kreft et al. (2021), referring to the data paper Kreft et al. (2020)
Rommel et al. (2023): Study 1	Austria	0.32	1.53	0.64	128	Rommel et al. (2023) report 11 different Studies, replicating Bocquého et al. (2014)
Rommel et al. (2023): Study 2	Croatia	0.33	1.82	0.60	104	
Rommel et al. (2023): Study 3	France I	0.29	1.70	0.56	96	
Rommel et al. (2023): Study 4	France II	0.28	1.75	0.56	28	
Rommel et al. (2023): Study 5	Germany	0.33	1.57	0.57	153	
Rommel et al. (2023): Study 6	Italy	0.30	1.46	0.55	130	
Rommel et al. (2023): Study 7	The Netherlands	0.31	1.19	0.63	160	

TABLE 1 (Continued)

Study	Country	α Coefficient (curvature of the utility function)	λ Coefficient (loss aversion)	γ Coefficient (probability distortion)	Sample size	Notes
Rommel et al. (2023): Study 8	Poland	0.30	1.81	0.59	169	
Rommel et al. (2023): Study 9	Slovenia	0.32	1.85	0.56	114	
Rommel et al. (2023): Study 10	Spain	0.28	2.16	0.49	130	
Rommel et al. (2023): Study 11	Sweden	0.33	1.35	0.55	218	
Vollmer et al. (2019)	Germany	0.68	1.88	0.71	112	
Average (unweighted)	n.a.	0.39	1.92	0.61	137	
Average (weighted by sample size)	n.a.	0.40	1.84	0.61	n.a.	

Note: See Appendix S1, Section D, for further details on parameters and studies.

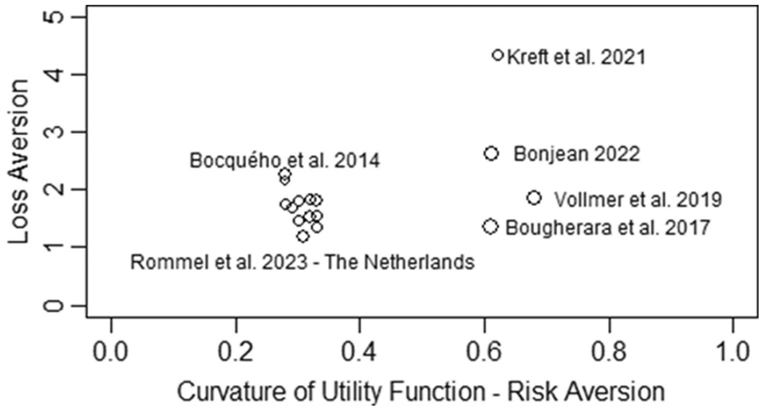

FIGURE 1 Summary of three cumulative prospect theory parameters of European farmers. Size of the point reflects the probability distortion (γ), that is, a larger γ is reflected by a larger point. Duden et al. (2023) is not plotted as they provide no estimate for loss aversion. For Bougherara et al. (2017) we use the average value for γ (cf. Table 1) in the figure. Only selected observations are labelled, for sake of clarity; see Table 1 for full details.

for European farmers give important insights and implications for policy and industry. For example, insurance products could be tailored towards farmers' preferences under cumulative prospect theory, for instance by having multi-year contracts and only paying premiums in years of no crop losses (Dalhaus et al., 2020). Also, policy design may be adjusted accordingly, for example by exploiting the finding of loss aversion, which implies that farmers are more sensitive to potential penalties rather than bonuses (Huijps et al., 2010). Moreover, Kreft et al. (2023) show that accounting for farmers' preferences under cumulative prospect theory can imply differences in farmers' responses to climate change mitigation policies. The quantification of risk aversion, loss aversion and probability distortion provided in our paper allows numerical consideration in future policy analysis, such as in modelling (Huber et al., 2022).

Despite clear overall patterns emerging from our analysis, we also find considerable heterogeneity and uncertainty within and across studies. This is potentially driven by differences in cultural backgrounds, institutional and environmental factors. Some of this could be due to differences in the sampling and execution of the experiments (e.g., regarding framing, recruitment and incentivisation) as well as analysis of the collected data (e.g., regarding specification of probability weighting function and estimation approach) (see Appendix S1 for details). To increase comparability and identify differences across farm and farmer types, cultures and countries, replication studies could be expanded in future work. Furthermore, there are several cautionary aspects regarding the elicitation of preferences under cumulative prospect theory that need further attention, especially with respect to reference points, incentivisation of participants, the use of Bayesian methods with priors and the potential elicitation of additional parameters, for example in differentiating risk and probability weighting parameters in the loss and gain domains further (Bougherara et al., 2017; Frydman & Jin, 2022; Gao et al., 2023; Lampe & Würtenberger, 2020). Along these lines, the instability of parameters under cumulative prospect theory could be explored, including whether the differences are a response to shocks (Finger et al., 2023). Finally, more refined methods to elicit risk preferences under cumulative prospect theory shall be exploited to complement the widely used Tanaka et al. (2010) approach. Alternative approaches may offer opportunities in execution and stability, but remain to be complex and correlated with cognitive ability (e.g., Chapman et al., 2018; Oprea, 2022).

DATA AVAILABILITY STATEMENT

The data is attached to the article

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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